

AN EXPLORATORY STUDY OF THE RELATIONSHIP BETWEEN IN-TRAINING
EXAMINATION PERCENTILES OF ANESTHESIOLOGY RESIDENTS AND THE
VERMUNT INVENTORY OF LEARNING STYLES

by

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B.S., Iowa State University, 1966

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AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

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Department of Educational Leadership

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Abstract

This study explored the relationship between anesthesiology residents' In Training Examination (ITE) percentile ranks and learning styles and domains with the variables of gender, ethnicity, and postgraduate year (PGY). The ITE is a national examination given annually as a measure of cognitive achievement. The learning style instrument was the adapted Vermont Inventory of Learning Styles (ILS), a diagnostic learning style instrument designed for use with university-level students. The study included 112 anesthesiology residents in anesthesiology graduate medical education (GME) at four universities (five sites) during the 2006-2007 PGY. Responses to the surveys were analyzed using descriptive statistics, the Pearson product-moment correlations, and stepwise and backward elimination regression analysis.

The results indicated that the residents' ITE percentile ranks had a bimodal curve. The ILS has 20 scales representing four learning domains factored into four learning styles. The relationships of the learning styles with the ITE percentile ranks were significant for two learning styles: positive for the meaning directed learning style (MDLS) and negative for the undirected learning style (UDLS). Analysis of the scales comprising the MDLS (seven) and UDLS (five) revealed significant relationships for 6 of the 12 scales for the anesthesiology residents (five positive, one negative).

An analysis of the domain scale relationships for the other eight scales identified an additional two scales positively related to ITE percentile ranks: vocation oriented and analyzing. The significant scales positively identified with ITE percentile ranks included relating and structuring, concrete processing, two self-regulation scales, construction of knowledge, analyzing and vocation oriented. The only scale significant with ITE percentile ranks was ambivalent, which was negative. The potential exists that the UDLS can identify, in part, residents at risk academically. The positive relationship of the meaning directed learning style and the two significant, positive scales (analyzing and vocation oriented) with ITE percentile ranks offered an indication of learning styles and strategies of residents with higher cognitive achievement outcomes. These learning strategies have the potential to help residents learn how to learn more effectively.

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Dedication

. . . .To my three earthly fathers: Squire W. Haviland who gave me the gift of life, a sense of humor, and a love of learning; J. Cedric Evans who modeled unconditional love, instilled a passion for industry, and challenged me to define the difference between good, better, and best; W. Kenneth Strait, who taught me the value of research and construction processes while demonstrating generosity of spirit.

CHAPTER 1 - INTRODUCTION

Overview

Because learning is essentially an internal process, only learners themselves can, in the end, decide to learn and to act upon their learnings. (Monette in Merriam, 2001, p. 302).

This chapter includes information about the background of the study, statement of the problem, statement of purpose, research questions, significance, limitations, and definition of terms. This study investigated anesthesia residents learning styles and domains and their relationship to an examination of cognitive achievement. For the purposes of this study, the following description of learning styles was used, “a coherent whole of learning activities that students usually employ, their learning orientation, and their mental model of learning, a whole that is characteristic of them at a certain period” (Vermunt & Verloop, 2000, p. 76). The In-Training Examination (ITE) (Appendix A) is a measure of cognitive achievement developed, standardized and administered by the American Society of Anesthesiology and the American Board of Anesthesia (ASA/ABA); the results are provided as scaled scores and percentile ranks. The study explored the relationship of the learning styles and domains with the ITE percentile ranks with postgraduate year (PGY), gender, and ethnicity.

Background

Medical residents (Doctor of Medicine or Doctor of Osteopathy) are a relatively homogenous group of highly educated individuals working in technical fields in an active way (Wunderlich & Gerde, 1978, p. 53). The formal medical education process starts with the first year of medical school and ends with the M.D. or D.O. degree (Seifer, 1998), continues with graduate medical education (GME), completed at graduation, and moves to Continuing Medical Education (CME) as a practicing physician. Residency or

GME is a complex educational system (Yudkowsky, Elliott, & Schwartz, 2002, p. 57) that occurs after the MD/DO degree has been received and is the preparation for the physician to practice independently (Leach, 2005, p. ii56; Yudkowsky, et al., 2002).

GME is a highly structured, and studied from multiple perspectives; these include establishing and maintaining national standards for physician training and developing the individual resident physician (Leach, 2005). The body charged with the charter of GME is the Accreditation Council for Graduate Medical Education (ACGME), a private, voluntary, nongovernmental corporate entity (Leach, 2005, p. i56). ACGME and small groups of medical specialists determine national residency standards, used for the accreditation of residency programs (Leach, 2005, ii56). National board standards are set in accordance with the American Board of Medical Specialties (ABMS) regulations. A strong partnership exists between the ABMS and the ACGME as both organizations support the same six competencies, allowing organizing principles as a basis for discussion about learning and work (Leach, 2001, p. ii57).

ACGME and ABMS (2000; *Toolbox of Assessment Methods*) worked together to determine a list of assessment tools. For the purposes of this study, the written multiple choice question (MCQ) examination, referred to as the In-Training Examination (ITE), was the assessment method used to assess individual residents' medical knowledge and understanding. Specialty societies with the assistance of psychometric experts prepare the ITE (p. 19). Members of ASA/ABA prepare and administer the ITE annually to anesthesiology residents as a measure of cognitive achievement.

Given the breath and depth of ACGME's mission to improve GME, there are many stakeholders and challenges (Kochar, Simpson, & Brown., 2003; Yudkowsky et al., 2002, p. 57), both inside and outside the residency environment. The challenges to the physicians are integrating the increasingly complex and rapidly changing medical technology to respond to the need for medical accountability in a changing social environment (Leach, 2001; McManus, Keeling, & Paice, 2004; Reich & David, 2005; Seifer, 1998). The challenges for physicians mentioned above include addressing health needs, maintaining professionalism, and educating medical students and residents to continue the profession (Lawrence, Lindeman, & Gottlieb, 1999; Slotnick, 2001). The need exists to enhance graduate medical educational learning to meet these challenges for

the individual physician and the medical profession (Holm, 2002; Kochar et al., 2003; Leach, 2005).

One of the goals of residency is to prepare residents to become members of medical profession (Slotnick, 2001, p. 1013). Past educational practices in medicine included a teaching approach where teachers presented the material to develop the mind of the resident without consideration of the social context. Teachers taught and residents learned. Minns (2006), who worked with faculty and students, concluded “there was a consensus among faculty and students that traditional teaching methods were not conducive to today’s medical students who have more life experiences than the medical student of the past” (p 1). Schultz, et al. (2004) concluded that there is a need to be aware of differences in learning and teachers needed at different levels and in different medical specialties (p. 2). The more-well educated physicians are better able to respond appropriately to the complex demands of modern life and societal expectations (Slotnick, 2001, p. 1015). Schein (1972) discussed the vision of more effective professional education that included “new kinds of learning modules built on better theories of how students learn” (p. 129), a theme reiterated through the current literature (Flexner, 1910; Swanwick, 2005).

Self-assessments are helpful in providing students and faculty information about learning how to learn. Many instruments measure aspects of learning, referred to as learning styles; however, overlapping definitions and terminologies result in outcomes that cannot be compared (Coffield, Moseley, & Ecclestone, 2004; Curry, 1999; Markham, 2004).

Learning styles have a role in helping to increase knowledge about learning how to learn. Curry (1999) stated, “The quickest and most cost-effective use of cognitive- and learning-style findings in medical education is to provide comprehensive, detailed, and interpreted information about his or her cognitive and learning styles to each first-year medical student” (p. 411). Students and teachers were able to apply the information gained about learning patterns and strategies as surveyed by learning style instruments to improve teaching, learning, motivating, and diagnosing. The objective is to respond to societal pressures to create independent learners well versed in their learning strengths and weaknesses (Coffield et al., 2004, p.2). While the choice of assessments is large, the

literature is clear about the need for instruments with validity, reliability, and relevance (Cassidy, 2004; Markham, 2004). “Learning styles research and applications have been limited by a paucity of evidence supporting the validity of assessment scores” (Cook, 2005, p. S100). The assessment instrument needs to provide valuable information from feasible data (ACGME, Toolbox of Assessment Methods; Leach, 2005).

Assessments can play an important role in developing professional competence (Curry, 1999). To accommodate students with different learning styles and different levels of competence at different stages of the learning process, flexibility is needed (Schein, 1972; Perry, 1970). Vermunt (1996, 2005) and Perry (1970, 1988) described ways that students think about learning and developmental trends that occur in the learning process. Teachers and students need knowledge and understanding about self-regulation, cognitive and metacognitive strategies, motivation, and thoughts and understanding (Curry, 1999; Oosterheert & Vermunt, 2003) in order to utilize a wider array of learning strategies. However, Gordon (1991) states that health professions’ training seldom provides specific information about valid self-assessments (p. 762). Many researchers have developed instruments to measure components of student learning, but few have researched the relationship of learning styles to standardized, measured cognitive examinations in GME.

Learning Styles

Educating physicians to deal with the increasing demands of medical knowledge and technology “in the face of the advancing standards of the best medical schools” (Flexner, 1910, p. viii) is an ongoing theme. This theme resonates throughout the history of physician education as discussed by Flexner in the first comprehensive report of medical education in North America. This theme continues today as the demands of medicine have become more complex; some have expressed concerns that new doctors may not be well prepared to meet challenges and expectations of the profession, the patients, and the community (Anderson, Cohen, Hallock, Kassebaun, Turnbull, & Whitcomb, 1999).

To improve resident learning, faculty may benefit from education on theory and techniques about learning styles and learning how to learn (Curry, 1999; Leach, 2005). Yudkowsky and Schwartz (2000) related that in the past teachers taught the curriculum and residents were responsible for learning (p. S100). Clinical instructors with teaching roles receive little formal background in educational principles and learning theory (Baker, Cooke, Conroy, Bromley, Hollon, and Alpert, 1988, p. 260).

The potential exists to enhance resident education by teaching both faculty and residents more effective learning (Curry, 1999; Leach, 2005). In 1978 Whitney and Caplan wrote that physicians were adult learners and that more information was needed about their learning strategies and patterns (p. 684), and this was again confirmed by Curry (1999), Ferguson, James and Madeley (2004) and Leach (2005). In studying teaching and learning, Newble and Entwistle (1986) demonstrated that a gap existed between hearing information from a teacher and learning it as a student. Daugherty, Baldwin, and Rowley (1998) concluded that learning activities, strategies and approaches that help enhance residents' learning increase the positive benefits received from residency (p. 1198).

For the purpose of this study, the Vermunt and Vermetten (2004) defined the four learning domains: "Cognitive processing activities are those thinking activities that students use to process subject matter. . . .affective activities involve emotions that arise during learning and lead to affective states that may positively, neutrally, or negatively influence the progress of a learning process. . . .regulation activities steer the cognitive and affective activities and, therefore, indirectly lead to learning outcomes" (p. 361).

An important component of effective learning is the understanding students have about the nature of learning. Evidence supports the relationship of particular learning activities to the quality of academic outcome (Trigwell & Prosser, 1991; VanderStoep, Pintrich, & Fagerlin, 1996). Learning is complex, and researchers study learning styles and effective learning strategies to examine the interrelationships of different aspects and components of study and learning (Boyle, Duffy, & Dunleavy 2003, p.269). McManus, et al. (2004) found that study habits and learning style information of medical students predict approaches to work (p. 1). More information is needed about which learning

styles are correlated with levels of academic performance and the changes that occur during the training process (Curry, 1999; Ferguson, James & Madeley, 2002).

Research on student learning first focused on cognitive processing strategies. Marton and Saljo (1976a) identified two different levels of processing: deep-level and surface-level processing (p. 7). Further research supported the importance of deep-level processing, believed to be a factor in academic success (Marton & Saljo, 1976a, 1976b). Research into student approaches to learning (SAL) demonstrated that students adopt approaches to learning based on the requirement of the learning context (Marton & Saljo, 1976b, p. 125). These approaches and strategies are modifiable according to the contextual requirements (1976a; Weinstein, 1978). Zhang (2002) verified that finding (p. 180) and noted that a positive relationship existed between higher cognitive levels and wider ranges of thinking styles (p. 191). Vermunt (1998) determined that while learning styles are relatively stable some traits of students are modifiable (p. 166).

Some differences in learning processes and strategies are evident in the progression from first year medical student to fourth year resident. An example is the well- documented trend toward surface learning used by students in their first years of medical education (McManus, Richards, & Winder, 1998, p. 349) to those more complex learning strategies used in later stages (Leach, 2005, p. ii58; McManus et al, 1998). Changes occur in the way students learn, what students consider important, and the context of that learning (Newble & Entwistle, 1986; Slotnick, 2001; Yudkowsky & Schwartz, 2000). These changes continue to occur during the course of medical education and the practice of medicine, as each educational level understands the skills and knowledge differently (Slotnick, 2001, p. 1021). As learning needs change, residents develop learning styles and strategies to manage their skills, abilities, and knowledge to adapt to the contextual requirement of their situations (Leach, 2005; McManus et al., 1998).

Learning differences exist between the cognitive apprenticeship levels of novice in medical school to advanced beginner as a first year resident to competent physician as a graduating resident (Kocher et al, 2003). Theory suggests learning needs in medical education vary both by levels (Perry, 1970; Sadler, Plovnick, & Snope, 1978; Shatzer, 1998; Van de Wiel & Boshuizen, 1999) and specialties (Baker, Wallace, Bryans, &

Klapthor, 1985; Kosower & Berman, 1996; Van de Wiel & Boshuizen, 1999; Kolb, 1984). Slotnick's summation is that doctors at various points in their career understand medical skills and knowledge differently (2001, p. 1021). Schultz, et al. (2004) concluded that teaching in an ambulatory setting would benefit if faculty were more aware of differences in learners at different levels and specific specialties (Schultz et al, 2004; Whitney & Caplan, 1978).

Learning Style Instruments

Many instruments measure learning styles and strategies in higher education. Analysis of a number of instruments identified over 30 different labels in use to describe a variety of learning styles (Riding & Cheema, 1991). Operational definitions and integration of domains of learning were needed to clarify terms (Cassidy, 2004; Markham, 2004). The instruments used more often in learning style research include the Approaches to Study Inventory (ASI), the Lancaster Group (Entwistle, Hanley, & Hounsell, 1979; Entwistle & Ramsden, 1983); the Learning and Study Strategies Inventory (LASSI) (Weinstein, Zimmerman, & Palmer, 1988), the Study Process Questionnaire (SPQ) (Biggs, 1987), and the Inventory of Learning Styles (ILS), (Vermunt, 1998, 1996).

The instruments listed above studied two or three components of learning (Vermunt, 1998, pp. 151-152). Vermunt developed the Inventory of Learning Styles (ILS) for use in higher education; the ILS integrated the learning domains of cognitive processing strategies, and metacognitive regulation strategies with mental models of learning as information was scarce in the literature about the combination (p. 152). Mental models of learning studied the role of the teacher, learner, and fellow students. and learning orientation into a model of learning styles (Boyle et al, 2003; Entwistle & McCune, 2004; Vermunt, 1998, 1996). Educational psychology (Markham, 2004) and constructivism provide the theoretical background for the ILS (Vermunt, 1998).

In a recent study Vermunt (1998, p. 269) proposed an approach to studying learning styles, grounded in modern constructivist views of learning, which explicitly attempted to provide a more comprehensive and integrated account of learning by bringing

together four different aspects of learning, cognitive processing strategies, regulation strategies, students' views of learning and orientations to learning (similar to motives). . He confirmed the reliability and validity of the four ILS components and, using factor analysis, identified four different learning styles, a meaning-directed style, a reproduction-directed style, an application-directed style and an undirected style (Boyle et al., 2003, p. 269).

While early research into learning strategies and approaches addressed cognitive and motivational strategies, Vermunt's diagnostic instrument integrated the learning components of cognitive processing strategies, metacognitive regulation strategies, mental models of learning, and learning orientations to clarify learning concepts and components in their application to advanced learning. The instrument was used in a study of tertiary education to explore the relationships between strategies for learning and academic process (Vermunt & Verloop, 1999; Weinstein, 1978; Zeegers, 2001; Zhang, 2002).

Vermunt (1996) and Boyle et al. (2003) researched the integration of components of learning and their interactions. While Vermunt's model of learning is somewhat complex, it "provides a fuller characterization of these learning styles, identifying metacognitive aspects of learning in addition to strategies and motivation components as important features of learning styles" (Boyle et al., 2003, p. 285). The Boyle et al. (2003) research added to the evidence that regulation activities are significant in learning and academic outcomes. Learning styles, as identified by Vermunt, have an order from the least desirable, undirected, to the most desirable, meaning-directed (p. 286). The ILS is limited in ability to predict academic outcomes. However, it is useful as a diagnostic tool to detect learners who have not adopted systematic strategies necessary for academic achievement (Boyle et al, 2003, p. 287).

In the 1970's, a family of information processing models emerged as a way to understand cognitive processes (Simon, 1979). The construction of learning strategies models shifted the view of the learner from being a passive recipient of knowledge to an active participant of a complex learning process (Weinstein, Underwood, Wicker, & Cubberly, 1979). "Cognitive strategies" encouraged self-directed learning and planning

in educational settings. Learning strategies became a factor in understanding differences between low achieving students and those meeting with academic success (Alexander & Murphy, 1998; Pintrich & De Groot, 1990; Weinstein, Zimmerman, & Palmer, 1988).

Educators developed programs to improve resident learning. One theory was that residents would benefit from course work in study skills, such as time management, concentration, study aids, self-testing, and test strategies (Kramer & Conoley, 1992, p.449) as a way to improve learning. Newble and Entwistle (1986) and Gibbs, Morgan, and Taylor (1984) researched the results of study skills coursework and reported that the outcomes did not achieve much impact and credibility in medical schools. Educators transitioned from presenting study skills to emphasizing learning to learn strategies (Hounsell, 1984).

Minns (2006) suggested improving medical education by augmenting faculty education about learning strategies and approaches of advanced adult learners. The authors of the Medical School Objectives Project (MSOP) concluded, “that faculty development is the key to MSOP’s success, we must equip our teachers with the knowledge and tools they need to be effective educators and evaluators of adult learners” (Cohen, 1998, p. 135). Armstrong and Parsa-Parsi (2005) concluded,

Curriculum planners are questioning both the content of medical education. . .and the methods of instruction and training. . .[R]esearch has focused on connecting content and teaching through an understanding of how learning occurs. . .A significant body of literature has shown that a learners’ new knowledge does not necessarily lead to new behavior. . .Ample evidence exists in the Continuing Medical Education literature to support the implementation of more active and self-directed learning strategies to promote the desired change in behaviors (p. 680).

Resident learning is an individualized, internal cognitive process (Merriam & Brockett, 1997, p. 6). Because each individual has to decide to learn and to utilize that learning (Custers and Boshuizen, 1997, p. 163; Monette in Merriam, 1995, p. 302), residents may benefit from having knowledge of different learning strategies. Research indicates that learning approaches may be modified depending on motivation and the

view that other approaches may be better suited to a task or context (McManus et al., 2004; Newble & Clark, 1986; Newble & Entwistle, 1986, Newble & Gordon, 1985; Vermetten, Lodewijks, & Vermunt, 1999; Vermetten, Vermunt, & Lodewijks, 1999).

However, there is little in the literature that explores the relationship between learning strategies and cognitive development as measured by standardized instruments. Mitchell, Srinivasan, West, Franks, Keenan, and Henderson et al. (2005) conducted a literature review on factors that affect resident performance that included five major categories: “learning style and personality, practice preferences, personal health, social/financial factors, and response to job environment” (p. 378). The authors were not able to find any research articles on “residents’ learning style that satisfied the above criteria (p. 387).

Adult Education

Application of adult education and psychology principles is beneficial for faculty development and resident growth in understanding learning how to learn (Cohen, 1998; Parsa-Parsi, 2005; Vermunt & Verloop, 1999; Zeegers, 2001; Zhang, 2002). This study focused on learning styles and strategies and their relationship with ITE percentile ranks to provide information about learning styles and strategies related to higher academic achievement. Ferguson et al. (2002) reported, “Relatively little research has been done into the importance of learning styles, interviews, ethnicity, sex, personal statements, and references” for medical training (p. 952).

Learning how to learn is a central component of advanced adult education; the objective is to develop independent learners who demonstrate higher levels of critical thinking (Vermetten, Vermunt, & Lodewijks, 1999, p. 222). Some have argued that it may well be the most important attribute (Carnevale, Gainer, and Meltezer, 1990). Students have demonstrated the ability to adopt different approaches to study, partly influenced by the learning style of the individual and partly by contextual requirements (Vermetten, Lodewijks, & Vermunt, 1999; Vermetten, Vermunt, & Lodewijks, 1999). Studies with medical students identified the use of different strategies to study, depending on the educational requirements (Newble & Entwistle, 1986, p. 164). The process is that

of a person being “transformed into a practitioner. . . part of a developing identity—in short, a member of a community of practice” (Lave and Wenger, 1991, p. 122).

Learning Patterns

Learning strategies are the patterns or combinations of learning activities and tools used by students (Hadwin, Winne, Stockley, Nesbit & Woszczyna, 1997; Vermunt, 1996). Zhang (2002) stated, “People’s thinking styles vary depending on the stylistic demands of a given situation and are at least partially socialized, suggesting that they can be modified” (2002, p. 180). Learning approaches are a result of the context and socialization of the learning situation and individual patterns of learning used rather consistently (Vermetten, Lodewijks, & Vermunt, 1999; Marton & Saljo, 1976a; Newble & Entwistle, 1986). Academic performance is strongly related to the learning activities used during the learning process (Trigwell & Prosser, 1991; VanderStoep et al., 1996).

Weinstein (1994) concluded that “the nature of skilled functioning in academic contexts is quite complex” (Weinstein, In Pintrich, Brown & Weinstein (eds.), 1994, p. 258). Expert learners have a variety of types of knowledge:

- Knowledge about themselves as learners
- Knowledge about different types of academic tasks
- Knowledge about strategies and tactics for acquiring, integrating, applying, and thinking about new learning
- Prior content knowledge
- Knowledge of both present and future contexts in which the knowledge could be useful (Weinstein In Pintrich, et al. (Eds.), 1994, p. 258).

In addition to the types of knowledge, the expert learner also needs to know how to monitor progress, adjust to learning outcomes, meet learning objectives, and self-assess to adapt strategies to educational requirements. The learner combines learning skills, motivation, and the ability to self-regulate (p. 258).

Potential to Modify Learning Patterns

With the emphasis on teaching learning how to learn, the question emerged about the potential to modify learning strategies and approaches from an individual and contextual perspective. Vermetten, Lodewijks, and Vermunt (1999) demonstrated an

ability of students to adapt learning strategies to contextual requirements resulting in learning strategy variability, further indicating potential for modification by education (p. 19).

Learning strategies and approaches are less fixed than personality traits; modifications depend on learner motivations and the view that the task required may benefit from other approaches (McManus et al., 2004; Newble & Clark, 1986; Newble & Entwistle, 1986; Newble & Gordon, 1985; Vermetten, Lodewijks, & Vermunt, 1999; Vermetten, Vermunt, & Lodewijks, 1999). Newble & Entwistle (1986) concluded that student learning affects both academic progress and success and shapes the quality of the knowledge gained. They stated, “Theoretically, this could be achieved in two ways: by improving basic learning skills or by ensuring that the learning environment evoked the desired approach. The difficulty of achieving the latter makes the former an attractive proposition” (p. 171).

Statement of the Problem

To enhance GME, educators and administrators need more information about the key factors of learning styles and strategies affecting resident learning and performance and the contextualization of learning strategies. The medical literature has been somewhat silent on the relationship between learning styles and cognitive measures of achievement. Little research has been done into the effect of learning styles of residents on academic and skills outcomes (Ferguson et al., 2002, p. 952).

Mitchell et al. (2005) studied the effect of learning styles on physician performance and concluded that basic questions about learning styles remain unanswered (p. 376). To identify the residents’ learning styles, the study explores the relationship between anesthesiology residents’ level of knowledge as measured by ITE percentile ranks and their learning styles and domains.

Student learning affects both academic progress and success and shapes the quality of the knowledge (Newble & Entwistle, 1986). The question becomes which learning styles and strategies are positive or negative for anesthesiology residents. Identification of learning strategies can help medical residents broaden their range of learning styles and strategies to balance the ever-present need to maximize learning

opportunities (Coffield et al., 2004, p. 12). As attending physicians usually have not received any formal training in learning how to teach (Baker et al., 1998; Slotnick, 2001, p. 1013), there is little preparation in the use and understanding of learning strategies and outcomes. Identification precedes application.

Statement of the Purpose

Although studies have shown that medical education needs to provide specific information about learning styles and patterns to medical students (Curry, 1999, p. 411), little research in anesthesia education references learning styles and their relationship to cognitive achievement measures. This study explored the relationship between cognitive outcomes as measured by ITE percentile ranks with learning styles as measured by the Inventory of Learning Styles. The study purpose was to identify learning strategies and scales that have positive and negative relationships to resident performance as measured by ITE percentile ranks. As the ILS has ordered learning styles from the least desirable (undirected learning style) to the most desirable (meaning directed learning style), the ILS is useful as a diagnostic tool to detect learners who have not adopted systematic learning strategies (Boyle et al, 2003, pp. 286-287).

The literature supports the ability of students to adapt new learning strategies; however, there is scant research on the efficacy of various learning styles with objective measures that are applicable in anesthesia graduate medical education. This study explored the effects of ITE percentile ranks, the ILS, and the personal characteristics of gender and ethnicity with postgraduate year.

For this study, it was assumed that resident ITE percentile ranks would range on a continuum from low to high; it was also assumed that the scores on the learning styles and scales would range on a continuum from least desirable (undirected learning style) to most desirable learning style (meaning directed learning style) (Vermunt, 1998). The relationships of ITE percentile ranks and learning styles were explored for significant positive and negative variables.

Research Question and Hypotheses

The following research question and research hypotheses guided this study and emerged from selected aspects of the adult education, cognitive and educational psychology, medical school, and graduate medical education literature.

Primary Research Question

Is there a relationship between resident achievement and learning styles and domains? If so, what is the nature of the relationship(s)? For this study, resident achievement was measured by In-Training Examination (ITE) percentile ranks. Learning styles and domains included cognitive processing strategies, metacognitive regulation strategies, conceptions of learning, and learning orientations which were assessed by the Inventory of Learning Styles (ILS).

Research Hypotheses

- H₁ There is a relationship between learning styles and resident achievement scores that varies by postgraduate year, gender, and ethnicity.
- H₂ There is a relationship between resident achievement and cognitive processing strategies domains, comprised of scales deep processing (relating and structuring, critical processing), stepwise processing (memorizing and rehearsing, analyzing) and concrete processing.
- H₃ There is a relationship between resident achievement and the metacognitive regulation strategies domain, comprised of scales self-regulation (learning process and outcomes, learning content), external regulation (learning process, learning outcomes), and lack of regulation.
- H₄ There is a relationship between resident achievement and the conceptions of learning domain, comprised of scales construction of knowledge, intake of knowledge, use of knowledge, stimulating education, and cooperative learning.
- H₅ There is a relationship between resident achievement and the learning domain, orientations domain, comprised of scales personally interested, certificate oriented, self-test oriented, vocation oriented, and ambivalent.

Significance of the Study

The educational challenges facing the medical profession include increasingly complex, rapidly changing medical technology, significant growth of medical knowledge, greater public access to medical information, and changes in the funding stream (Holm, 2002; Kochar et al., 2003; Leach, 2005). ACGME has limited resident duty hours to 80 per week averages over a four-week period. Information and technology are expanding while the duty hours and graduate medical education periods are defined and limited. To continue to meet these challenges, medical educators have a responsibility to identify potential ways to enhance learning how to learn (Leach, 2005). The results of the analyses of the systematic learning styles of residents with higher ITE percentile ranks include the identification of successful learning strategies (by scales); this information can be used to provide additional learning strategies to lower achieving residents. Understanding learning styles that have a negative relationship with ITE percentile ranks provides a point of reference to identify residents at risk academically. Early identification of residents at risk allows opportunities for development of more effective learning strategies.

This study explored the relationship between ITE percentile ranks and learning styles and domains, using a diagnostic learning style instrument, Inventory of Learning Styles (Vermunt, 1995, 1998). The aim was to provide tools to aid in postgraduate teaching and learning at the individual and group level. The learning styles identify positive and negative relationships with ITE percentile ranks. The learning domains reveal specific information about the learning strategies and patterns of the higher and lower achieving residents, as measured by ITE percentile ranks. Analysis by domains identifies contextual and personal patterns in anesthesia graduate medical education. . Laurillard (1979) demonstrated that context was an important part of learning activities, with teaching implications for helping the student learn more effectively on the journey to becoming a successful self-learner (p. 7).

Anesthesia residency directors and faculty benefit from an understanding of the learning styles that have a significant positive or a negative relationship with ITE percentile ranks as a basis for more effective communication, resident understanding of learning, and focused teaching. Adult educators, researchers, and physicians can work

together to implement specific teaching interventions to assist individual residents and to present education seminars and meetings on ways to continue to improve educational practices. Medical educators potentially benefit from having a deeper understanding of resident learning strategies, more knowledge about more effective ways of teaching and learning using learning styles and strategies, and tools (ILS learning styles) to identify residents who may struggle unnecessarily in the learning process.

Limitations of the Study

Guided by the research question and hypotheses, this study investigated the relationship between ITE percentile ranks and learning styles of anesthesiology residency in four programs at five sites. The exploratory study included a relatively small number of participants. Therefore, sub-group size limited the analyses of gender, ethnicity, and postgraduate year variables. Because the study included only anesthesiology residents, the results will not generalize to residents in other medical specialties. The postgraduate year data provided information from four different cohorts, precluding any analysis about learning style changes over the period of graduate medical education. The study results are limited by the self-report features of the survey instrument; there are no objective measures of individual learning (Boyle et al., 2003, p. 287). The wording of the instrument was adapted, with permission, for this group. Survey data provided information about the resident's perception of the learning style and strategies and not necessarily the application or process.

Definition of Terms

The following definitions were used for the purposes of this study.

Ability: “refers to what one can do” (Zhang, 2002, p. 179)

Abilities: “Specific to a particular content domain or function and are measured in terms of maximal performance” (Curry, 2002, as cited in Norman, van der Vleuten, & Newble, eds. Part Two, p. 265).

Accreditation: process “which examines those educational programmes preparing individuals for board certification and independent practice” (Leach, 2005, p. ii56).

Adult education: “activities intentionally designed for the purpose of bringing about learning among those whose age, social roles, or self-perception define them as adults” (Merriam & Brockett, 1997, p. 8).

Adult learning: “the process of adults gaining knowledge and expertise” (Knowles, Holton, III, & Swanson, 2005, p. 174).

Affective activities: those activities that “involve emotions that arise during learning and lead to affective states that may positively, neutrally, or negatively influence the progress of a learning process” (Vermunt & Vermetten, 2004, p. 361).

Andragogy: “The art and science of helping adults learn” (Knowles, 1980, p. 24).

Application directed learning style: a style of students who “try to employ what they learn to actual, real-world settings” (Busato, Prins, Elshout, & Hamaker, 1999, p.130).

Assessment: “a process whereby a doctor’s or dentist’s performance is measured and compared to known criteria” (Oxley, 1996, p. 14).

Board certification: “process “which examines individual physicians” for certification (Leach, 2005, p. ii56).

Cognitive processing activities: “thinking activities that students use to process learning contents and to attain their learning goals by doing so” (Vermunt, 1998, p. 151).

Conception of learning: “a coherent system of knowledge and beliefs about learning and related phenomena (e.g., knowledge and beliefs about oneself as a learner, learning objectives, learning activities and strategies, learning tasks, learning and studying in general, and about the task division between students, teachers, and fellow students in learning processes)” (Vermunt & Vermetten, 2004, p. 362).

Deep processing: “involves the learner in developing an understanding of the underlying structure and meaning of material” (Lindeman, Duek, & Wilkerson, 2001, p. 162).

Effective learning: “(1) is based on personally caused experience, (2) is usually produced by expressing and examining dilemmas, (3) values individuality and expression of conflicts, (4) must be guided by an instructor who has more faith in the participants than they may have in themselves, (5) who recognizes the limits of participants’ learning methodologies, (6) whose idea of rationality integrates feelings and ideas and (7) who can encourage spontaneity” (Argyris & Schon, 1974, p. 98).

Graduate medical education (GME): “Graduate medical education in the United States refers to those educational programmes conducted after the MD degree has been conferred but before the physician is able to practice independently” (Leach, 2005, p. ii56).

Graduate year: year of graduate medical education referred to as graduate year, starting July 1 and ending June 30.

Informal learning: “Defined as characteristically collaborative, usually involving the manipulation of tools and leading to context-specific forms of knowledge and skills” (Swanwick, 2005, p. 860).

Learning activities: “thinking activities that people employ to learn” (Vermunt, 1996, p. 25).

Learning orientations: “the whole domain of students’ personal goals, intentions, motives, expectations, attitudes, concerns, and doubts with regard to their studies (Gibbs et al, 1984) (By Vermunt & Vermetten, 2004, p. 362).

Learning strategies: patterns or series of learning activities used by students naturally (Hadwin et al., 1997; Vermunt, 1996; Vermetten, Lodewijks & Vermunt, 1999).

Learning style: “Vermunt (1992, 1996) uses the term ‘learning style’ to denote a coherent whole of learning activities that students usually employ, their learning orientation, and their mental model of learning, a whole that is characteristic of them at a certain period” (Vermunt & Verloop, 2000, p. 76).

Meaning directed learning style: a style of students who “wish to find out what is meant exactly in their study material, interrelate what they have learned, and try in a critical sense to develop their own view” (Busato et al., 1999, p. 130).

Medical education: the educational process “to produce physicians who are prepared to serve the fundamental purposes of medicine” (Anderson, et al, 1999, p. 15).

Mental model of learning: “a coherent whole of learning conceptions: conceptions and misconceptions about learning processes” (Vermunt, 1998, p. 151).

Metacognition: “the ability to think about thinking, to be consciously aware of oneself as a problem solver, and to monitor and control one’s mental processing” (Bruer, 1993, p. 67).

Metacognitive regulation strategies: “directed at regulating the cognitive activities and therefore lead to learning results indirectly” (Vermunt, 1998, p. 151).

Output: “the effect of that performance on the patients, the health care system and the population” (Mitchell, et al, 2005, p. 377).

Percentiles: “the percentage of cases falling below a given score. Thus, if an individual scores at the 95th percentile, that individual has exceeded 95% of all persons taking that particular test. If test scores are normally distributed, and if the standard deviation of the distribution is known, percentile scores can easily be converted to the resulting z scores” (Sprinthall, 2003, p. 633).

Regulation activities: those activities that “steer the cognitive and affective activities and, therefore, indirectly lead to learning outcomes” (Vermunt & Vermetten, 2004, p. 361).

Reliability: “the degree of consistency that the instrument or procedure demonstrates: Whatever it is measuring, it does so consistently” (Best & Kahn, 2003, p. 277).

Reproduction directed learning style: a style “students characterized by study behaviour directed mainly at reproducing what is learnt at examinations, in order to pass these successfully” (Busato et al., 1999, p. 130).

Resident index score: “resident index scores permit comparison of the performance of any program’s residents with the performance of all U.S. residents who took the examination” (Hall & Cotsonis, 1990, p. 475).

Strategic (or achieving) learner: “Focuses on the requirements of assessment” (Aaron & Skakun, 1999, p. 260).

Style: “a stable trait, a consistent preference, or choice of an action strategy across a range of tasks” (Lindeman, et al, 2001, p. 162).

Surface learner: a student “memorizes lists of superficial knowledge” (Aaron & Skakun, 1999, p. 260).

Thinking: “the immediate, conscious psychological processes of associating, differentiating, imagining, and inferring (Mezirow, 1991, p. 12).

Undirected learning style: a style of students who have “problems to process the material for study, experience difficulties with the amount of study material and with discriminating what is important and what is not” (Busato et al., 1999, p. 130).

Validity: “that quality of a data-gathering instrument or procedure that enables it to measure what is supposed to measure” (Best & Kahn, 2003, p. 277).

Summary

The need exists to enhance graduate medical educational learning for the individual physician and for the medical profession (Holm, 2002; Kochar et al., 2003; Leach, 2005). Curry (1999) declared that medical education needs to provide specific information about medical students’ learning styles and patterns; specific information about learning styles can help students be more flexible in responding to the demands and changes that result from increasing responsibilities (p. 411). However, little research exists in that explores the relationships in learning styles and strategies between anesthesiology residents who receive higher ITE percentile ranks and those with lower scores. The role of stage development by postgraduate year and changes in learning styles for anesthesia residents has also not been explored using learning styles and ITE percentile ranks.

This research investigated the relationship between the Inventory of Learning Styles (learning styles and domains) and the ITE percentile ranks, a cognitive assessment of knowledge as measured annually for anesthesiology residents, by gender, ethnicity, postgraduate year.

CHAPTER 2 - LITERATURE REVIEW

Introduction

This chapter includes a review of literature on learning styles, strategies, and domains from the fields of adult education, educational psychology, and medical education. The literature from these areas provided the theoretical underpinnings for the research questions exploring the relationship between learning styles and strategies and medical education cognitive achievement outcomes.

Review of Related Literature

Adult education, educational psychology, and medical education literatures address dimensions of learning styles and strategies in advanced learning required in graduate medical education. The focus of the literature review includes: learning styles and strategies, the context of the educational process and cognitive apprenticeships, and graduate medical education (GME). The background information will help to familiarize the reader with the topic and to provide the theoretical support for the research questions.

Professional Adult Education

Learning in professional adult education can be viewed from the perspective of the student, the adult educator, and the program director/administrator. Knowles (1980) determined that the adult educator's functions were:

1. helping the learners diagnose their needs for particular learnings within the scope of the given situation (the diagnostic function);
2. planning with the learners a sequence of experiences that will produce the desired learnings (the planning function);
3. creating conditions that will cause the learners to want to learn (the motivational function);
4. selecting the most effective methods and techniques for producing the desired learnings (the methodological function);

5. providing the human and material resources necessary to produce the desired learnings (the resource function);
6. helping the learners measure the outcomes of the learning experiences (the evaluative function) (pp. 26-27).

The program directors/administrators of adult education have functions that include:

1. assessing the individual, institutional, and societal needs for adult learning relevant to their organizational settings (the diagnostic function);
2. establishing and managing an organizational structure for the effective development and operation of an adult-education program (the organizational function);
3. formulating objectives to meet the assessed needs and designing a program of activities to achieve these objectives (the planning function);
4. instituting and supervising those procedures required for the effective operation of a program, including recruiting and training leaders and teachers, managing facilities and administrative processes, recruiting students, financing and interpreting (the administrative function);
5. assessing the effectiveness of the program (the evaluative function) (p. 27).

The student's role is to learn. The ways in which students understand the nature of learning have a direct impact on their learning outcomes (Marton & Saljo, 1976b, p. 268). Higher level knowledge is different from that at a lower level regarding content (Marton & Saljo, 1976b). Lonka and Linblom-Ylänne (1996) and Boyle et al. (2003) concluded that advanced students with a detailed understanding of the nature of learning had a more sophisticated view of learning.

Individual Learning

Learning can occur in a group or individual setting; for the purposes of this study, the learning focus is on the individual. As learning occurs through life experiences, learning is primarily an individual activity (Finger & Asun, 2001, p. 25). One of the theoretical explanations is the constructivist stance that “maintains that learning is a process of constructing meaning; it is how people make sense of their experience”

(Merriam, Caffarella, & Baumgartner, 2007, p. 291). The individual constructs meaning from experiences, and the whole becomes greater than the sum of the parts (Merriam & Brockett, 1997 p. 46). Candy (1991) wrote,

Learning (is) an active process of *constructing* a system of meanings and then using these to *construe* or interpret events, ideas, or circumstances. As such, the constructivist view of learning is particularly compatible with the notion of self-direction, since it emphasizes the combined characteristics of active inquiry, independence, and individuality in the learning task (p. 278).

From the constructivist perspective, the learner in higher education learns from experience, connects new insights to other existing informational structures and adds to understanding (Van Eekelen, Boshuizen, & Vermunt, 2005). Oosterheert and Vermunt (2003) expressed the view that learning occurs because of the internal control of the learner; learning is controlled by the learner (Custers & Boshuizen, 2002, in Norman, van der Vleuten & Newble, Part One, Part Two). The learner is the former and framer of meaningful learning; the integration of lifelong learning skills adds expertise to the learning processes (Van Eekelen et al., 2005). Zhang (2002) iterated, “Students who reason at a higher cognitive developmental level tend to use a larger repertoire of thinking styles than students reasoning at a lower cognitive developmental level who are confined to a narrow range of thinking styles” (p. 191). Educators may encourage students’ cognitive development by motivating them to utilize a variety of thinking styles in interpersonal and educational learning. The result can help students progress developmentally to more advanced levels (Perry, 1970).

By helping the student more fully understand individual learning processes, the educators help each diagnose learning needs within a given situation, the institutional requirement, and societal needs. Professional adult education produces specialists capable of functioning autonomously upon completion of formal education (Schein, 1972; Leach, 2005). The importance of learning styles and strategies is recognized for various reasons in professional curricula. Curry (1999) suggested providing first year medical students cognitive and learning styles information to help the student integrate learning strategies more effectively (p. 411).

In recent decades, the professional knowledge and technology available have exploded (Kegan, 1994; Leach, 2005; Reich & David, 2005; Schein, 1972). Kegan (1994) summarized,

[I]t may still remain for us to discover that adulthood itself is not an end state but a vast evolutionary expanse encompassing a variety of capacities of mind. And if we have been able to extend a disciplined sympathy to children, evoked by our analytic exploration of their capacity to meet the challenges of the various curricula we create for them, it remains for us to extend the same disciplined sympathy to adult experience. *It remains for us to look at the curriculum of modern life in relation to the capacities of the modern mind* (1994, p. 5).

Vermunt (1996) stressed the importance of developing skills in thinking activities to help integrate new knowledge for coping with the information explosion. Professional education needs to support learning how to learn to assist members in the transitions required to handle rapidly expanding knowledge and avoid obsolescence (Vermunt, 1996; Schein, 1972). Both students and teachers benefit from greater understanding of their cognition, behavior, and motivation by thinking about their learning (Pintrich, 1995, Vermunt, 1998, 2005). Metacognition is the ability to think about one's thinking and to select learning strategies appropriate for the context of the learning (McKechie, 1990; Pintrich et al., 1994; Vermunt, 1998).

Becoming a skilled learner in professional education is complex and multifaceted. Pintrich et al. (1994) summarized the five basic categories of knowledge:

1. knowledge about themselves as learners;
2. knowledge about different types of academic tasks;
3. knowledge about strategies and tactics for acquiring, integrating, applying, and thinking about new learning
4. prior content knowledge;
5. knowledge of both present and future contexts in which the knowledge could be useful (p. 258).

Cognitive Apprenticeships

In creating a positive learning atmosphere in apprenticeships, consideration of relational factors is important (Holm, 2002, p. 401). Leach (2005) affirmed the importance of nurturing the relationship between the teacher and student (p. ii55) as the expert-novice relationships were at the core of traditional medical learning. The learner gains the necessary skills by participating in the process. The challenge is to rethink what it means to learn and to understand in the process of becoming a member of a professional community (Lave & Wenger, 1991). Akre and Ludvigsen (1997) studied the learning processes in apprenticeships:

In interaction with a more experienced physician the novice transcends what she can do alone and develops as a professional. The quality of the learning depends on the dialogue between the novice and the expert in the actual situations. The physicians' descriptions of their own learning processes change with increasing competence and position in the hospital hierarchy (p. 275).

“Science seeks universal truths; art is always unique. Medicine, when good, fully expresses both. . .An educational model that does not nourish the relationship between student and teacher is not robust enough to support the contract to discern and obey the truth” (Leach, 2005, pp. ii54-ii55).

Graduate Medical Education (GME)

Graduate medical education is the intertwining of formal, informal and nonformal learning. “Residency training is a long, arduous experience that presents the maturing professional with ever-increasing demands” (Archer, Keever, Gordon, & Archer, 1991, p. 303). The education and practice of medicine are a combination of sciences and humanities (arts); and the topics of how to learn and how to teach have resulted in decades of discussion, research, and debate about learning styles (Curry, 2002 in Norman, van der Vleuten, & Newble).

Research about learning styles focused two main areas of emphasis: careers and specialty choice and the improvement of educational outcomes at all levels from first

year medical student and continuing through the process to continuing medical education; this literature review is focused on the latter.

One focus of complex learning is the topic of “Advanced knowledge acquisition, which can be viewed as a middle ground between the fundamentals of learning and the various forms of learning that operate in medical education” (Custers & Boshuizen, 2002, in Norman, van der Vleuten, & Newble, p. 163). Adult education literature combined psychology with the practical application of forms of learning styles at all levels of medical education (Newble & Entwistle, 1986, p. 183). Research Learning styles centers on the study is of approaches, strategies, and patterns students apply to learning tasks and activities and the impact on these on learning outcomes.

Educating physicians to deal with greater cognitive complexity is an ongoing theme resonating throughout the history of physician education from medical school through residency, certification, and recertification (Flexner, 1910; Leach, 2005). During the seventeenth and eighteenth centuries, medical schools in the United States existed “as a supplement to the apprenticeship system” (Flexner, 1910, p. 3). In the 1800’s medicine began to develop a scientific basis, thus providing medical schools a different purpose and structure (p. 8). Flexner mentioned the development of “competent and humane physicians” (p. 9); he stated,

The question is, then, not merely to define the ideal training of the physician; it is just as much, at this particular juncture, to strike the solution that, economic and social factors being what they are, will distribute as widely as possible the best type of physician distributable (p. 13).

Questions asked by medical educators about medical education of medical students during the 1970’s and 1980’s focused on discussions about what they should learn, how they learn, the differences between how they learn and how they should learn, and the impact on the quality of their medical education (Vu & Galofre, 1983). Other questions that followed included those on the differences in learning at various levels of education and at various stages and ages of life (Whitney & Caplan, 1978). Medical education is a process that starts in medical school, continues through residency, and

extends as independent, self-directed learning during the professional and personal life as a physician.

Reporting about teaching and learning and their outcomes in medical education was fragmented prior to the 1980's. Newble and Gordon (1985) summarized, "The literature in the area of student learning is complex and confusing and is poorly represented in the medical education literature" (p. 3). The traditional learning approach was the norm where the teacher presented the material and the resident was expected to learn (Yudowsky & Schwartz, 2000, p. S100). Clinical instructors, in general, had little or no training in educational theory and principles (Baker, Cook et al., 1998, p. 527). Newble and Entwistle (1986) observed that clinical teacher/student interaction was usually a request for more information or a game of one-upmanship (p. 172). Little emphasis was placed on the impact of academic activities on how students learned (p. 162) not on determining how residents learned based on motivations, environmental conditions, study techniques and approaches, learning orientation, and learning styles (Armstrong & Parsa-Parsi, 2005; ten Cate, Snell, Mann, & Vermunt, 2004). Later research on learning styles indicated a gap between hearing information from a teacher and learning it as a student. "Researchers are increasingly recognizing the complexity of learning and are interested in examining how different aspects of learning work together" (Boyle et al., 2003, p. 269). The individual physician perspective includes practice outcomes, job satisfaction, personal health, work/life balance, personality traits, and learning styles (Mitchell et al., 2005, p. 377).

Medical residency is contextual, experiential learning designed to prepare the resident for transition to assume the role of a practicing physician, to continue and contribute to the practice of medicine, to function as a professional, to respond to society's expectations, and to continue learning outside of a supported formal educational structure (Holm, 2002; Lave & Wenger, 1991; Slotnick, 2001; Swanwick, 2005). In the medical literature GME is advanced learning utilizing situated learning based in part on cognitive psychology and adult education applications (Gibbs, 1981, Custers & Boshuizen, 1997). GME is a formalized adult advanced educational learning process set in contexts designed to facilitate learning in a supported experiential setting, called an

apprenticeship model. Custers and Boshuizen (1997) stated the psychological theories of learning

(D) deal with what is going on in the mind of the learner during the learning process, and they tend to focus on processes within the learner, or on the influence of individual aspects of the context in which learning takes place (p. 163).

The issues of medical education and learning addressed by Flexner have been and are being addressed in a variety of forums. In 1993 ACME-TRI (*Educating Medical Students: Assessing Change in Medical Education—The Road to Implementation*, 1993) produced recommendations for changing medical schools, which received support for the suggestions and the analysis of needs, but which resulted in little change. This was followed by the Medical School Objectives Project (MSOP) started in 1996 in which the group identified the need for medical education to be relevant to current needs and to identify learning objectives (Curry, in Norman et al, 2002).

Medical resident education is being impacted by a variety of factors including changes and cutbacks in Medicare funding, major changes in specialty accreditation standards, work hour standards established by the ACGME known as Resident Duty Hours, rapidly increasing medical information and technical advances, and greater patient attention to health care standards and results (ACGME; Leach, 2005; Mitchell et al., 2005). In response to greater demands placed upon resident education, ACGME defined six general competencies needed for the practice of medicine and assessment procedures to measure the results. The competencies include are patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and system based practice.

Several goals and objectives for learning are reoccurring in medical literature:

- What can be done to reduce time demands while maintaining and/or increasing educational outcomes (Archer et al., 1991)?
- What interventions can be used without adding extra demands on resident's time (Archer et al., 1991)?

- How to help residents grow in understanding and comprehension of the issues facing physicians, their lifestyles, and specialty demands (Lawrence et al., 1999, p.716).
- Does a match of preferred style of learning between resident and instructor result in the most effective learning (Whitney & Caplan, 1978, p. 686).
- What role is played by the natural tendencies of the individual learner and what is the context in which the studying takes place (Newble and Gordon, 1985)?

For the purposes of this study, focus is on the learning styles which residents use and their relationship to cognitive achievement as learning is essentially an individual process.

Accreditation Council for Graduate Medical Education (ACGME)

The ACGME is a public, voluntary entity composed of volunteer peer experts, residents and non-medical representatives; the intent is to regulate the profession internally without reporting to the government. Its mission is to “improve the quality of health care in the United States by ensuring and improving the quality of graduate medical education experiences for physicians in training” (Leach, 2005, ii56). “In 1997, ACGME committed to the use of educational outcome measures as an accreditation tool. This initiative is supported by three principles:

1. *Whatever we measure we tend to improve.*
2. *Programmes need more flexibility to adapt intelligently to their particular environment and available resources.*
3. *Public accountability* (Leach, 2005, ii56).

As the demands of medicine have become more complex, some have expressed concerns that new doctors may not be well prepared to meet the demands and expectations of the profession (Anderson, et al: The Medical School Objectives Writing Group, 1999). Basic questions from the educators and administrators’ perspective include the definition and measurement of physician performance and the role played by key factors including learning style, job stress, and personality to outcome measures (Mitchell et al., 2005, p. 376).

Six Competencies

In order to improve and measure graduate medical education, ACGME has identified six competencies: patient care; clinical science; interpersonal skills and communication; professionalism; practice-based learning and improvement; and systems-based practice (ACGME Outcomes Project available at <http://www.acgme.org/outcome/comp/compmin.asp>).

The traditional medical educational model has transitioned into competency-based education where there is a requirement for accountability of teaching and learning as measured by a variety of assessments (Brasel, Bragg, Simpson, & Weigelt, 2004). The assessments need to be practical, applicable, valid and reliable in order to provide information to the assessor and the assessed (pp. 9-11).

These six competencies are “patient care, clinical science; interpersonal skills and communication; professionalism; practice-based learning and improvement; and systems-based practice” (ACGME Outcomes Project). Leach (2005) said the competencies “may be thought of as organizing principles that help to clarify thinking about the substance of medicine. We can be constant to these competencies as the forms of medicine change” (p. ii57).

Competency-based learning outcomes is a model for the acquisition of skills and knowledge of the six core competencies as the learner progresses from the novice stage, as a first year medical student, to that of advanced beginner, a first year resident, to competence upon graduation from residency and to proficiency following several years of practice. Some can move on to the expert category, which is attained when other physicians calling upon them when they need guidance and help about a case (Dreyfus & Dreyfus, 1980). Paul Batalden added the category of “master”, those physicians positively challenged by the usual and unexpected (Leach, 2005, p. ii58).

Certification and Accreditation

The professional organizations have lobbied for licensing and/or certification to control membership, the profession, and ethical standards (Leach, 2005, p. ii48), thereby impacting the educational curriculum. “The ACGME has as its mission the improvement of patient care by improving graduate medical education in the USA. It has three points

of leverage: Medicare money to support graduate medical education is linked with accreditation; the eligibility of residents to sit for certifying examinations conducted by the boards is linked to accreditation of the programme that is preparing them, and state licensure is also linked with training in an accredited programme” (Leach, 2005, ii57).

ACGME since 1997 has been “committed to the use of educational outcomes measures as an accreditation tool” (Leach, 2005, ii56). Accreditation examines the graduate medical education programs that prepare residents for board certification. The Specialty Boards examine individual physicians for board certification (ii56). In order to achieve GME objectives, ACGME and the American Board of Medical Specialties (ABMS), working as partners, adopted the same six core competencies.

The six competencies are used by residencies to prepare individuals for the examinations that determine individual outcomes of interest to the boards and the programmatic outcomes of interest to ACGME, which accredits the residencies. The approach presents the opportunity to improve medical education for the individual and the system. For physicians the need for medical and continuing education is permanent and ongoing and is requisite to blending scientific information and technology with the art of medicine, healing, patient care, and education (Leach, 2005).

Educational Goals for Residency

“The Association of American Medical Colleges (AAMC) should stimulate changes in medical education to create a better alignment of educational content and goals with evolving societal needs, practice patterns, and scientific development” (*Taking Charge of the Future: The Strategic Plan for the Association of American Medical Colleges*, 1999, as quoted by The Medical School Objectives Writing Group, p. 13).

Research with students who have failed final examinations in medicine and surgery has demonstrated that the failures did not occur because of lack of effort or for other problems; however, they seemed to have used inappropriate preparations in learning and study leading to examinations. “Educators must continue to provide students opportunities to fully develop the basic professional knowledge, skills, and attitudes desirable in a truly competent physician. The challenge, then, is to achieve a balance between the ‘new competencies’ and those basic professional competencies valued by

our medical students” (Lawrence et al., 1999). Newble and Gordon (1985) identified the need to research students’ learning and study styles to discover more effective strategies to help each resident reach full potential (p. 3). The theme of encouraging more effective learning outcomes has been consistent from Flexner (1910) to Schein (1972) to Curry (1999) and to Leach (2005).

Learning Styles

Research on learning styles has stemmed from two research approaches: 1. cognitive and psychometric psychology, and 2. everyday experiential learning (Newble & Entwistle, 1986a, p. 162). Learning styles have many different definitions, often resulting in confusion about the differences and similarities with approaches to learning, approaches to study, learning orientations, learning patterns, learning process, and learning strategies (Coffield et al., 2004; Curry, 2002, 1999; Laurillard, 1979; Markham, 2004; McManus et al., 2004).

Over the past 50 years, the results of cognitive research have been wide and varied (Curry, 1999, p. 410). Instrument selection included the Allport-Vernon-Lindzey Study of Values (Allport, et al, 1960), the Cognitive Preference Inventory (Tamir, Schiffman, Elstein, Molidor, & Krupka, 1979), the Learning Style Inventory, (Kolb, 1976), the Embedded Figures Test (Witkin, Oltman, Rasking, & Karp, 1971) and many others. Available instruments for research on learning styles had overlapping definitions by overlapping definitions of terms and categories; the broad nature of the learning categories limited the ability to compare results (Vu & Galofre, 1983).

Two camps of learning outcomes’ research emerged. The North American research identified basic learning practices based on stable personality characteristics and information processing (Newble & Entwistle, 1986a, p. 163). Because personality constructs were viewed as more stable, the emphasis was on learning outcomes. The results from learning style assessments were used to match teachers and residents for teaching and learning styles, to understand various ways to present educational materials base, and to assist with career and specialty selection. McManus et al. (2004) concluded that “Formal education, particularly effective formal education, can also alter study habits and learning styles, which are less fixed and ‘trait-like’ than personality measures” (p.

10). Another stream of research, begun as European and expanded to include work from Australia, England, and the United States, identified student approaches to learning based on “the differences observed in how students approach a learning task and how these affect learning” (Newble & Entwistle, 1986, p. 163).

The identification of qualitative differences in learning outcomes led to research on differences in the process of learning—how different individuals go about learning (Marton & Saljo, (1976a, 1976b). Zhang (2002) noted that medical residents use many different ways to integrate skills and abilities and choose strategies that are comfortable, results oriented, and adapted to specific contexts. Zhang concluded, “People’s thinking styles vary depending on the stylistic demands of a given situation and are at least partially socialized, suggesting that they can be modified” (p. 180). In order to help residents learn more effectively, a diagnostic instrument is needed to assess the cognitive, metacognitive, affective, and motivational aspects of learning (Curry, 1999).

Academics outside of adult education and educational psychology embraced learning styles as a relatively straight forward means to improve teaching by identifying ways that students learned. This view connected teaching and learning style with learner outcomes. While learning activities and teaching activities can be described in similar terms, the results of those activities involve a complex process of learning in which the learner is considered as a psychological whole (Laurillard, 1979, p.395).

An important contribution to learning approaches was made by Marton and Saljo (1976a, 1976b) through their exploration of deep and surface approaches to learning. They (1976a) analyzed approaches to studying used by students when reading a complex academic article that was applicable to their coursework. One group of students read for understanding and comprehension of the author’s meaning and intent with the objective of relating new ideas found in the reading to existing knowledge; this pattern was called the *deep approach*. Another group of students tried to memorize the important facts and ideas, influenced by perceived need and application to the specific class requirements. In this process, sometimes the structure of the article and the core information and assumptions were missed. This was identified as the *surface approach*. The students using the deep approach to learning were more successful academically (pp. 7-10).

The Marton and Saljo (1976b) research confirmed that the students using the deep approach had a more complete comprehension of the material and were able to recall more facts directly after reading and when assessed again within a few weeks. The more successful results of students using the deep approach were verified in the pattern of higher examination results. An interesting corollary is the fluidity that students showed in being able to switch between surface and deep approaches to learning (Newble & Entwistle, 1986). Research has shown that it is easier for a deep learner to switch to the surface approach than it is for the surface to adapt the deep approach. Newble and Entwistle (1986) concluded that the deep approach has positive learning consequences and is most used in continuing life-long learning; they noted that students who used the deep approach at times performed better than those who more consistently used a surface approach (p. 164). “Not only does the deep approach seem to be closely allied to the intellectual processes we would wish to see in all university students, but it also seems to be the type of learning of most use to medical practitioners as the basis of their life-long continuing education” (p. 174

Learning Style Research in Medical Education

A panel of the Association of American Medical Colleges looked at the need to learn efficiently and recommended that students’ “approaches to learning the knowledge essential for their general professional education should facilitate the development of their analytic and independent learning skills” (Muller, 1982). Assessments were needed to learn more about the process of learning to learn. With the identification of ACGME six core competencies came the need for measurement and evaluation. Veloski, Fields, Boex, and Boex and Blank, (2005) cited the need for instruments used to evaluate outcomes of medical education have content validity, reliability, and practicality (p. 366). Practicality was defined “as ease of administration; cost-effectiveness; and acceptance by participants, observers, and academic leaders” (p. 369). For medical education purposes, the instrument chosen needed to support academic decision making for relevance and utility (p. 369). The following studies indicate the diversity of learning style research in medical education using a variety of learning style instruments.

Learning styles were used to identify styles of medical educators and physician learning outcomes. Whitney and Caplan (1978) studied learning styles and instructional preferences of family physicians in continuing medical education utilizing the Kolb Learning Style Inventory (LSI); they concluded that while physicians may find greater satisfaction when presented materials utilizing their preferred learning style that it might not result in the most effective learning (p. 686). Sadler et al. (1978) administered the LSI to family practice residents to better understand residents' learning styles and the relationship to learning and performance. The accommodator's learning style and preference for concrete experience and active experimentation in learning was identified for 40% of those who participated.

The relationships of learning styles and career choices were researched. Plovnick (1975) studied medical student learning styles and career choices focusing on the primary care career choices and role models in medical school. Jewett, Greenberg, Foley, Goldberg, Spiegel and Green (1987) looked at learning preferences and career choices, discovering different approaches to learning among the different medical specialties (p. 248).

Vu and Galofre (1983) administered the Inventory of Learning Processes (ILP) to second year medical students, and the results indicated students in both traditional and objective-based mastery schools used a variety of effective and ineffective learning behaviors and techniques. Entering medical students do not seem to use or develop independent learning skills through the first two years. This may be a reflection of the basic science curriculum, where the dependent learning style is consistent with those who have a scientific orientation, it may be a reflection of the academic course load and requirements, and/or it may be a reflection of examinations discouraging independent learning.

Aaron and Skakum (1999) conducted a study of medical students' age and approaches to learning. They confirmed a positive relationship between younger age students at the time of admission to medical school and a tendency to surface approaches (instrumental learning). They administered the Approaches and Study Skills Inventory (ASSIST) to students at the University of Toronto and found two positive correlations. The first is that the younger students tended toward surface learning on entry to medical

school. Those students who entered at the younger ages still showed differences in learning styles at the third and fourth years. The second positive correlation was between GPA, prerequisite courses, and surface learning, and Aaron and Skakun (1999, p. 261) postulated that the science courses required in a premedical curriculum have led to the use of surface learning because of the pressures to get high grades and the scientific nature of the material.

A study by Lonka and Lindblom-Ylänne (1996) looked at differences in learning approaches between students in psychology and medicine. The medical students utilized more characteristics of surface learning including external motivation and reliance on memorization and reproduction-type learning. Higher scores for the medical students on professional factors indicated more interest in professional development rather than more theoretical approaches. (Vermetten, Lodewijks & Vermunt, 1999a, p. 4). The reproduction orientation to learning or surface approaches to learning were noted in all four years of medical school (Coles, 1985; Newble & Gordon, 1985; Martenson, 1986; Leiden, Crosby, & Follmer, 1990; Lonka & Lindblom-Ylänne, 1996). This is also supported by studies on sciences versus the deeper approach to learning used in the humanities; this is a theme that occurs in medical education for specialties that are heavily science oriented.

Learning Style Instruments

Educators and psychologists have used a variety of assessments to measure learning styles with varying results. In the 1970's learning-style instruments were used in research with medical school, resident education and continuing medical education (CME). The learning style instruments used in medical education research were the Rezler Learning Preference Inventory (LPI), the Kolb Learning Style Inventory (LSI) (Baker et al., 1998, p. 527; Jewett, Greenberg, Foley, Goldberg, Spiegel & Green, 1987), and the Lancaster Approaches to Learning Inventory (LI) (Entwistle, Hanley, & Hounsell (1979).

Learning style instruments have been used to identify learning and teacher learning styles (Kolb, 1984), to help with medical career selection (Kolb, 1984; Plovnick, Wunderlich & Gjerde, 1978), to relate to examination scores (Marton & Saljo, 1976b),

and to help with educational planning (Armstrong & Parsa-Parsi, 2005). Past focus has been on helping the poorly performing student improve. The belief was that instructors who had access to learning style results would be better prepared to appreciate differences, utilize the information to focus and improve instructional methods, and identify students with the potential for academic difficulties early as possible (Newble & Gordon, 1985). Researchers focused on various combinations of learning domains and their significance Biggs (1987) provided clarification about three types of learning strategies: deep, surface, and achieving and related each to three study motivations: internal, external, and achievement. Weinstein (1988) developed an inventory for the domains of cognitive processing, motivation, and parts of metacognition.

Vermetten, Lodewijks and Vermunt (1999), Marton and Saljo (1976a) ; Newble and Entwistle (1986) studied learning approaches and verified approaches that were a result of the context of the learning and individual patterns of learning used rather consistently. Data supports academic performance is strongly related to the types of learning activities used during the learning process (Trigwell & Prosser, 1991; VanderStoep et al., 1996). Learning strategies are the patterns or combinations of learning activities and tools used by the student (Hadwin, Winne, Stockley, Nesbit & Woszczyzna, 1997; Vermunt, 1996). The case has been presented that learning styles and approaches are sensitive to contextual features of the teaching (Hadwin et al., 1997) while others (Schmeck, 1983) contend that learning approaches are part of an individual pattern occurring with consistency.

De Bello (1990) provided criteria for the selection of a learning style instrument for use in research studies: reliability, validity, practicality of administration, and applicability by practitioners. The instruments reviewed are *Kolb's Learnings Style Inventory*; *Approaches to Study Inventory* (ASI) the Lancaster group (Entwistle et al. 1979) and the revised version RASI (Entwistle & Tait, 1995); *Learning and Study Strategies* (LASSI) (Weinstein , Goetz, & Alexander, 1988); *Motivated Strategies for Learning Questionnaire* (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1993); and *Inventory of Learning Styles* (ILS) (Vermunt, 1992, 1996, 1998). Note that the ASI (Entwistle and Ramsden, 1983), the ILS, and the SPQ were not developed to predict

academic outcomes but rather to examine relationships between learning strategies and academic progress.

Learning Style Inventory (LSI)

In the 1970's, Kolb researched the psychology of learning and concluded that different individuals learn from the ways in which experience was perceived and processed, resulting in four basic learning style types: diverging, assimilating, converging, and accommodating. His emphasis on the experiential approach differentiated his research from other learning styles work (Guild & Garger, 1998). Kolb indicated two dimensions were needed for learning to occur: the first is the ability to understand and perceive, and the second was the processing of that information. Within the processing was the transformation that occurred when learning had taken place (Armstrong & Parsa-Parsi, 2005). The benefits of using Kolb's LSI (1984) were that the learning styles of instructors and residents helped to increase rapport, improve learning outcomes, lower residents learning stress, and provide a basis for coaching residents experiencing academic difficulties. The objectives were to maximize learning, problem solving, improving relationships, managing conflict, and working in teams (Kolb, 2005, p. 2)

Learning was viewed as four basic processes of a cycle to assist in learning how to learn. In Kolb's model, the scores came from ranking the four choices: choice number four which is "*most like the person*" to choice number one which is *least like the person*, on 12 open-ended choices. The self-scoring results were placed on the Perception and Transformation scales, with four potential learning style outcomes. The four learning modes are Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE) (Kolb, 2005, p. 4). Four basic learning style types emerged which were diverging, assimilating, converging, and accommodating (p. 8) The learning style types provided preferred learning strengths and suggested strategies and ways to develop learning style skills (pp. 8-11).

Kolb's LSI has been used in U.S. studies in medical education resulting in information about learning styles and the choice of medicine and/or specialty choices, identification of learning styles of medical students and physicians to enhance learning

and teaching, and preferred ways of learning. The educational applications included developing more effective curricula, offering learning opportunities designed for the majority of learners, and providing information for curriculum development (Armstrong & Parsa-Parsi, 2005). Plovnick (1975) suggested a correlation existed between medical students' learning styles and medical specialty choices. Wunderlich and Gjerde (1978), however, concluded that learning style and career choice in medicine are not associated. Although both educators and learners with similar learning styles were more comfortable in teaching environments, the learning outcomes did not vary by learning styles. Contradictory results may be explained by varying methodologies, different physician profiles, or different research years. However, irrespective of the medical specialty choice and varying methodologies, most study "findings suggest that medical students and physicians would prefer the learning styles of either accommodators or convergers" (Armstrong & Parsa-Parsi, 2005).

Putting the information about the learning styles represented by Kolb's LSI into a group composite helps faculty instructors understand the necessity of presenting material in a variety of ways that engage the various learning styles, most of which are present in each group. Developing materials in styles differing from the faculty member's preferred style expands the theoretical framework of curricula to include all four learning styles. The emphasis is not on adapting materials to the learning styles of individuals but to design curriculum to maximize curriculum for the group. Curriculum designers use understanding of different learning styles for instructional development and for faculty information to prepare for working with residents more effectively (Armstrong & Parsa-Parsi, 2005).

The instrument was used in medical school studies to research learning styles and career choice and to review the learning style matches between faculty and medical students and residents. Jewett et al. (1987) researched the LSI and the Rezler Learning Preference Inventory (LPI) and concluded there were no significant differences between the two instruments. However, the important application of their learning style studies was in helping doctors in their selected residency programs to more fully understand their learning process.

Approaches to Study Inventory (ASI)

The Approaches to Study Inventory (ASI) by the Lancaster Group (Entwistle, Hanley, & Hounsell, 1979; Entwistle & Ramsden, 1983) was based on the work of Marton and Saljo (1976a, 1976b) on deep and surface approaches to learning. The ASI has been revised as the Revised Approaches to Study Inventory (RASI) (Entwistle & Tait, 1994) and “identifies six approaches to learning: deep approach; surface approach; strategic approach; lack of direction; academic self-confidence; and metacognitive awareness of studying” (Cassidy, 2004, p.434). The ASI was not designed to measure academic performance (Entwistle and Ramsden, 1983; Zeegers, 2001) but focused on study methods, academic motivation (Entwistle & Entwistle, 1970) and achievement motivation (Atkinson & Feather, 1966).

The ASI was a student self-report questionnaire with four major factors and sixteen subscales (Newble & Gordon, 1985, p. 3). The subscales include “meaning orientation (deep approach, relating ideas, use of evidence and logic, and intrinsic motivation); reproducing orientation (surface approach, syllabus bound, fear of failure and extrinsic motivation); achieving orientation (disorganized approach, negative attitudes, strategic approach and achievement motivation), and holistic orientation or styles and pathologies (comprehension learning, globetrotting, operation learning and improvidence)” (p. 4).

Lindemann, Duek, and Wilkerson (2001) administered the ASI to medical students, and their results indicated that the majority of medical students starting medical school were more similar to the learning styles of science students than to art students; high scores were demonstrated high on the reproducing orientation. Group scores on this factor did not differ significantly between entering and graduating groups. However, there were yearly rises in meaning orientation with the highest scores registered by students in their last year of medical school (pp. 164-165). This may be a factor of a developmental component of growing maturity, as shown by Perry (1970) interviews. The question remained about the outcomes: were they a factor of individual tendencies or a result of the context of study (p. 7). The ASI has been used widely in educational research and Duff (2000) examined psychometric properties and recommended its continued use.

Learning and Study Strategies Inventory (LASSI)

Weinstein et al. (1987) published the Learning and Study Strategies Inventory (LASSI) in 1987); the LASSI was diagnostic instrument to link training in study skills and achievement outcomes of beginning and undergraduate college students (Entwistle & McCune, 2004; Weinstein et al. 1987, p. 2). The self-administered, self-reported, and self-scored instrument revealed attitudes, motivations, and study practices; this data helped focus presentations about study skills and strategies in training programs (Blackwell in Kramer & Conoley, 1992, p.449; Entwistle & McCune, 2004, p. 332). The instrument was diagnostic and prescriptive in identifying areas of strengths and weaknesses in three domains: cognitive (information processing and strategies), motivation, and self-regulation (Entwistle & McCune, 2004; Zeegers, 1999). The instrument had high face validity and was suited for use with entry-level study skills training for undergraduate students; it lacked informative statistical validity and reliability data (Blackwell and Hayes, in Kramer & Conoley, 1992, pp. 449-450).

Motivated Strategies for Learning Questionnaire (MSLQ)

Pintrich and Garcia (1993) and colleagues began development of the Motivated Strategies for Learning Questionnaire (MSLQ) in the 1980's as a research and evaluation tool to enrich student learning, as viewed by students and faculty, and to evaluate learning to learn courses (Pintrich & Garcia, 1994; Pintrich et al. 1993). The instrument, self-report, had two sections: a motivation and a learning strategies section. Further development led to work on the potential for predicting its relationship to grades (Pintrich et al. 1993). The instrument was based on a theoretical model that integrated cognitive information processing and motivation (Pintrich et al. 1993; Pintrich & Garcia, 1993, 1994), learning strategies, self-regulation, and self-efficacy (Zeegers, 2004). The motivation strategies comprised three broad areas: expectancy, value, and affect (Entwistle & McCune, 2004, p. 334; Pintrich et al. 1993). The learning strategies included nine scales, separated into cognitive, metacognitive, and resource management strategies. Scale reliabilities were strong, and the instrument showed reasonable predictive validity to students' academic performance (Pintrich et al., 1993, pp. 811-812).

Vermunt's Inventory of Learning Styles (ILS)

The ILS was developed by Vermunt for use in higher education as a diagnostic instrument to study student-learning processes (Busato, et al., 1998, 1999; Vermetten, Lodewijks, & Vermunt, 1999; Vermunt, 1998). The ILS has been used in university studies, including medical education. The instrument was based on educational psychology and constructivist theory (Boyle, Duffy, & Dunleavy, 2003; Vermunt, 1998). The early work in the 1980's resulted in the use of the term learning styles. Because of comments about the lack of definition, the usages of instruments and the overlapping of constructs, Vermunt (2005) responded with the use of the term learning patterns. The term learning style was used by Vermunt (1996, 1998) as a super ordinate concept and was modified to learning patterns in his later research about learning.

Learners do not automatically learn because teachers teach. Understanding what activities individual students use and how they use them in their learning plays an important part in higher education outcomes. To understand the domains of learning, perspective and integration of cognitive, metacognitive, affective, and motivational elements were needed (Curry, 1999; Vermunt, 1996). To develop his instrument, Vermunt (1996) interviewed students to determine performance on cognitive, metacognitive, and affective learning functions as regulated by internal and external sources. The four learning domains were identified as cognitive processing strategies (cognition), metacognitive regulation strategies (metacognition), conceptions of learning (views about teaching and learning), and learning orientations (motivation). Each of these had five scales (Vermunt, 1996, 1998, 2005). Following are the four domains of the ILS.

Cognition

The cognitive domain centered on knowledge and the development of intellectual processes such as the thinking activities used by students that result in increased knowledge and skills (Vermetten, Lodewijks, & Vermunt, 1999, p. 150). Marton and Saljo (1976a, 1976b) studied the approaches students used in reading an article connected to their area of study. The results of the qualitative study were the identification of two cognitive approaches to studying: deep and surface. "The results also confirmed a

relationship between the students' approach to learning and their subsequent level of understanding" (Newble & Entwistle, 1986, p. 164).

In the ILS, the cognitive processing strategies domain had five scales: two subscales for deep processing, two sub-scales for stepwise processing, and the scale concrete processing.

Metacognition

Custers and Boshuizen (2002) stated, "Learning is viewed as an active, constructive process: central aspects of learning are the mental activities of the learner, including the active selection of stimuli, organization of the material, construction of responses, and the use of learning strategies. In addition learning is viewed as largely under the control of the learner; learners use the knowledge of how they learn and other factors that influence their learning. . . (e.g., by planning and monitoring), a phenomenon that is called metacognition—thinking about thinking (Custers & Boshuizen, 2002, in Norman, van der Vleuten, & Newble, p. 172). Vermetten, Vermunt, and Lodewijks (1999) defined metacognitive regulation activities as those that regulate and control the cognitive processes and therefore indirectly influence learning outcomes (p. 222).

In the ILS, the metacognitive regulation strategies domain had five scales; two sub-scales for self-regulation, two sub-scales for external regulation, and the scale lack of regulation (Vermunt, 1998).

Motivation

Motivation at its core deals with what people think, why they think as they do, and how it affects their behavior (Wlodkowski, 1999, p. 67). Learning orientations and student motivations refer to personal goals, doubts, and attitudes that influence the actions of students in learning activities (Vermunt, 1998, p. 151). These included orientations of certification, vocational, and self-testing. Doubts and worries about academic ability to do the work are expressed in an ambivalent orientation (Vermunt, 1996; Vermetten, Vermunt & Lodewijks, 1999).

In the ILS, the learning orientation domain (motivation) has five scales: personally interested, certificate oriented, self-test oriented, vocation oriented, and ambivalent.

Conceptions of Learning

Conceptions of learning, also referred to as mental models of learning, revealed the students' views about the teaching and learning process, the view of self as a learner, and role of other students (Vermunt, 1998). The broader term includes theories about learning and teaching along with who has responsibility for the tasks of the learning process including teaching and learning activities, learning objectives and tasks (p. 151).

In the ILS, the conceptions of learning domain has five scales: construction of knowledge, intake of knowledge, use of knowledge, stimulating education, and cooperative learning.

Four Learning Styles

Vermunt (1998) identified the four learning styles, which were the meaning directed learning style (MDLS), the reproduction directed learning style (RDLS), the undirected learning style (UDLS), and the application directed learning style (ADLS). The identification of these learning styles resulted from a factor analysis of the interplay of learning domains (conceptions of learning and learning orientation) and regulations (cognitive processing strategies and metacognitive regulation strategies). Through factor analysis of the 20 scales that comprise the learning domains, Vermunt (1996) identified four learning styles: meaning-directed, reproduction-directed, undirected, and application-directed learning style (p. 47).

A variety of definitions of learning styles exist amid various grouping of learning domains; however, for the purposes of this study the definition of learning styles selected is that of Vermunt (1996): "a coherent whole of learning activities that students usually employ, their learning orientation and their mental model of learning; a whole that is characteristic of that at a certain period" (p. 29). Table 1 lists the domains of each learning style or pattern.

Vermunt and Vermetten (2004) summarized the learning patterns and characterized them from the least desirable to the most desirable: undirected learning style, reproduction directed learning style, application directed learning style, and meaning directed learning style (p. 364). The conclusion included the assumption that one style would be more dominant, but that the elements of each style are present in each learner (Vermunt, 1995, 1998; Vermunt and Vermetten, 2004).

Vermunt summarized the learning styles (1995): The student with an undirected learning style has difficulty identifying the major and minor points, tends to read and reread, feels overwhelmed by the amount of material, lacks regulation of the learning processes, senses uncertainty about academic abilities, and questions the choice of academic discipline. Students with a reproduction learning style rely on memorizing and analyzing to fulfill the academic requirements, look to the instructor to provide guidance about what to learn, and are motivated by certificate requirements. RDLS students have a mental model of learning where the intake of knowledge is guided by others, an external regulation. Students with the application directed learning style are regulated both internally and externally, knowledge is to be used and applied, and the motivation is vocationally oriented. The meaning directed learning style focuses on deep processing strategies, self-regulated learning strategies, personal interest in learning, and construction of knowledge. The meaning directed learning style is positively related with academic results (Vermunt, 1998, 2005; Boyle 2003).

As a part of understanding learning styles, student learning is viewed as a combination of individualized patterns, context, and learning requirements. Three groups of factors were identified by Entwistle (1983) as influencing student learning: these characteristics included student patterns, teaching influences, departmental structure, curriculum, and standards. In student learning patterns, three developmental phenomena emerged. Differentiation in learning domains is related to student experience; the more experienced students show a greater flexibility in their use of learning strategies, conceptions and orientations. More experienced students demonstrate more integration between learning strategies, conceptions and orientations. Vermunt (1996) noted that adult or advanced students apply application-directed learning, which is a separate learning pattern that appears relatively late; this learning style appears in strongly application oriented educational environment like vocational education (p. 379). Differentiation demonstrated that learning patterns can be changed and that they evolve with experience with higher education which includes variables of student characteristics, teaching, programmatic characteristics, and context. On a course specific level, students were able to use individual and context specific domains in their learning strategies. (Vermunt & Vermetten, 2004, p. 379).

The role of the learning context is important to the structure of the learning patterns; Vermunt and Vermetten (2004) explained:

The more the context deviates from the first years of higher education, the more the internal structure of the learning patterns differs from this four-dimensional structure. The meaning-directed, reproduction-directed and undirected patterns are found in various contexts. Application-directed learning is especially found as a strong separate dimension among adult students. In strongly application-oriented environments. . .all students seem to become more application directed in their learning (p. 379).

Vermunt and Vermetten (2004) studied the learning environment for stability of learning patterns. The outcome included a context-specific and individualistic component of learning strategies, demonstrating both consistency and variability. The relationship between learning style and achievement resulted in better outcomes for students with deep learning patterns and negative ones for students with undirected learning (Vermunt & Vermetten, 2004).

Additional authors have conducted research in the analysis and application of the ILS. Boyle et al. (2003) studied the relationship of learning styles and academic outcomes in British higher education using the Inventory of Learning Styles. The ILS provided a useful tool for the identification of the learning styles, and more integration and comprehension of models of effective learning. The results confirmed that the ILS is a diagnostic instrument not a predictive one; an important diagnostic role may be the early prediction of learners at risk for poorer academic outcomes as identified, in part, by the undirected learning style (p. 287). The analysis of learning styles with grade point average was significant and positive for scales deep processing, relation and structuring, critical processing, stepwise processing, analyzing, self-regulation learning process and results, and self-regulation learning content. The significant negative findings were for intake of knowledge, co-operative learning, and ambivalent scales. The positive scales are relatively consistent with the meaning directed learning style as identified by Vermunt and the latter with the undirected meaning style. Students with the undirected learning style had lower grade point averages.

Busato, Prins, Elshout, and Hamaker (1999) studied the relationship between learning styles as determined by the ILS, personality traits, and achievement motivation with first year university psychology students. The ambivalent scale, addressing fear of failure, had a negative correlation with the meaning directed learning style. One of the conclusions was, “The results of this research might have some diagnostic implications for students characterized by an undirected learning style, because a clearer picture of these students is beginning to emerge” (p. 137). This supports the findings of Busato et al. (1999) of the undirected learning style as a negative predictor of success. The research contributes to understanding learner motivations and practices; the practical application is for educators and counselors to develop training programs to help students at risk academically (Busato et al., p. 138).

Inventory of Learning Styles Validity and Reliability

Vermunt (1998) provided information to support the reliability of the 20 scales with Cronbach alphas from the lowest one at .48 to the majority in the .60 to .79 range with the highest being .90. The factor analysis of the 20 scales supported the construct validity of the four learning styles. Boyle et al. (2003) concluded that the reliability estimates for the four learning styles and the 20 scales were reasonable (p. 284). Some of the scales on the ILS had low reliabilities, suggesting a need to simplify; however, the authors did believe that the ILS was a useful diagnostic instrument (p. 287). Boyle et al. (2003) conducted a backward regression of four ILS domains and concluded that the four factor model was the best fit (p. 276).

History of In-Service Training Examinations

Measures of the medical knowledge of residents are used to guide education and assess preparation for medical practice. In-Service Examinations (multiple-choice questions) were written to help the resident determine areas of weakness early enough in the residency for improvement, to help residency directors in curriculum development, and to assess various programs for accreditation with specialty boards. The orthopedic surgery and neurosurgery specialties began their examinations in 1964 with three primary goals:

1. to define a content domain of knowledge necessary for competent practice

2. to assess the relative strengths and weaknesses of individual residents at a time early enough in their training that deficits can be corrected
3. to help directors of residency training programs detect areas of relative strength and weakness of their programs (Gross et al.,1980, p. 654).

The American Board of Surgery In-Training Examination (ABSITE) resulted from the work of an In-Training Examination Subcommittee, and has been offered annually since 1975. Almost all board members were directors of residency programs and dedicated to the improvement of surgical residencies. Surveys of residency directors have been conducted with the following results: 86% utilized the results, in part, for considerations of promotion to the next year, and 87% identified areas of residency program strength and weakness as reflected in the residents' scores. This resulted in more useful performance results for residency directors (Grosse, Cruft, & Blaisdell, 654).

Anesthesiology In-Service Training Examinations serve several functions: to determine advancement to the next postgraduate year; to assess strengths and weaknesses early in the residency program to allow time for improvement; to help residency directors make necessary curriculum adjustments, and to prepare residents for the American Board of Anesthesiology (ABA) certification examination at the conclusion of the residency. Hall and Cotsonis (1990) devised a new calculation to provide more access to usable data from In-Training Examinations resulting in the development of a resident index score (RIS). As a result of looking at ITE results "among the eight programs in four of the five years"(1990, p. 475), they were able to provide data to the residency directors of "a categorized key work listing of all items and an indication for each item that more than 50% of the program's PGY III residents missed" (1990, p. 477). Prior to this the information available to program directors was the "Growth in Knowledge curve, which was limited to one PGY level" (1990, p. 477). Analysis of the results showed residents above and below national averages in all residency years and in almost all categories listed as viewed for the eight anesthesiology residency programs. "Analyses using categorized item performance by PGY level have served as a useful supplement to the current ABA-ASA reports" (Hall & Cotsonis, 1990, p. 477) resulting in curriculum content change, modification of teaching format, and focused ISTE review for residents.

The ITE results are generated nationally, offering residency directors information about program and resident standards relative to national results.

Summary

This chapter included a review of educational psychology, adult education, and medical school and graduate medical education literature focused on professional adult education. The literature from this review provided a foundation for the study of the relationship between anesthesiology residents' cognitive scores (as measured by the In-Training Examination) and learning styles and patterns by post-graduate year (as measured by the Vermunt Inventory of Learning Styles). A review of learning styles and patterns is relevant to this study for several reasons:

1. The resident learning styles are a function of individualized regulation strategies.
2. The learning styles change as learning requirements increase over time.
3. Wider ranges of thinking and learning options result in higher levels of cognitive functioning.
4. Learning styles include a combination of contextual and personological variables.
5. The resident has the ability to modify these styles.

Previously thought was that learning occurred as a part of routine residency tasks; however, the traditional views that the teacher teaches and the resident learns are no longer adequate for the increasing complexity facing the medical profession. Learning is an active, individual, constructive process.

In the past, courses that taught study skills were not well received by medical students. However, research demonstrated that medical students who are given information about their learning styles and patterns early in medical school benefited from information about learning how to learn more effectively through understanding their learning strengths and weaknesses. Studies have shown that students who fail in medicine usually do not do so for lack of effort but instead lack of understanding about more effective ways to prepare and learn.

Faculty physicians often have not been provided with any training in educational theories or information about how residents learn, the nature of cognitive apprenticeships, and the importance of the relationships between the novice-level entering resident and the expert-level faculty physician. Often the faculty physician is so skilled at procedures and the theories that support medical decisions and procedures that it is difficult to break skills down into understandable steps for teaching.

The ITE scores are given nationally and scored by postgraduate years. The analysis of scaled scores indicates that the number of correctly answered questions goes up with every postgraduate year. Percentile ranks are provided for each postgraduate year, which helps the resident to help understand individual results in the national context (Rosenthal & Hughes, 2005).

The expanding medical knowledge base and rapidly improving technology bounded by limitations on weekly work hours and the defined period of graduate medical education necessitates the enhancement of graduate medical education learning. To understand how to do this more effectively, more information is needed about the learning approaches and strategies of resident physicians as professional adult learners. The study of relationships between learning styles and domains leads to patterns of learning how to learn more effectively in order to guide physicians in their life-span development.

The academic demands on anesthesiology residents continue to increase while the period of graduate medical education stays fixed. The learning styles of residents with higher ITE scores reflect learning strategies related to cognitive achievement. Understanding the importance of these strategies and their relationship to higher cognitive achievement may help individual residents modify learning activities, residency directors to adapt strategies as needed, and faculty to receive some background in the basic sciences of adult education. Learning styles offer an opportunity for early identification of residents who may be potentially at risk academically. To enhance anesthesiology learning, data is required about the learning strategies and activities that are positively and negatively related to cognitive achievement.

Chapter 3 - METHODOLOGY

Introduction

This chapter includes information about the methods used in this study. The research questions are followed by an overview of the research design and a discussion of the criteria for selection of instruments. A discussion includes the assumptions of the research, details of the study design, data collection procedures, and data analysis procedures.

Research Question and Hypotheses

The following research question and hypotheses were used to guide this study:

Primary Research Question

Is there a relationship between resident achievement and learning styles and domains? If so, what is the nature of the relationship(s)? For this study, resident achievement was measured by In-Training Examination (ITE) percentile ranks. Learning styles and domains included cognitive processing strategies, metacognitive regulation strategies, conceptions of learning, and learning orientations, which were assessed by the Inventory of Learning Styles.

Research Hypotheses

- H₁ There is a relationship between learning styles and resident achievement that varies by postgraduate year, gender, and ethnicity.
- H₂ There is a relationship between resident achievement and the learning domain cognitive processing strategies, comprised of the scales deep processing (relating and structuring, critical processing), stepwise processing (memorizing and rehearsing, analyzing) and concrete processing.

- H₃ There is a relationship between resident achievement and the learning domain metacognitive regulation strategies, comprised of the scales self-regulation (learning process and outcomes, learning content), external regulation (learning process, learning outcomes), and lack of regulation.
- H₄ There is a relationship between resident achievement and the learning domain conceptions of learning, comprised of the scales construction of knowledge, intake of knowledge, use of knowledge, stimulating education, and cooperative learning.
- H₅ There is a relationship between resident and the learning domain learning orientations, comprised of the scales personally interested, certificate oriented, self-test oriented, vocation oriented, and ambivalent.

Research Design Overview

The research was a descriptive study using survey methods to gather data on anesthesiology residents' learning styles. The primary purpose was to explore the relationships between ITE percentile ranks as a measure of cognitive achievement and learning styles to test the hypotheses and explore generalizations (Best & Kahn, 2003). The survey method was used to gather information from residents to be analyzed as aggregate data, to standardize the data gathering process, and to provide uniformity in questions, using a relatively inexpensive format (Barribeau, Butler, Megan, Gault et al. 2005; Best & Kahn, 2003).

Instrumentation

The instruments selected for this study were chosen based on the research questions and potential for operational use. Veloski et al. (2005) stated that instruments used to evaluate outcomes of medical education must have content validity, high reliability, ease of administration, cost effectiveness, and acceptance by faculty and residents (p. 366-369). For medical educational use, the instrument(s) chosen need to support "operational use for academic decision making" (p. 369).

A variety of instruments using the terms learning style, learning patterns, self-regulated learning, learning strategies, and study strategies are available. Cook (2005)

stated, “Learning styles research and applications have been limited by a paucity of evidence supporting the validity of assessment scores” (p. S100). With over 71 instruments related to the assessment of learning styles and strategies, criteria were developed for instrumentation selection based on the research question and hypotheses of this study. Mitchell et al. (2005) conducted a literature review to develop a model of factors affecting resident performance in response to competency reviews and accreditation. Their model includes the main headings of Physician Performance Factors, Health Care System Infrastructure, and Individual Physician State (p. 77). The latter has five main sections which are Learning Style and Personality, Social/Financial Influences, Preferences for Practice, Personal Health, and Response to Job Environment. For the purposes of this study, the following categories for Learning Style and Personality are listed:

- Learning Style
- Metacognitive knowledge structure
- Self-learning habits
- Self-learning expectations
- Personality type
- Motivation (Mitchell et al., 2005, p. 77).

Instrument selection in this study was based, in part, on the above variables with the exception of personality type, which is beyond the scope of this research. To support instrument selection, the following are Inventory of Learning Styles literature citations. The inventory was developed for use in higher education (Busato et al., 1998; Vermetten, Lodewijks, & Vermunt, 1999; Vermunt, 1998, 1996). An analysis of the instrument revealed that the components measured were based on educational theory (Boyle et al., 2003; Markham, 2004; Vermunt, 1998). The instrument supports the philosophy that learning activities are controlled by the learner, the constructivist theory (Boyle et al., 2003; Lonka & Lindblom-Ylänne, 1996; Vermunt, 2005, 1998). Learning activities have cognitive, affective, and regulative components, and the interplay of these activities with teaching and learning as measured by the ILS provides valuable information about the student and the learning context in an integrated model of learning (Busato et al, 1999; Coffield et al., 2004, Vermunt, 1996, 1998). The ILS was designed as a diagnostic

instrument for use in higher education (Busato et al., 1999; Vermunt, 1996, 1998) and has been used in studies in medical education (Lonka & Lindblom-Ylänne, 1996). Validity and reliability have been established (Boyle et al., 2003; Coffield et al., 2004; Severiens, 1997; Vermunt, 1998). The instrument has a history of adaptability to the study context (Ajisuksmo & Vermunt, 1999; Klatter, 1996 as cited in Vermetten, Vermunt, Lodewijks, 1999). The instrument is used with adult students (Van Eekelen et al., 2005; Vermunt & Vermetten, 2004) and has a history of international use (Ajisuksmo & Vermunt, 1996; Alexander et al., 1997; Klatter, 1996; Boyle et al., 2003; Moore, 1994; Morris, 1997; Vermetten, Vermunt, Lodewijks, 1999). Study results have been published in multiple journals (*British Journal of Educational Psychology*, *Contemporary Educational Psychology*, *Educational Psychology*, *European Journal of Psychology of Education Review*, *Higher Education*, and *Learning and Instruction*).

The following criteria for the use of educational assessments in GME were described by ACGME (Lynch & Swing, 2000) were used in selecting an assessment instrument for this study: The assessment instrument needs and reliable data, demonstrate external validity of application to the assessment circumstances, and provide valuable information (pp. 1-2). The ITE is a measure of cognitive achievement accepted by ASA/ABA as meeting the previous criteria (Rosenthal & Hughes, 2005, p. 33).

The Educational and Demographic Questionnaire (Appendix C), designed by the investigator, was used to report information about personal characteristics and educational information of anesthesiology residents.

Inventory of Learning Styles

Although use of learning style inventories in the 1970's and 1980's centered on career selection and prediction of academic performance, more recent work studied context and circumstances, the ideas of metacognition and self-regulation, and a review of study processes (Entwistle & McCune, 2004, p 334). Student learning activities exert a significant effect on the learning results achieved reflecting three components: cognitive, affective, and regulatory. Categories of cognitive activities include analyzing, relating, concretizing, applying and memorizing. The affective components are motivations, concentration, evaluation, expectations, and emotions about learning. The regulative activities coordinate and control the cognitive processes including planning, adjusting,

and testing. As teaching does not always lead to learning, another domain of learning to the role of the teacher, the student, and other students.

Vermunt developed the Inventory of Learning Styles (ILS) as a diagnostic research tool to help higher education students and teachers think about learning how to learn by integrating existing models of learning, investigating the role of context, and studying the regulation of learning processes and outcomes (Vermunt, 1998, p. 150). The instrument has four domains identified in qualitative research studies designed to explore students' understanding of learning (Vermunt, 1996); these domains include cognitive processing strategies, metacognitive regulation strategies, conceptions of learning, and learning orientations; each of the domains has five scales. Some scales have subscales; for example, deep processing has two sub-scales: are relating and structuring and critical processing (Table 1, p. 61).

The ILS is a view of “a coherent whole of learning activities that students usually employ, their learning orientation and their mental model of learning: a whole that is characteristic of them at a certain period” (Vermunt, 1996, p. 29). Factor loadings of the 20 ILS scales in a four-factor oblique rotation resulted in the identification of four learning styles: meaning directed learning style, reproduction directed learning style, undirected learning style, and application directed learning style. The undirected learning style indicates a lack of regulation, difficulty in recognizing the most important points, doubts about ability to do the work, and an absence of use of systematic and effective strategies; the undirected learning style is the least desirable (Boyle et al., 2003, p. 286). The reproduction directed learning style reveals external regulation, a focus on memorization, surface learning, and lower critical processing. The application directed learning style identifies the practical, personal application of use of the knowledge that is learned. The meaning directed learning style, the most desirable, is self-regulated with deep processing strategies with the focus of practical application and use (Vermunt, 1988, 1996, 1998).

Learning style is not viewed as unchangeable but as a representation of the relationship between personal and contextual influences. Therefore, learning style, as defined by Vermunt, is a coordinating concept identifying interrelations among the components of cognitive processing strategies, metacognitive regulation strategies, and

conceptions of learning. Big differences can occur between students in the execution of learning activities, even when guided by the same instructors (p. 45). Researchers identified the ability of students to adapt their strategies in the context of the learning environment, and to evaluate thinking and learning (metacognition) (Entwistle, 1997; Vermunt, 1996, 1998).

One of Vermunt and Vermetten's (2004) stated research objectives was the "integration of existing conceptualizations of student learning components and to link metacognitive aspects of student learning to students' cognitive process strategies and study motivation" (p. 361). The objective of learning style and strategies inventories shifted from the earlier emphasis on usefulness in academic prediction and career selection to a focus on self-regulation and the teaching/learning conceptions as viewed by the student (Entwistle, 1997; Vermunt, 1996, 1998). Newble and Entwistle (1986) stated that learning styles and strategies research contributes to deeper understanding of the teaching-learning process by helping teachers assist students in learning how to learn (pp. 172-173). Research indicates that learning approaches may be modified depending on motivation and the view that the task required may benefit from other approaches (McManus et al. 2004; Newble & Clark, 1986; Newble & Entwistle, 1986; Newble & Gordon, 1985).

Learning how to learn is an important component of professional education. In order to improve teaching methodology and assist residents in developing a more advanced deep-level learning, additional information is needed about the learning styles of anesthesiology residents, both within and between post-graduate years. The literature does not address the learning styles of anesthesiology residents based on cognitive, metacognitive, motivations, and conceptions of learning components.

The Inventory of Learning Styles was modified with permission of the author, J.D. Vermunt, to adapt only the terminology of teacher/student to faculty/resident for applicability to graduate medical education.

In-Training Examination

Medical specialty boards produce written, multiple-choice examinations given yearly to residents in training for three purposes: 1) to determine a level of knowledge

necessary for the competent practice of the specialty, 2) to determine the relative strengths and weaknesses of residents early enough in the training program so that deficits can be corrected, and 3) to assist residency directors in determining areas of strengths and limitations in residency training and education (Grosse et al. 1980; Hall & Cotsonis, 1990; Rosenthal & Hughes, 2005). In-Service Examinations were created by the American Society of Anesthesiologists and American Board of Anesthesiology (ASA-ABA) in 1972. In addition to the three purposes listed above, ABA assessed various programs for accreditation with specialty boards (Hall & Cotsonis, 1990; Rosenthal & Hughes, 2005). To assist with examination preparation, The Educational Testing Service (ETS) Princeton, New Jersey, participated with ABA from 1957 to 1965. Since 1965, the National Board of Medical Examiners (NBME) has provided support and consultation (Rosenthal & Hughes, 2005, pp. 32-33).

Anesthesiology In Training Examinations serve several functions: to contribute scores to help determine advancement to the next PGY, to assess strengths and weaknesses early in the residency program, to allow time for improvement, to help residency directors make necessary curriculum adjustments, and to prepare residents for the ABA certification examination (Hall & Cotsonis, 1990). The resident index score (RIS) was developed “to assess performance by category and by postgraduate year (PGY) level within and among residency training programs” (pp. 475-476). As a result, data from ITE scores are provided to residency directors about items missed by more than 50% of PGY III residents (p. 477). Prior to this, the information available to program directors was the Growth in Knowledge curve which provided information on only one PGY (p. 477). Analysis of the results of the RIS showed residents above and below national averages in all residency years and in almost all categories. “Analyses using categorized item performance by PGY level have served as a useful supplement to the current ABA-ASA reports” (Hall & Cotsonis, 1990, p. 477), resulting in curriculum content change, modification of teaching format, and focused ITE review for residents.

The ITE is given to anesthesiology residents as a measure of cognitive achievement; the resulting standardized scores are equated to a benchmark scale. Each resident receives scale scores, percentile rank, and an “ABA/ASA Improvement In Performance Report” (Rosenthal & Hughes, 2005, p. 34). The Joint Council on In-

Training Examinations, formed with members of ABA and ASA, guide the test development process and work in conjunction with NBME, using the Rasch (1966) psychometric model (Rosenthal & Hughes, 2005, pp. 33-34). The equated scores on ITE are different from ABA scores for board certification, preventing comparisons between the two (p. 36).

All residents of accredited anesthesiology residency programs take the ITE annually. Scaled scores and percentile ranks are based on national scores of all participating anesthesiology residents and are sent to the resident directors. “The ABA reported a percent correct score to candidates until 2001 when a standardized score, equated to a benchmark scale, replaced it” (Rosenthal & Hughes, 2005, p. 34).

Assumptions

The following assumptions guided this study:

1. Residents are highly educated adult advanced learners.
2. Residents have identifiable learning strategies and approaches to learning.
3. Learning strategies and approaches affect cognitive information gained from learning activities.
4. The residents in the study will provide honest answers.

Participants

The population for this study consisted of all residents enrolled at the following accredited residencies for anesthesiology graduate medical education for the postgraduate year beginning July 1, 2006 and ending June 30, 2007. The programs were the University of Kansas School of Medicine—Wichita (UKSM-ICT) and Kansas City (UKSM-KC); Penn State, Milton S. Hershey Medical Center (PSHMC); the University of Arkansas Medical Sciences (UAMS); and Ochsner Clinic Foundation Program (OCFP). A total of 169 residents were enrolled in anesthesia graduate medical education at all five sites. A total of 112 residents participated, with the sizes of the programs ranging from 16 to 57. The number of participating residents were 16 (UKSM-ICT), 15 (UKSM-KC), 36 (PSHMC), 30 (UAMS), and 15 (OCFP). All of the residents who attended the

information session received a copy of the Study Explanation (Appendix D); all residents who attended the informational meeting participated in the study. The sample varied in sizes of subgroups by gender, ethnicity, and postgraduate year. The average age of the residents was 31 years with a range of 28.7 to 32.6 years over the four year postgraduate period. Of the participants, 68% were men, 32% were women, and 73% were Caucasian. The postgraduate class size ranged from 15 for postgraduate year zero to 35 for postgraduate year one.

Reliability, Validity, and Factor Analysis of Measures

The Inventory of Learning Styles

The Inventory of Learning Styles (Vermunt, 1998) measured the residents' perceptions of their individualized learning applications in the cognitive, metacognitive, motivation, and conceptions of learning components. Vermunt (1998) designed the instrument in two parts: Part A: Study Activities, and Part B: Study Motive and Views on Studying. The instrument used a Likert-type scale with a set of alternatives for Part A and another set for Part B. Part A's alternatives for questions number 1 - 55 were: 1. *I do this seldom or never*, 2. *I do this sometimes*, 3. *I do this regularly*, 4. *I do this often*, and 5. *I do this almost always*. For questions 56 – 120 in Part B, the alternatives were: 1. *Disagree entirely*, 2. *Disagree for the most part*, 3. *Undecided*, 4. *Agree for the most part*, and 5. *Agree entirely*.

Vermunt (1998) conducted a study ($N = 1449$) with regular and open university students analyzing the ILS learning domains. Open university students use self-instruction materials that support the learning processes with tutorial support. The regular university students combine independent study, lecture and tutorials (p. 154). The Cronbach alphas of the cognitive processing strategies by scales varied between .63 to .85; the metacognitive regulation strategies varied between .67 to .81; the mental model of learning varied between .74 to .93; the learning orientations varied between .74 to .86 (Vermunt, 1998, p. 160). In research studies, the main scales or subscales may be used, dependent on the research goals. The exploratory factor analysis (Table 1, p. 61), an oblique rotation selected because of possible scale interrelationships, resulted in the identification of four learning styles. Other studies supported the theoretical and

statistical identification of the four learning styles from the ILS scales (Boyle et al., 2003; Severiens, 1997; Vermunt, 1992).

Vermetten, Vermunt, and Lodewijks (1999) studied learning strategies in higher education using the ILS with freshmen and again with the same students three semesters later as advanced students. The Pearson correlation coefficients between freshmen and advanced students for the domain scale variables of learning strategies varied between .51 and .72. For the learning orientations the coefficients varied between .58 and .71. With mental learning models the coefficients varied between .54 to .64. All coefficients were significant at the .01 level. A factor analysis of the ILS component scales of the freshmen and advanced students indicated that the advanced students reported more use of the meaning directed learning style. The scales identified for the meaning directed learning style of the freshmen were critical processing, the two self-regulated scales, concrete processing and relating and structuring. Two additional meaning directed learning style scales were identified for the advanced students: construction of knowledge and personally interested. (p. 233).

Table 1
Factor Loadings (Pattern Matrices) of ILS

| ILS Scales | F1 | | F2 | | F3 | | F4 | |
|--|-------|------|------|------|------|-----|-----|------|
| | OU | RU | OU | RU | OU | RU | OU | RU |
| <i>Processing Strategies</i> | | | | | | | | |
| Deep processing | | | | | | | | |
| Relating & structuring | .71 | .72 | | | | | | |
| Critical processing | .75 | .70 | | | | | | |
| Stepwise processing | | | | | | | | |
| Memorizing & rehearsing | | | .65 | .73 | | | | |
| Analyzing | .27 | | .69 | .76 | | | | |
| Concrete Processing | .58 | .65 | | | | | .43 | -.39 |
| <i>Regulation Strategies</i> | | | | | | | | |
| Self-regulation | | | | | | | | |
| Learning process & results | .78 | .74 | | | | | | |
| Learning content | .69 | .72 | | | | | | |
| External regulation | | | | | | | | |
| Learning process | | | .82 | .73 | | | | |
| Learning results | | | .67 | .54 | | | | |
| Lack of regulation | | | | | .75 | .74 | | |
| <i>Mental models of learnings</i> | | | | | | | | |
| Construction of knowledge | .72 | .75 | | | | | | |
| Intake of knowledge | | -.36 | .67 | .54 | .35 | .33 | | |
| Use of knowledge | | | | | | | .67 | -.74 |
| Stimulation education | | | | | .59 | .73 | | |
| Co-operative learning | | | | | .67 | .61 | | |
| <i>Learning orientations</i> | | | | | | | | |
| Personally interested | (.24) | .54 | | | | | | |
| Certificate prompted | | -.41 | .40 | .40 | | | .59 | -.33 |
| Ste-test-oriented | | | .34 | | .32 | .29 | | |
| Vocation-oriented | | | | | | | .84 | -.80 |
| Ambivalent | | | | | .73 | .65 | | |
| Eigen Value | 3.6 | 4.3 | 3.0 | 3.0 | 2.4 | 1.9 | 2.0 | 1.3 |
| % explained variance | 17.6 | 21.3 | 14.9 | 15.2 | 11.9 | 9.6 | 9.8 | 6.4 |
| Cumulative % | | | | | | | | |
| Principal component analysis; loading > -.25 and .25 omitted | | | | | | | | |
| (Vermunt, 1998 p. 162). | | | | | | | | |

The factor analysis (Table 1) labeled the learning styles F1 to F4. The meaning directed learning style (F1) contains the following scales: *relating and structuring, critical processing, self-regulation of learning processes and learning contents, construction of knowledge, personal inter, and concrete processing*. The reproduction directed learning style (F2) includes the following scales: *memorizing and rehearsing, analyzing, external regulation of learning processes and learning results, intake of knowledge, certificate oriented, and self-test directed*. The undirected learning style (F3) is composed of the following scales: *lack of regulation, ambivalent, cooperative learning, and stimulating education*. The application-directed learning style is comprised of the following scales: *concrete processing, use of knowledge, vocation oriented, and certificate oriented* (Vermunt, 1998, p. 161).

Data Collection Procedures

The residency directors who expressed an interest in participating in the study received a letter and a Dissertation Recruiting Summary (Appendix E) from Robert S.F. McKay, M.D, Program Director of the Department of Anesthesiology, University of Kansas School of Medicine-Wichita, in November 2006 that explained the study and requested participation of their anesthesiology residents. Included was a copy of the Kansas State University Informed Consent Form (Appendix F). The residency directors worked with their university to receive IRB approval and coordinated any IRB changes. The investigator traveled to each residency site at a mutually agreed date and time to administer the Inventory of Learning Styles. Each site provided a representative of their program to provide each resident a copy of the signed Consent Form and to record random numbers from survey packets to assure resident anonymity. The site coordinator later recorded the In Training Examination scores and percentile ranks by random number only for the investigator.

The investigator read the Study Explanation and answered participant's questions. All residents who attended signed the Consent Form indicating that participation was voluntary and that they could leave at any time. All who attended and heard the study explanation participated. Each resident received a survey booklet that contained the Educational and Demographic Survey and the Inventory of Learning Styles with a

random number located on the upper right hand corner; instructions given suggested that residents record the random number from their survey booklets in order to receive feedback on the four learning styles, following completion of the study. The survey required less than 45 minutes; upon completion the site coordinator received the surveys and provided a copy of the Consent Form for the resident. This same process was followed at each site.

Data Analysis Procedures

All statistical data analyses were conducted with the statistical software package, *SPSS*. The data sets were gathered in 2007 from February to June, for four institutions and five sites ($n = 112$). Descriptive statistics, including measures of central tendency, measures of dispersion, and measures of relative position, were used to analyze the composition of the sample with respect to ITE%, the dependent variable, and the Inventory of Learning Styles, the independent variable. The relationships between the ILS and the ITE were explored separately with the variables of gender, ethnicity, and postgraduate year.

The correlation analyses measured the relationship and the numerical strength. A series of regression analyses determined the predictive relationships between the meaning directed and undirected learning styles and ITE% and between significant domain scales and ITE percentiles. A backward elimination regression analysis determined the predictive relationships of the scales and ITE percentiles. Variables for possible inclusion included the Learning Styles, Learning Components, and Scales x Gender x Postgraduate Year x Ethnicity. The ITE percentile rank was the dependent variable.

Vermunt's Inventory of Learning Styles

Although ways of learning are relatively stable, they are also the result of interactions between contextual influences and personal ways of being (Vermunt, 1996, p. 25, 29). Vermunt's initial work on ILS resulted from an analysis of student interviews, study of existing inventories and a literature review on student learning. The model is based on processing strategies, regulation strategies, conceptions of learning, and learning orientation, each of which have five categories. As a result of factor analysis,

four learning styles were identified: meaning-directed, reproduction directed, undirected, and application-directed learning style (Vermunt, 1996, 1998).

Educational and Demographic Information

The educational and demographic questionnaire provides resident information about age, gender, postgraduate year and ethnicity identified from the following studies. The independent variables include the demographics of age (Aaron & Skakun, 1999; Archer et al., 1991; Feil, Kristian, & Mitchell, 1998; Schultz et al., 2004), gender (Archer et al., 1991; Collier, McCue, Markus, & Smith, 2002; Ferguson et al., 2002; Schultz et al., 2004), medical specialty (Baker et al., 1988; Seelig, 1993; Schultz et al., 2004; Wunderlich & Gjerde, 1978), and year in residency (Schultz et al., 2004; Seelig, 1993).

Summary

A questionnaire was used to collect data about the education and personal characteristics of anesthesiology residents. The learning survey consisted of the modified version of Vermunt's Inventory of Learning Styles; the instrument adapted the terms teacher/learner to attending physician/resident to be consistent with the terms used in anesthesia graduate medical education. The Inventory of Learning Style was chosen due to its use with university students, diagnostic design, reliability, construct validity, and integration of learning components. The In-Training Examination was included as a national measure of cognitive achievement of anesthesiology residents prepared by the ASA/ABA. The dependent variable, ITE scaled scores and percentile ranks were provided by ASA/ABA.

CHAPTER 4 - RESULTS

Introduction

This chapter reports the findings of this study, including an overview of the study, a discussion of data collection procedures, demographic characteristics of the population, and descriptive and summary statistics for the dependent and independent variables. Based on the research question and hypotheses, the variables influencing learning styles are discussed followed by regression analysis.

Overview

This study investigated the relationship between anesthesiology residents' cognitive achievement percentile ranks and learning styles. The In-Training Examination, as described in the previous chapter, was administered to anesthesiology residents enrolled in the 2006-2007 postgraduate year at four universities. The measures of academic achievement are standardized nationally with postgraduate results provided as scaled scores and percentile ranks. The learning style instrument was administered to residents enrolled in postgraduate medical education in anesthesia.

Data Collection Procedures

The study population consisted of all residents enrolled in anesthesia postgraduate education, 2006-2007, at the University of Arkansas Medical Sciences in Little Rock, Arkansas; University of Kansas School of Medicine in Kansas City and Wichita; Ochsner medical Center in New Orleans, Louisiana; and Penn State, Milton S. Hershey Medical Center, in Hershey, Pennsylvania ($N = 169$). The institutional review boards for the universities approved the research project. The residency directors picked a time and location that was most convenient for the administration of the ILS, expressed strong support for the research study to the residents, and attempted to free the residents of surgery responsibilities during the time scheduled for participation in the research. Residents were provided with a copy of the Study Explanation and were requested to sign

the consent form. Directions indicated that participation was voluntary, that they could leave at any time, and that the results would be reported in aggregate form to protect confidentiality. After signing the consent form, residents completed the Educational and Demographic Questionnaire and the Inventory of Learning Styles. The time to complete the survey was less than 45 minutes. Residents received instructions to keep their random numbers if they wanted to receive feedback on their learning styles after the completion of the study.

Table 2 displays the population and sample size by universities and sites, ITE completers, and valid ILS instruments. All residents who attended the information session received the Study Explanation and chose to participate. Although 119 residents completed the surveys, only 112 participants met the requirements of the study, which included completion of the 2006 ITE and valid responses on the ILS. Seven participating residents were not included in the study: two residents had not taken the ITE, and five had invalid responses on the Vermont Inventory of Learning Styles. Table 2 summarizes the total number of residents by university and site who completed the ITE and the ILS. Also displayed are the numbers of those who did not meet the study criteria.

Table 2*Frequencies by Site, Number of Participants, ITE Status, and ILS*

| University | <i>n</i> | ITE Completed | Invalid ILS | Study Participants | Total Enrolled |
|------------|----------|------------------|----------------|-----------------------|-------------------|
| Ochsner | 17 | 17 | 2 | 15 | 18 |
| Penn State | | | | 36 | 54 |
| 3 Year | 10 | 10 | 0 | 10 | |
| 4 Year | 26 | 26 | 0 | 26 | |
| UAMS | 35 | 33 | 3 | 30 | 57 |
| UKSM-ICT | 16 | 16 | 0 | 16 | 16 |
| UKSM-KS | 15 | 15 | 0 | 15 | 24 |
| Totals | 119 | 117 | 5 | 112 | 169 |

Note. Ochsner Medical Center; Penn State = Penn State Milton S. Hershey Medical Center; UAMC = University of Arkansas Medical Sciences; UKSM-ICT = University of Kansas Medical Center—Wichita; UKSM-KC = University of Kansas Medical Center—Kansas City.

Resident Demographic Characteristics

The residents completed the Educational and Demographic Survey, providing information about gender, age, ethnicity, and postgraduate year. Graduate medical education begins after the completion of the medical degree, and each year of postgraduate education is a postgraduate year (PGY). All anesthesiology residencies include four postgraduate years, and there are two types of residencies. In the traditional program, the first year of residency is a medical year, spent outside the anesthesiology department. The three years of anesthesia residency taken within the department are designated as PGY 1, PGY 2 and PGY 3. In the non-traditional program, all four years reside within the anesthesiology department with anesthesia education integrated into the first year, referred to as PGY 0. The last three years have the same designations for both

types of residencies. For the purposes of this study, the reference to PGY 0 indicates the initial year in a four-year, non-traditional program residing within the anesthesiology department.

The variables listed in Table 3 include postgraduate year, gender, and ethnicity, demonstrating that the size of some of the subgroups listed above is extremely small. Ethnicity is categorized as African-American, American Indian, Asian, Caucasian, Hispanic, and Mixed or Interracial.

Table 3 summarizes the variables of gender, postgraduate year, and ethnicity.

Table 3

Frequencies by Postgraduate Year (PGY), Gender, Ethnicity

| PGY | <i>n</i> | Gender | | Ethnicity | | | | |
|--------|----------|--------|----|-----------|----|----|----|----|
| | | M | W | AA | AN | CA | HS | MI |
| PGY 0 | 15 | 11 | 4 | 0 | 1 | 13 | 1 | 0 |
| PGY 1 | 35 | 20 | 15 | 2 | 7 | 25 | 0 | 1 |
| PGY 2 | 33 | 22 | 11 | 3 | 9 | 17 | 3 | 1 |
| PGY 3 | 29 | 24 | 5 | 0 | 2 | 27 | 0 | 0 |
| Totals | 112 | 77 | 35 | 5 | 19 | 82 | 4 | 2 |

Note. AA = African-American; AN = Asian; CA = Caucasian; HS = Hispanic; MI = Mixed or interracial.

Table 4 displays the summary statistics by age. Postgraduate year is positively related to age ($r = .39, p = .01$), and each year has a larger mean, as expected.

Table 4

Summary Statistics for Age by Postgraduate Year (PGY)

| PGY | <i>n</i> | <i>M</i> | <i>SD</i> |
|-------|----------|----------|-----------|
| PGY 0 | 15 | 28.67 | 2.50 |
| PGY 1 | 35 | 29.92 | 3.34 |
| PGY 2 | 33 | 32.36 | 3.61 |
| PGY 3 | 29 | 32.55 | 3.49 |

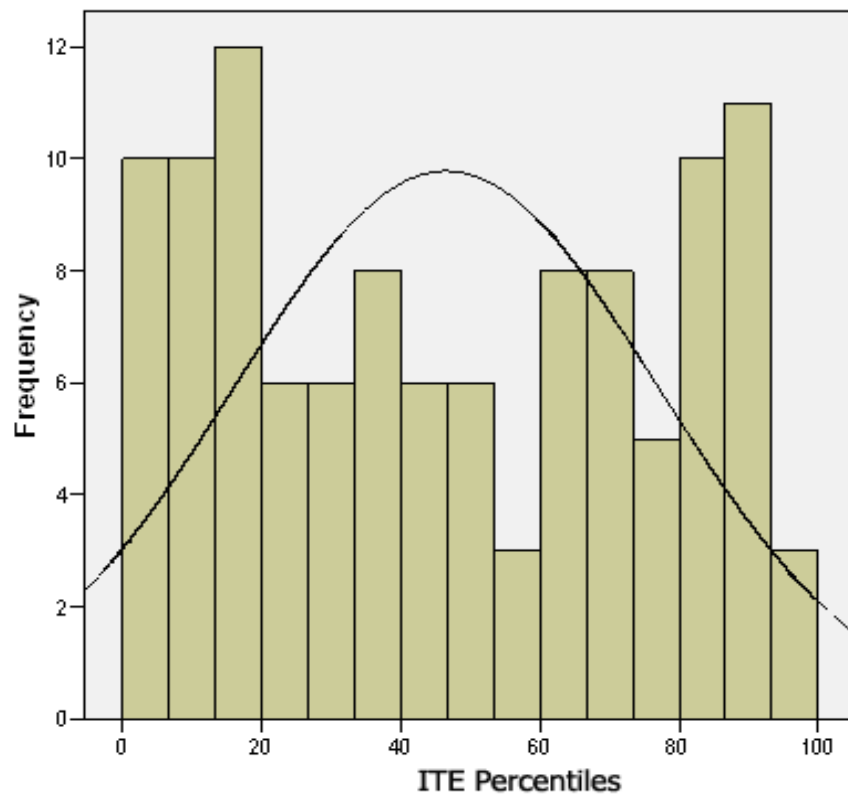
Dependent Variable

The dependent variable was the ITE percentile rank. The In-Training Examination was administered at all sites in July 2006 for the 2006-2007 postgraduate year. The American Board of Anesthesiology provided scaled scores and percentile ranks, calculated from the year's examination data by PGY. The frequencies of the 2006-2007 ITE percentiles by postgraduate year follow in Table 5 and Figure 1.

The histogram (Figure 1) depicts the bimodal curve for summary ITE percentiles reflecting low scores, less than the 20th percentile, and high scores, greater than the 80th percentile.

Figure 1

In Training Examination Percentile Rank Means



The summary ITE percentiles are presented in Table 5 by postgraduate year. PGY 0 ($n = 15$), was the smallest group with the highest mean (57.33). The higher mean for PGY 0 resulted, in part, from the introduction and integration of anesthesia education in the first year of residency for the non-traditional program.

Table 5

In Training Examination Percentile Rank Means by Postgraduate Year (PGY)

| PGY | <i>N</i> | Minimum | Maximum | <i>M</i> | <i>SD</i> | <i>SEM</i> |
|---------------|----------|---------|---------|----------|-----------|------------|
| PGY 0 | 15 | 8 | 99 | 57.33 | 31.85 | 8.22 |
| PGY 1 | 35 | 2 | 93 | 47.20 | 30.00 | 5.07 |
| PGY 2 | 33 | 4 | 94 | 43.06 | 30.18 | 5.25 |
| PGY 3 | 29 | 1 | 92 | 44.00 | 30.82 | 5.72 |
| Totals | 112 | | | | | |
| Mean of Means | | | | 46.51 | 30.44 | |

The relation of ITE percentile ranks with the variables of gender, ethnicity, and postgraduate year were analyzed with individual t-tests; the results were not significant.

Independent Variables

The independent variables included four learning styles and four learning domains. The variables of gender, postgraduate year, and ethnicity were explored in relation to the learning styles and the learning domains. The four learning domains are cognitive processing strategies, metacognitive regulation strategies, conceptions of learning, and learning orientations. The four domains have five scales each for a total of 20 scales. From a factor analysis (Table 1) of the 20 scales, Vermunt identified four learning styles: the meaning directed learning style (MDLS), the reproduction directed learning style, the undirected learning style (UDLS), and the application directed learning style (ADLS). The learning style descriptive statistics follow in Table 6.

Vermunt (1998) noted that the application directed learning style emerges later than the other learning styles and is consistent with advanced and adult students (Vermunt, 1998, 2005; Linblom-Ylänne & Lonka, 2000). The application directed learning style (Table 6) had the highest mean of all the learning styles but the lowest standard deviation, indicating it had the least variability. The residents were strongly application directed, as expected both professionally and age-related.

Table 6

Summary Statistics of Learning Styles (n = 112)

| Learning Styles | Minimum | Maximum | <i>M</i> | <i>SD</i> |
|-----------------|---------|---------|----------|-----------|
| MD | 2.13 | 4.83 | 3.20 | .56 |
| RD | 1.84 | 4.30 | 2.90 | .47 |
| UD | 1.51 | 4.03 | 2.80 | .47 |
| AD | 3.03 | 4.93 | 4.11 | .36 |

Note. MD = Meaning-directed learning style; RD = Reproduction-directed learning style; UD = Undirected learning style; AD = Application-directed learning style.

The following histograms (Figures 2, 3, 4, and 5 respectively) revealed the distributions of the meaning directed, reproduction directed, undirected, and application directed the learning styles with an overlay of the bell-shaped curve.

Figure 2

Meaning Directed Learning Style

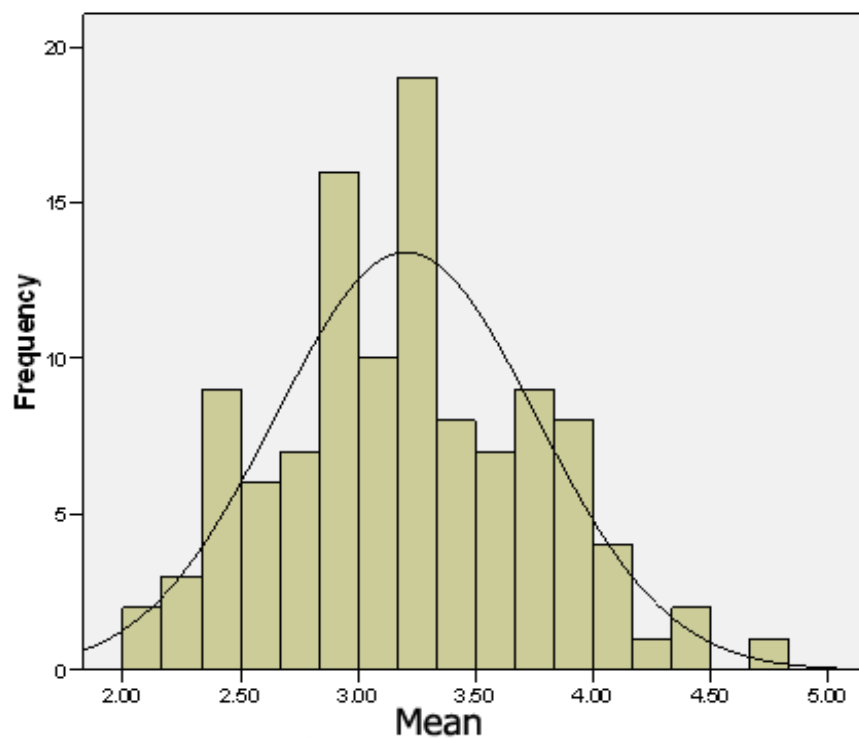


Figure 3

Reproduction Directed Learning Style

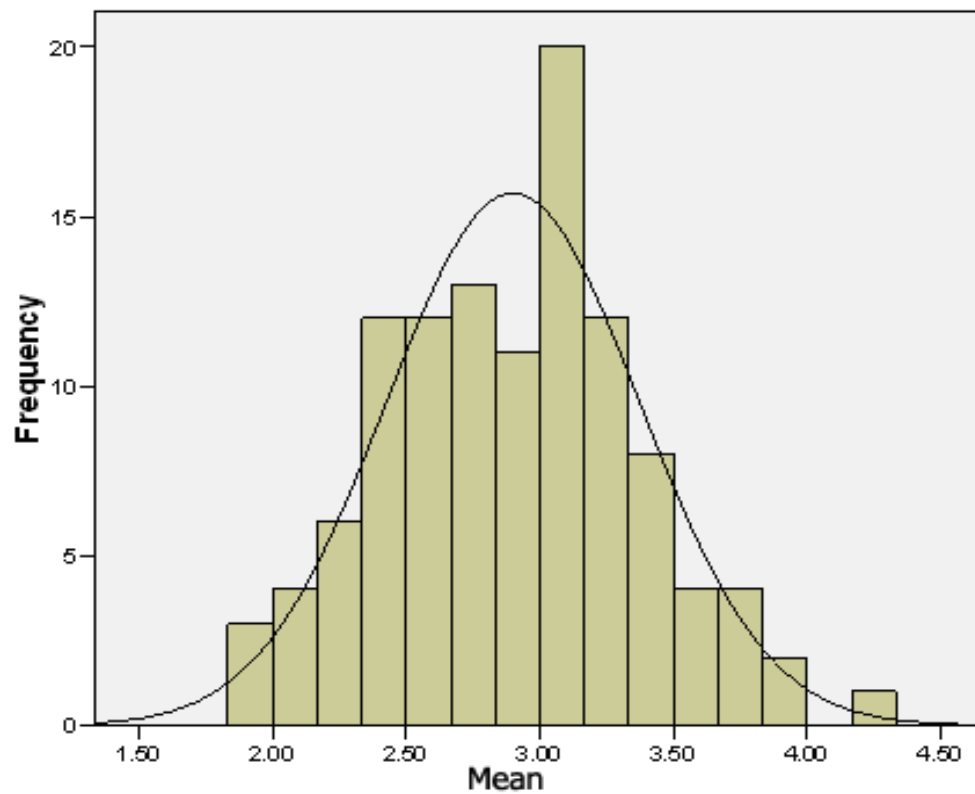


Figure 4

Undirected Learning Style

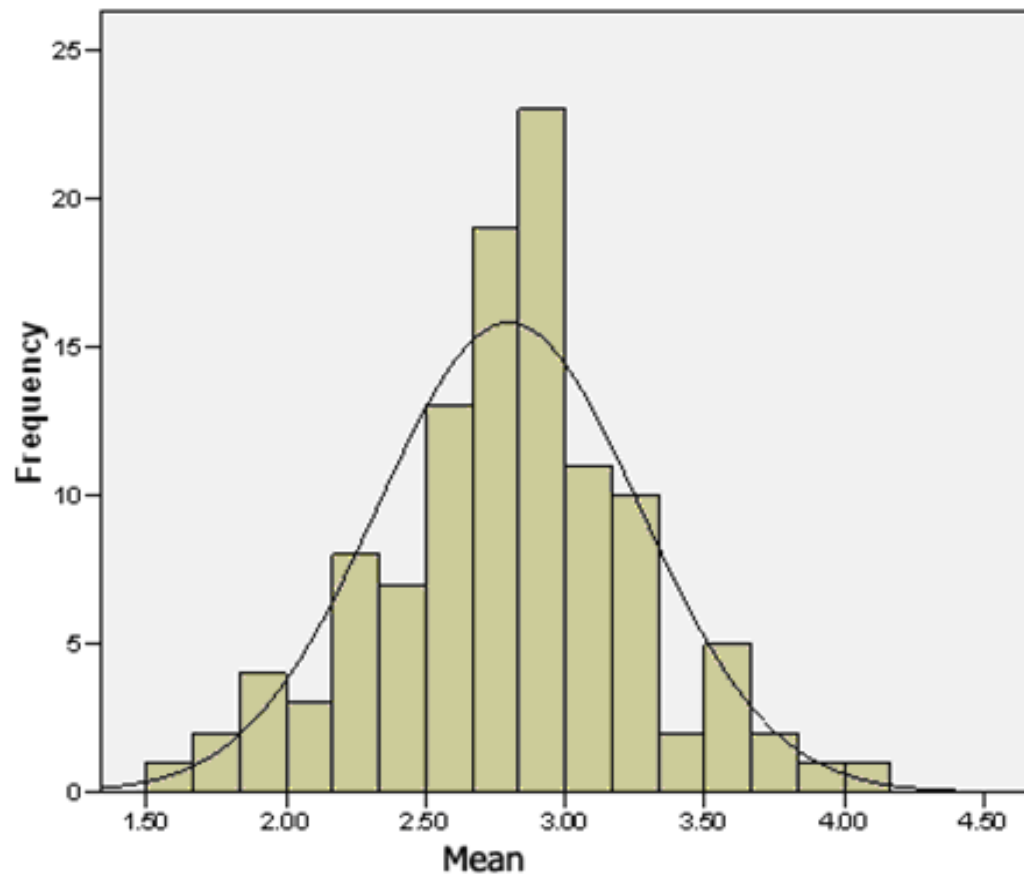


Figure 5

Application Directed Learning Style

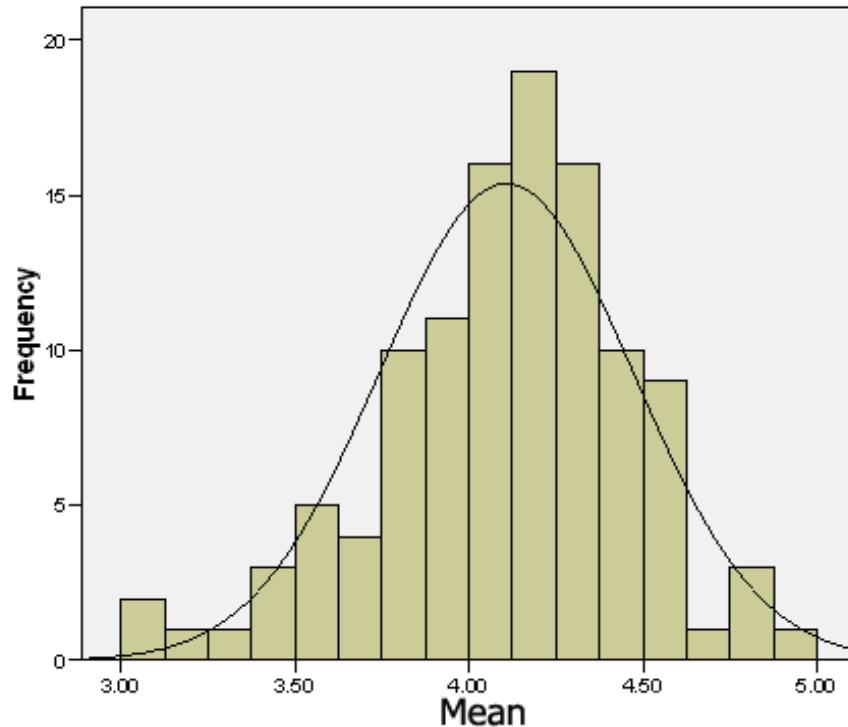


Table 6 presents summary statistics for the four learning styles. The results of the t-tests exploring the relationships of learning styles to the variables of postgraduate year, ethnicity and gender follow. The results of the t-tests of the learning styles and postgraduate year were not significant. When the relationship of learning styles with ethnicity is explored with t-tests, the results were not significant. Table 3 reports frequencies for ethnicity for subgroups ranging from a 2 to 82.

Table 7 summarizes the learning styles for men and women. The meaning directed learning style means were higher for the men than for the women.

Table 7

Summary of Learning Styles and Gender

| Learning Style | | <i>n</i> | <i>M</i> | <i>SD</i> |
|----------------|-------|----------|----------|-----------|
| MD | | | | |
| | Men | 77 | 3.28 | .58 |
| | Women | 35 | 3.04 | .46 |
| RD | | | | |
| | Men | 77 | 2.94 | .47 |
| | Women | 35 | 2.82 | .47 |
| UD | | | | |
| | Men | 77 | 2.77 | .47 |
| | Women | 35 | 2.82 | .47 |
| AD | | | | |
| | Men | 77 | 4.11 | .36 |
| | Women | 35 | 4.09 | .37 |

Note. MD = Meaning directed learning style; RD = Reproduction directed learning style; UD = Undirected learning style; AD = Application directed learning style.

Table 8 presents the t-tests of learning styles by gender. The relation of the meaning directed learning style with gender was significant; the men scored higher. The comparison of the reproduction directed, undirected, and application directed learning styles with gender was not significant.

Table 8

T-tests for Learning Styles by Gender

| Learning Style | <i>T</i> | <i>df</i> | Sig. (2-tailed) | Mean Difference |
|----------------|----------|-----------|-----------------|-----------------|
| MD | 2.19 | 110 | .03 | .244 |
| RD | 1.25 | 110 | .22 | .120 |
| UD | -.78 | 110 | .43 | -.075 |
| AD | .29 | 110 | .77 | .022 |

Note. MD = Meaning directed learning style; RD = Reproduction directed learning style; UD = Undirected learning style; AD = Application directed learning style.

The Relationship of In Training Percentile Ranks and Learning Styles

The meaning directed learning style generally has been positively linked to various indicators of academic performance (Boyle et al., 2003; Vermunt, 1998, 2005). Students with an undirected learning style may be more at risk academically, due to a lack of systematic learning strategies and concerns about learning (Boyle et al., 2003, Vermunt, 1998). As noted earlier, the application directed learning is consistent with advanced and adult learners (Vermunt, 1998, 2005; Linblom-Ylänne & Lonka, 2000).

The purpose of the study was to identify relationships between ITE percentile ranks and the learning styles for anesthesiology residents. Correlations of ITE percentile rank and learning styles (Table 9) identified a significant positive relationship with the meaning directed learning style (Pearson $r = .31, p < .01$) and a significant negative relationship with the undirected learning style (Pearson $r = -.28, p < .01$); the correlations for the reproduction directed and application directed learning styles were not significant (see Table 9).

Table 9

Correlation Analysis of Learning Styles and In Training Examination Percentile Rank

| | MD | RD | UD | AD |
|------|-------|------|--------|-------|
| ITE% | .31** | .09 | -.28** | .10 |
| MD | | .21* | -.33** | .09 |
| RD | | | .16 | .50** |
| UD | | | | .10 |

Note. * $p < .05$. ** $p < .01$.

ITE% = In Training Examination percentile rank; MD = Meaning directed learning style;
RD = Reproduction directed learning style; UD = Undirected learning style;
AD = Application directed learning style.

Relationships of ITE Percentile Ranks and MDLS/UDLS Scales

Learning styles are associated with contextual, personal factors, and academic disciplines (Boyle et al., 2003, Vermunt, 1998, 2005). Exploration into the relationships within the learning domain scales provides more information about the context of anesthesia education (conceptions of learning) and the residents' strategies (cognitive processing strategies and regulation strategies) and motivation (learning orientations). The relationships between ITE percentile ranks and the meaning directed and undirected learning styles are significant (Table 9). Correlation analysis was conducted with the scales of the two learning styles related to ITE percentile rank; the analysis revealed information about strategies, regulation, motivation, and resident's view of the role of teachers, learners, and other residents by scales.

The meaning directed learning style has seven scales: self-regulation learning process and outcomes, self-regulation learning contents, critical processing, relating and structuring, concrete processing, construction of knowledge, and personally interested (Vermunt, 1998, p. 162). Correlations (Table 10) with ITE percentile rank and the seven scales that make up the meaning directed learning style resulted in positive correlations of five of the seven scales, representing the four domains. Relating and structuring, critical processing, and concrete processing are cognitive processing strategies. Self-regulation learning process and outcomes and self-regulation learning contents are metacognitive regulation strategies. The construction of knowledge scale is part of conceptions of learning, and personally interested is a part of learning orientations.

Table 10

Correlations with Meaning Directed Learning Style Scales

| | SELP | SELC | CRIT | RELA | CONC | CONS | PERS |
|------|------|-------|------|-------|-------|------|------|
| ITE% | .20* | .31** | .18 | .26** | .31** | .20* | .15 |

Note. * $p < .05$. ** $p < .01$.

ITE = In Training Examination Percentile rank; SELP = Self-regulation learning process and outcomes; SELC = Self-regulation learning contents; CRIT = Critical processing; RELA = Relating and structuring; CONC = Concrete processing; CONS = Construction of knowledge; PERS = Personally interested.

The scales of the undirected learning style as identified by Vermunt (1998, p. 161-162) are co-operative learning, lack of regulation, ambivalent, and self-test oriented. The analyses with ITE percentile ranks follow in Table 11. The ambivalent scale ($r = -.34, p < .01$) was the only ILS scale in this study with a significant negative correlation with ITE percentile rank; the other scales were not significant. Ambivalent is a part of the learning orientations domain. The negative relationship with the ambivalent scale indicates the self-doubt of residents, either about their ability academically or the match with the subspecialty, or both.

Table 11

Correlation with Undirected Learning Style Scales

| | COOP | LACK | AMBI | SETE |
|-------|------|------|--------|------|
| ITE % | -.16 | -.14 | -.34** | .01 |

Note. * $p < .05$. ** $p < .01$. ITE% = In Training Examination percentile rank; COOP = Co-operative learning; LACK = Lack of regulation; AMBI = Ambivalent; SETE = Self-test oriented.

The four learning styles (MDLS, RDLS, UDLS, and ADLS) have been identified through a factor analysis of the 20 scales that comprise the four domains (cognitive, metacognitive, motivation, and conceptions of learning). The meaning directed learning style has seven scales (Table 10) and the undirected learning style has four (Table 11). In this study, there was a significant relationship with five of the seven scales in the meaning directed learning style and one of the five scales of the undirected learning style. The relationship of the ITE percentile rank with the reproduction directed and application directed learning style was not significant. Deeper-level, self-regulated learning during a cognitive apprenticeship is consistent with higher academic achievement. The reproduction directed learning style is externally regulated with a focus on memorizing academic material; the deeper-level learning expected during a cognitive apprenticeship is associated with academic achievement.

Relationship of In Training Percentile Ranks and the Four ILS Components

Vermunt (2005) concluded that all 20 scales are related to personal and contextual factors (p. 227). The 20 scales of the Inventory of Learning Styles instrument were identified from four (interrelated) components of learning: (1) cognitive processing strategies, (2) metacognitive regulation activities, (3) conceptions of learning, (4) learning orientations (Vermetten et al, 1999, p. 222). To understand the relationships of the component scales to the In Training Examination percentile ranks, each of the domains (five scales each) with ITE percentile ranks to identify significant positive and negative relationships.

The five scales of the cognitive processing strategies domain are: deep processing (2 subscales: relating and structuring, critical processing), stepwise processing (2 subscales: memorizing and rehearsing, analyzing), and concrete processing. Table 12 reveals a significant, positive relationship with analyzing, not previously reported in the correlations with the meaning directed and undirected learning styles (Tables 10 and 11). The residents use deep processing, step-wise processing, and concrete processing scales combining a scale of the reproduction learning style with those find in the meaning directed learning style.

Table 12

Correlation with Cognitive Processing Strategies Scales

| | RELA | CRIT | MEMO | ANAL | CONC |
|------|------|------|------|-------|-------|
| ITE% | .26* | .18 | .11 | .28** | .31** |

Note. * $p < .05$. ** $p < .01$.

ITE% = In Training Examination percentile rank; RELA = Relating and structuring; CRIT = Critical processing; MEMO = Memorizing and rehearsing; ANAL = Analyzing.

The five scales of metacognitive regulation strategies domain are: self-regulation (2 subscales: learning process and outcomes, learning contents), external regulation (2 subscales: learning process, learning outcomes), and lack of regulation. The correlation of these scales with ITE% reveals no new significant data.

Five scales comprise the learning orientations domain (Table 13): personally interested, certificate oriented, self-test oriented, vocation oriented, and ambivalent. The correlation of ITE% ranks with vocation oriented is significant and positive ($r = .22, p < .05$); this scale was not a part of the meaning directed or undirected learning styles (Tables 10 and 11). A positive relationship with the vocation oriented scale confirms the residents' high application directed learning style and is consistent with a cognitive apprenticeship.

Table 13

Correlation with Learning Orientations Scales

| | PERS | CERT | SETE | VOCA | AMBI |
|------|------|------|------|------|--------|
| ITE% | .15 | -.03 | .01 | .22* | -.34** |

Note. * $p < .05$. ** $p < .01$.

ITE% = In Training Examination percentile rank; PERS = Personally interested;

CERT = Certificate oriented; SETE = Self-test oriented; VOCA = Vocation oriented; AMBI = Ambivalent.

The last domain is the conceptions of learning domain with the following five scales: construction of knowledge, intake of knowledge, use of knowledge, stimulating education, and cooperative learning. The only significant and positive relationship was with construction of knowledge, identified in Table 10. The residents look for strategies to add to knowledge, find extra sources as needed, and ask questions to individualize knowledge.

The four domains have five scales each; analyses of the 20 scales revealed two scales not reported in Tables 10 and 11. Those scales are analyzing ($r = .28, p < .05$) and vocation oriented ($r = .22, p < .01$) that are significant and positive with In Training

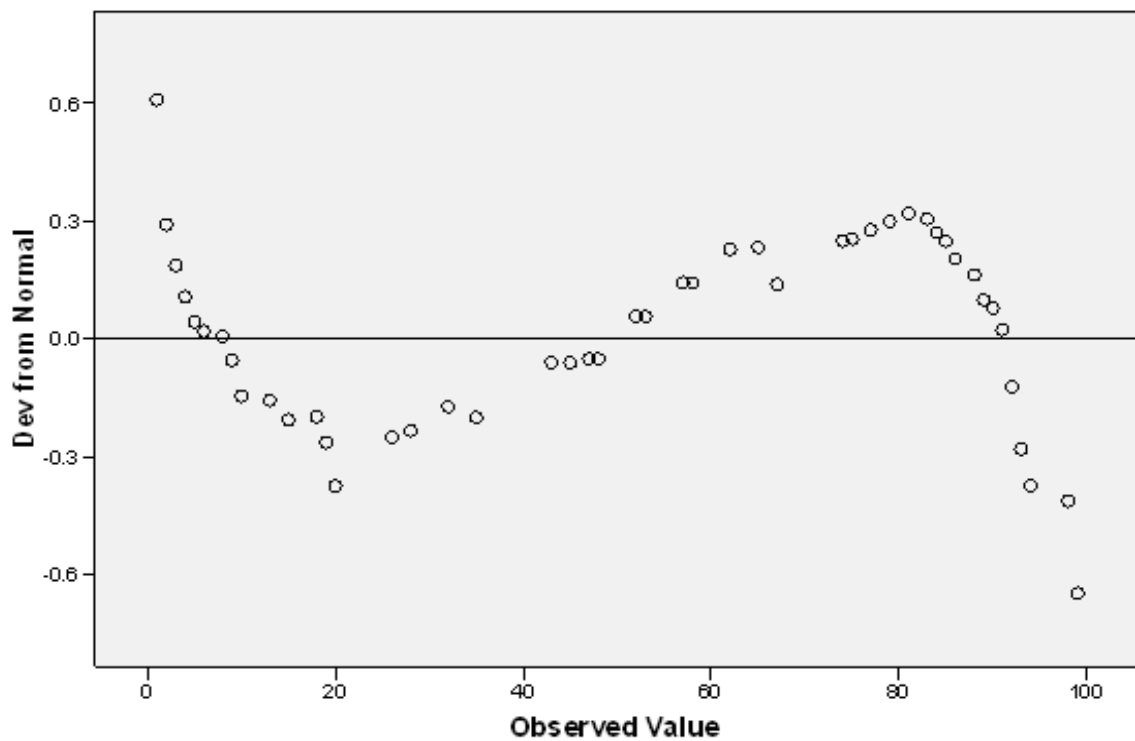
Examination percentile ranks. Two learning styles were not significant with In Training Examination percentiles ranks, and those were the application directed learning style and the reproduction directed learning style. The vocation-oriented scale is identified as a factor of the application directed learning style, and analyzing scale is a factor of the reproduction directed learning style.

Regression Analysis Results

The correlation analyses of the In Training Examination percentile ranks and the meaning directed learning style was positive and significant and for the undirected learning styles was significant and negative. One of the assumptions for regression analysis is normally distributed data. Figure 6 shows the bimodal curve of the In Training Examination percentile ranks.

Figure 6

ITE Percentile Rank Means



As the bimodal curve of the ITE percentiles did not fit the assumptions for regression analyses, The Komogorov-Smirnov (K-S) test compared the ITE percentile ranks to a sample that is normally distributed, which resulted in $D(112) = .14, p < .01$, confirming that the data were not normally distributed (Table 14).

Table 14

Komogorov-Smirnov Test of Normality on ITE Percentiles

| | Statistic | <i>df</i> | Sig. |
|------|-----------|-----------|------|
| ITE% | .138 | 112 | .001 |

Based on the results of the K-S test, a square root transformation was conducted on the In Training Examination percentile ranks, and the regression analyses were conducted with the transformed ITE percentile ranks; no significant difference was found in R^2 between the transformed and the untransformed ITE percentile ranks. Therefore, the square root transformed data were not used. Collinearity analyses were conducted, and tolerance and variance inflation factors were within the acceptable range.

A stepwise regression was conducted to determine the predictive validity of the meaning directed and undirected learning styles (Table 9) with the dependent variable, In Training Examination percentile rank. The meaning-directed learning style entered on the first step (see Table 15), explaining approximately 10% ($R^2 = .098$) of the variance in ITE scores. On the second step, undirected learning style explained an additional 3.6% ($R^2 \text{ Change} = .036$) of the variance. The combination of both predictors resulted in an $R^2 = .134$. The amount of variance explained in ITE scores was greatest with the inclusion of both learning styles as predictor variables.

Table 15

Model Summary for Meaning Directed and Undirected Learning Styles

| Model | R | R Square | Adj. R Square | SE of the Estimate | R Square Change | Sig. F Change |
|-------|---------|----------|---------------|--------------------|-----------------|---------------|
| 1 | .313(a) | .098 | .090 | 29.047 | .098 | .001 |
| 2 | .366(b) | .134 | .118 | 28.591 | .036 | .035 |

ANOVA

| Model | | SS | df | Mean Square | F | Sig. |
|-------|------------|------------|-----|-------------|--------|------|
| 1 | Regression | 10063.579 | 1 | 10063.579 | 11.928 | .001 |
| | Residual | 92808.412 | 110 | 843.713 | | |
| | Total | 102871.991 | | | | |
| 2 | Regression | 13771.914 | 2 | 6885.957 | 8.424 | .000 |
| | Residual | 89100.078 | 109 | 817.432 | | |
| | Total | 102871.992 | | | | |

Note. Predictors: (Constant), Meaning learning style; b Predictors: (Constant), Undirected learning style; Dependent Variable: ITE%.

Table 16*Stepwise Regression Coefficients for Model 1 and Model 2*

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|--------------|-----------------------------|------------|---------------------------|--------|------|
| | B | Std. Error | Beta | | |
| 1 (Constant) | -8.142 | 16.137 | | -.521 | .603 |
| MDLS | 17.141 | 4.963 | .313 | 3.454 | .001 |
| 2 (Constant) | 39.392 | 27.496 | | 1.433 | .155 |
| MLDS | 13.558 | 5.167 | .247 | 2.624 | .010 |
| UDLS | -12.982 | 6.095 | -.201 | -2.130 | .035 |

Vermunt (2005) concluded, all 20 scales of the Inventory of Learning Styles are related to personal and contextual factors (p. 227). The correlations in Table 12 and 13 identified two significant and positive scales not identified earlier. Although there is little in the literature that identifies learning styles and scales for anesthesiology residents, a backward elimination regression analysis was conducted with a significant scale as a predictor variable from each of the domains (cognitive, metacognitive, motivation, and conceptions of learning). These predictor variables included: concrete processing, self-regulation learning contents, ambivalent, and construction of knowledge; In Training Examination percentile rank was the dependent variable. Tables 17 and 18 report the results.

The backward elimination regression in Model 1 consisted of all four scales and had an $R^2 = .165$. In Model 2, the elimination of construction of knowledge changed the R square very little (.164). The third model eliminated construction of knowledge and concrete processing, resulting in an $R^2 = .157$; Table 18 reveals that the remaining scales (self-regulated learning and construction of knowledge) in Model 3 were significant at the .05 significance level.

Table 17

Model Summary for a Scale from Each Component: Concrete Processing, Self-regulation Learning Contents, Ambivalent, Construction of Knowledge

| Model | R | R Square | Adj. R Square | SE of the Estimate | R Square Change | Sig. F Change |
|-------|--------|----------|---------------|--------------------|-----------------|---------------|
| 1 | 406(a) | .165 | .133 | 28.341 | .135 | .001 |
| 2 | 405(b) | .164 | .164 | 28.233 | -.001 | .751 |
| 3 | 396© | .157 | .142 | 28.203 | -.007 | .359 |

ANOVA

| Model | | SS | df | Mean Square | F | Sig. |
|-------|------------|------------|-----|-------------|--------|------|
| 1 | Regression | 16928.482 | 4 | 4232.120 | 5.269 | .001 |
| | Residual | 85493.509 | 107 | 803.210 | | |
| | Total | 102871.991 | 111 | | | |
| 2 | Regression | 13847.380 | 3 | 5615.793 | 7.050 | .000 |
| | Residual | 86024.611 | 108 | 796.524 | | |
| | Total | 102871.991 | 111 | | | |
| 3 | Regression | 16170.304 | 2 | 8085.152 | 10.165 | .000 |
| | Residual | 86701.687 | 109 | 795.428 | | |
| | Total | 102871.991 | 111 | | | |

Note. a Predictors: (Constant), Construction of knowledge, concrete processing, ambivalent, self-regulation learning contents; b Predictors: (Constant) Concrete processing, ambivalent, self-regulation learning content; c Predictors (Constant) Ambivalent, self-regulation learning content; d Dependent Variable: ITE%.

Table 18*Backward Elimination Regression Coefficients for Model 1, Model 2, and Model 3*

| Model | Unstandardized Coefficients | | Standardized Coefficients | <i>t</i> | Sig. |
|--------------|-----------------------------|------------|---------------------------|----------|------|
| | B | Std. Error | Beta | | |
| 1 (Constant) | 22.201 | 32.203 | | .689 | .492 |
| CONC | 4.822 | 5.232 | .107 | .0922 | .359 |
| SELC | 5.677 | 4.295 | .155 | 1.322 | .189 |
| AMBI | -9.443 | 4.118 | -.229 | -2.293 | .024 |
| CONS | 2.118 | 6.667 | .031 | .318 | .751 |
| 2 (Constant) | 29.916 | 21.067 | | 1.420 | .158 |
| CONC | 4.803 | 5.210 | .107 | .922 | .359 |
| SELC | 6.053 | 4.111 | .165 | 1.472 | .144 |
| AMBI | -9.719 | 4.009 | -.236 | -2.424 | .017 |
| 3 (Constant) | 43.186 | 15.372 | | 2.809 | .006 |
| CONC | 8.136 | 3.432 | .222 | 2.371 | .020 |
| SELC | -10.707 | 3.860 | -.260 | -2.774 | .007 |

Note. CONC = Concrete processing; SELC = Self-regulation learning contents; AMBI = Ambivalent; CONS = Construction of knowledge.

Summary

The study results established a significant relationship between In Training Examination percentile ranks, a measure of cognitive achievement, and two of the four learning styles (meaning directed, reproduction directed, undirected, and application directed learning styles). The relationship with the meaning directed learning style was significant and positive, and with the undirected learning style was negative. T-tests established a positive relationship of the meaning directed learning style and gender, with men scoring higher; the variables of ethnicity and postgraduate year were not significant.

As Vermunt indicated, all 20 scales are related to personal and contextual factors. The meaning directed learning style had seven scales; for this study, five were significant and positive. The undirected learning style had five scales, and only one was significant: ambivalent was negative. The four domains (cognitive processing strategies, metacognitive regulation strategies, conceptions of learning, and learning orientations) have five scales each. To better identify scales that are significant, correlation analysis by domains (20 scales) resulted in the addition of two significant, positive scales: vocation oriented and analyzing.

The results of correlations of the ITE percentile ranks with the four domains follow. The positive cognitive processing strategies domains scales were relating and structuring (deep processing), analyzing (stepwise processing), and concrete processing. The results indicated that anesthesiology residents utilize deep processing, stepwise processing, and concrete processing strategies in their learning.

The correlations of ITE percentile ranks with metacognitive regulation strategies were positive and significant for the two self-regulation sub-scales. The other scales were not significant. The relationships of ITE percentile ranks with the conceptions of learning domain identified construction of knowledge as significant and positive; the other scales were not significant. Residents were self-regulated learners.

The correlations of ITE percentile ranks with the learning orientations domain revealed the only significant and negative scale, ambivalent, in this study. The vocation oriented scale was significant and positive; this is an additional scale that was not a part of the two significant learning styles.

The profile by scales of the anesthesiology resident included a deep processing, stepwise wise processing and concrete processing strategies, using all of the categories of cognitive strategies. For metacognitive strategies, the residents were clearly self-regulative; they understood how to regulate their cognitive strategies in a positive manner. The residents are vocationally oriented, as expected given their academic preparation. Residents with lower ITE percentile ranks had higher undirected learning style scores, indicating some doubts about residency performance and a more scattered approach to learning. Not surprisingly, construction of knowledge was positive. The positive learning strategies for the residents included relating and structuring, analyzing, concrete processing, two self-regulation scales, construction of knowledge, and vocation oriented. The only negative scale was ambivalent.

A stepwise regression was conducted to determine the predictive validity of the meaning directed and undirected learning styles with the dependent variable, ITE percentile, resulting in an R^2 of .134. A backward regression was conducted with four scales (construction of knowledge, concrete processing, self-regulation learning contents, ambivalent) as predictor variables with the ITE percentile rank, dependent variable. The remaining two scale, self-regulation learning content and ambivalent, had an R^2 of .157, significant at the .05 significance level.

The study findings included the identification of two learning style (MDLS, UDLS) with a significant relationship with ITE percentile ranks. Analysis of the relationship of ITE percentile ranks by domains identified eight significant scales: seven positive scales and one negative. The scales that are significant and positive help identify learning strategies associated with cognitive achievement; the significant negative scale can be used to help identify residents potentially at risk academically.

CHAPTER 5 – DISCUSSION

Introduction

This chapter provides a summary of the study design, the research hypotheses, and a discussion of the findings related to the research hypotheses. The connections between the literature about postgraduate anesthesia education, in training examination percentiles, learning styles, and the study findings are discussed in detail. Recommendations for further research and implications of the study are also discussed.

Summary of the Study Design

The relationship between in-training examination percentiles of anesthesiology residents and learning styles was investigated. The In-Training Examination is a measure of cognitive knowledge. The Inventory of Learning Styles provides scores on four learning styles and four domains. The independent variables include the learning styles, learning domains, gender, ethnicity, and postgraduate year. The dependent variable, the In-Training Examination, measured anesthesia cognitive knowledge.

Discussion of the Findings

The study of learning, incorporating the cognitive, metacognitive, regulative, and motivational domains, spans many disciplines including adult education, educational psychology, and medical education. Art and science combine in the education and practice of medicine as academic medical centers apply educational models to incorporate improvement knowledge. Growth and improvement are parts of medical education and the practice of medicine (Leach, 2005).

The transition from the first year of medical school, where the student functions as a novice, to that of competent physician, prepared to practice medicine upon residency graduation, involves many adjustments, self-assessments, medical education assessments, learning styles and strategies. Slotnick (2001) commented that growth and development during this time markedly affects identity (p. 1016). In order to facilitate learning throughout the process, Gordon (1991) summarized, “Valid self-assessment is

fundamental to continuing professional competence but is seldom explicitly taught in health professions training” (Gordon, 1991, p. 762).

Applicable information related to cognitive achievement is one of the measurement criteria for a learning-style instrument. The literature supports the effort spent on curriculum content, teaching and assessment; however, the effect of these approaches on resident learning and the learning process is not well documented in the literature (Newble & Entwistle, 1986, Vu & Galofre, 1983).

“Humans are designed for learning. . . .An educational model that does not nourish the relationship between student and teacher is not robust enough to support the contract to discern and obey the truth” (Leach, 2005, p. ii55). Residents and faculty physicians benefit from an exploration of learning styles and their relationship to cognitive achievement to enhance the teaching/learning relationships and improve individual learning.

Research Question: Is there a relationship between resident achievement and learning styles and domains? If so, what is the nature of the relationship(s)? For this study, resident achievement was measured by In Training Examination (ITE) percentile ranks. Learning styles and domain included cognitive processing strategies, metacognitive regulation strategies, conceptions of learning, and learning orientations which were assessed by the Inventory of Learning Styles (ILS).

Learning styles research includes these applications: specialty selection, faculty development, and medical student or resident feedback on learning styles and preferences. Curry (1999) concluded that the research in learning styles has been flawed, and “The result of these flaws is that the research base cannot provide a strong foundation for the application of learning or cognitive styles to medical education” (p. 411). The anesthesiology graduate medical education literature is silent on the relationship of learning styles to measures of cognitive achievement.

The most significant findings of this study were that the meaning directed learning style was positively related to ITE percentile ranks and the undirected learning style was negatively related. The regression analysis with the predictor variables of MDLS and UDLS was able to predict 13.4% of the variance of the ITE outcomes. The reproduction directed and application directed learning style relationships with ITE

percentile ranks were not significant. The application directed meaning style had a high mean across the four postgraduate years with a small standard deviation, demonstrating little variation and high stability for this learning style.

Vermetten, Vermunt, and Lodewijks (1999, p. 233) identified the meaning directed learning style for advanced students as being comprised of seven scales (self-regulation learning process and outcomes, self-regulation learning contents, critical processing, relating and structuring, concrete processing, and personally interested). The correlations of the residents' meaning directed learning style scales with ITE percentile ranks were significant and positive for five of the seven. The scales critical processing and personally interested were not significant. The undirected learning style had five scales for the advanced students; the study results identified only one of the scales as significant, ambivalent, was negative.

The Inventory of Learning Styles has 20 scales; the meaning directed learning style has seven scales, and the undirected learning style has five, accounting for 12 out of 20 scales. For information about the other eight scales (two that comprise the application directed learning style and six for the reproduction directed learning style), correlation analysis was completed by domains (cognitive processing strategies, metacognitive regulation strategies, conceptions of learning, and learning orientations). As a result of the analyses with ITE percentile ranks, two additional scales were identified as being significant and positive: analyzing and vocation oriented.

The relationship between cognitive processing strategies and ITE percentiles was significant and positive with scales relating and structuring, analyzing, and concrete processing. The scales critical processing and memorizing and rehearsing were not significant.

The results of the analysis of the domain metacognitive processing strategies with ITE percentile rank were significant and positive for self-regulation learning process and outcomes and self-regulation learning contents; the two are highly interrelated. The scales external regulation learning process and learning outcomes (interrelated) and lack of regulation and ITE percentiles were not significant.

The domain learning orientations scales are personally interested, certificate oriented, self-test oriented, vocation oriented, and ambivalent. The relationship of ITE

percentile rank with the vocation oriented scale was significant and positive; with the ambivalent scale, the result was significant and negative. Ambivalent was the only learning orientations scale significant with ITE percentile rank; the results was a negative relationship. The following scales were not significant: personally interested, certificate oriented, and self-test oriented.

The relationship of the construction of knowledge scale (conceptions of learning domain) and ITE percentile rank was significant and positive. The other scales (intake of knowledge, use of knowledge, stimulating education, and cooperative learning) were not significant.

Each of the domains had at least one significant scale related with ITE percentile ranks. Of the domains scales that were significant, only one scale, ambivalent, had a negative relationship to ITE percentile ranks. Ambivalent (learning orientations) measured the student's attitudes about ability and capability relating to the educational tasks and the chosen program (Vermunt, 2000, p. 78). Higher ambivalent scores are related with lower ITE percentiles. Boyle et al. (2003) and Busato et al. (1999) reported a negative relationship of ambivalent with academic outcomes. The study results were consistent with those findings.

The results of the backwards elimination regression analyses with self-regulation learning contents and ambivalent scales revealed the potential to predict 15.7% of the variance of ITE outcomes. By identifying scales in addition to the learning styles, the resident and faculty member understand the relationships of the learning styles to the ITE percentile rank and have access to specific learning scales to understand strengths and weaknesses.

Hypothesis 1: There is a relationship between learning styles and resident achievement that varies by postgraduate year, gender, and ethnicity.

A number of researchers discussed age, gender, and ethnicity in learning style research in medical education (Ferguson, James, & Madeley, 2004; Vermetten, Lodewijks, & Vermunt, 1999). However, research with anesthesiology residents exploring the relationship between ITE percentiles, learning styles, and variables of gender, ethnicity, and postgraduate years is virtually nonexistent. "Relatively little

research has been done into the importance of learning styles, interviews, ethnicity, sex, personal statements and references. . . associated with success in medical training: (Ferguson, James, & Madeley, 2004, p. 952). A number of researchers discussed age, gender and ethnicity in learning style research in medical education (Ferguson, James, & Madeley, 2004; Vermetten, Lodewijks, & Vermunt, 1999). The size of the groups used in past research with residents was small, resulting in even smaller sub-groups providing little information about age, gender, and ethnicity. For the purposes of this study, age was positively correlated and significant with postgraduate year, so data were reported by postgraduate year, consistent with ITE percentiles reporting from the ASA/ABA.

The relationship of ITE percentiles with the meaning directed learning style was significant and positive and with the undirected learning style was significant and negative; the results of the meaning directed and undirected learning styles by postgraduate year, gender, and ethnicity were not significant. The evidence supports the relationship between ITE percentiles and the meaning directed and undirected learning styles. There is no evidence to support the relationship of variables of postgraduate year, gender, and ethnicity with ITE% and the meaning directed and undirected learning styles. There is no evidence of a relationship of the reproduction directed, undirected, and application directed learning styles by gender, ethnicity, and postgraduate year.

Residents with a negative correlation on the scale ambivalent may be at risk for academic difficulty. The learning style research using the ILS offers a more articulated characterization of the undirected learner. The relationships between ITE percentile ranks learning styles and domains provide a better method to assess positive learning strategies practiced by residents, as measured by cognitive achievement.

Hypothesis 2: There is a relationship between resident achievement and the learning domain, cognitive processing strategies comprised of the factors deep processing (relating and structuring, critical processing), stepwise processing (memorizing and rehearsing, analyzing) and concrete processing.

Students use cognitive processing activities to process learning content, to achieve their educational goals and to lead to learning outcomes (Vermunt, 1998, p. 151). The cognitive processing strategies include deep processing (relating and structuring and critical processing), stepwise processing (memorizing and rehearsing, and analyzing), and

concrete processing (Vermunt, 1998, p. 158). In the analysis with ITE percentiles, the scale relating and structuring, analyzing, and concrete processing were significant and positive; the other scales were not significant. The evidence supports a positive relationship with ITE percentiles for the scales relating and structuring, analyzing, and concrete processing. The relationship of the scales critical processing and memorizing and rehearsing is not significant. For learning strategies, residents report using the scales relating and structuring (deep processing), and analyzing (stepwise processing) for learning that is applied in a realistic setting.

Hypothesis 3: There is a relationship between resident achievement and the learning domain, metacognitive regulation strategies comprised of self-regulation learning process and outcomes, self-regulation learning contents, external regulation learning process, external regulation learning outcomes, and lack of regulation.

Learning strategies in the ILS are cognitive processing strategies and metacognitive regulation strategies (Vermetten, Lodewijks & Vermunt, 1999, p. 3). The metacognitive regulation strategies concern the control and interaction with the cognitive processing strategies (Vermetten, Lodewijks, and Vermunt, 1999, p. 3). The metacognitive regulation strategies scales are self-regulation (learning process and outcomes, learning contents), external regulation (learning process and learning outcomes) and lack of regulation (Vermunt, 1998, p. 158).

In this study, the relationships of the self-regulation learning process and outcomes and self-regulation learning contents scales with ITE percentiles were significant and positive. The self-regulation strategies are highly interrelated and are, at times, reported as one scale (Vermetten, Lodewijks & Vermunt, 1999; Vermetten, Lodewijks & Vermunt, 2001; Vermunt, 1995). The scale self-regulation learning contents was represented in all the models of the backward elimination regression analyses using significant domain scales as predictor variables and the ITE percentiles as the dependent variable. The scales external regulation learning process, self-regulation learning outcomes, and lack of regulation were not significant. The positive relationship of self-regulation to ITE percentiles indicated that residents with higher ITE percentiles report more self-regulation strategies and an ability to control and coordinate their thinking activities to process content. The evidence in this study supported the significant, positive

relationship between ITE percentiles, self-regulation learning process and outcomes, and self-regulation learning contents. There was no evidence to support the other scales in the metacognitive regulation strategies domain.

Residents who report external-regulation would benefit from instruction strategies to transition to self-regulation, which is positively related to academic achievement in this study. Faculty education including information about external regulation may help in the early identification of learners who are being more outwardly directed.

Hypothesis 4: There is a relationship between resident achievement and the learning domain, conceptions of learning comprised of construction of knowledge, intake of knowledge, use of knowledge, stimulating education, and cooperative learning.

The domain conceptions of learning (mental models of learning) includes both conceptions and misconceptions of a student about learning; the domain considers the views about teaching, learning, and conceptions about self as a learner as an individual and in relationships with other students (Vermunt, 1998, p. 151). The scales of the conceptions of learning are construction of knowledge, intake of knowledge, use of knowledge, stimulating education, and cooperative learning (Vermunt, 1998, p. 158).

The analysis of construction of knowledge scale with ITE percentile ranks was significant and positive; the other scales were not significant. The evidence supported the positive relationship between ITE percentiles and construction of knowledge. The relationship of the other scales in this domain were not significant. For residents with lower scores on construction of knowledge, education about more effective ways to look for relationships, reference material from several sources, and use self-questioning may be useful and necessary to enhance learning.

Hypothesis 5: There is a relationship between resident achievement and the learning domain, learning orientations comprised of personally interested, certificate oriented, self-test oriented, vocation oriented and ambivalent.

Learning orientation refers to the student's motivation, goals, concerns about abilities, and expectations (Vermunt, 1998, p. 151). The learning orientation scales include personally interested, certificate oriented, self-test oriented, vocation oriented, and ambivalent (Vermunt, 1998, p. 158). Two scales in this domain were significant: vocation directed was positive and ambivalent was negative with ITE percentile ranks.

Ambivalent was the only negative scale in this study. In the backward regression analysis using the domain scales, ambivalent was a predictor variable in all models. In this study there was evidence to support the positive relationship of the vocation directed scale and the negative relationship of ambivalent scale with ITE percentiles. There was no evidence to support the relationships of the other scales.

The early identification of the resident with high ambivalent scale scores provides both the resident and the faculty an opportunity to discuss fit with the anesthesiology subspecialty and to structure support for academic concerns. As the ambivalent scale is the only one that is significant and negative with ITE percentile rank, the ILS is a means of diagnosis of residents with a potential for academic risk; the goal is to improve the quality of the learning processes for the residents. The positive scale findings also provide a deeper understanding of the learning patterns and strategies that are associated with academic success in anesthesiology graduate medical education.

In summary, the most significant findings of this study were the identification of learning styles that were significantly related to results on the In Training Examination. The meaning directed learning style is significant and positive and the undirected learning style is significant and negative with In Training Examination percentile ranks. The analysis of the scales by domains in relationship with ITE percentile ranks revealed information about specific strategies that were significant and positive. The only negative scale, ambivalent, can be used, in part, to help identify residents at risk academically. The interpretation of the learning styles and scales for both residents and faculty are beneficial for identification of students potentially at risk and understanding of learning styles and strategies that are more successful. The resident's results on the ILS provides results about learning strengths and weaknesses to improve learning strategies.

This study provided an indication that residents' learning styles and domain variables can predict some of the variance in ITE percentiles. The resident has the potential to explore more effective ways to learn and to become more self-regulating in the process through the use of the ILS.

Recommendations for Further Research

Based on the results of this study, the following areas for further research are offered:

1. In general, research about the learning styles of residents is limited in its importance in medical training (Ferguson, James and Madeley, 2004, p. 956). Little information exists about the relationship of learning styles and the results of nationalized cognitive examinations for anesthesiology residents. The sample in the study was relatively small and limited to four university postgraduate programs (five sites). Boyle, et al. (2004) studied academic outcomes and learning styles using the ILS with students in British higher education and established a significant positive correlation with the meaning directed learning style and a negative one with the undirected learning style. In this study, the learning style findings were consistent with those of Boyle, et al. The results of this study should be replicated by other studies using a similar design with a larger, more diversified sample.
2. The participants in this study were all anesthesiology residents from four universities. More research into other graduate medical education programs is needed to explore the relationships between learning styles and the results of In Training Examination percentile ranks. Questions exist about the relationship of medical specialties and learning styles and domains and any changes that occur and the potential impact on graduate medical education theory and practice.
3. Longitudinal research needs to be conducted over the entire period of residency to explore the relationships between learning styles and ITE percentiles with gender, postgraduate year, and ethnicity. Vermetten, Lodewijks, and Vermunt (2001) noted that understanding personal factors embedded in learning approaches helped in describing learning. Vermunt (2005) noted differences in the learning styles for age, academic discipline, and gender. If differences exist, what is the potential of adapting education

techniques for greater effectiveness, and what is the impact of that education on the results of ITE percentile ranks.

4. Quantitative research needs to test the hypotheses about changes, if any, over the four years of graduate medical education. Case studies in qualitative research offer a richness of data that is contextually sensitive and realistic and supply in-depth data useful for developing hypotheses about learning, useful in guiding resident education, faculty development, and curriculum implementation.
5. Research using the Inventory of Learning Styles as a diagnostic instrument is needed. Curry (1999) commented that information about learning styles would allow residents to structure their coping strategies and both contextually and personally from the identification and application of learning style information early in the residency program.
6. Research is needed into the question of the usefulness of the application directed style to graduate medical education. Vermunt noted that the application directed learning styles appears later than other learning styles (1998, p. 166). As the application directed learning styles for the four postgraduate years of anesthesia graduate medical education had high mean with a small standard deviation, it provided little variation within or between years and no significance with ITE percentiles. If these findings are replicated in larger studies and with other specialties, then the inclusion of that learning style for use in graduate medical education should be reconsidered.
7. Longitudinal research is needed to explore the changes that occur in learning styles and the relationship with the results of the In Training Examination over the four-year residency period. The questions remain about the relationship of growth in resident learning and the changes that occur in learning styles.

Implications

The learning challenges facing anesthesiology residents have increased due to advanced technology, ever-expanding medical knowledge, patient knowledge, and challenges of providing improved medical care. Graduate medical education continues to

t enhance learning to respond to these challenges for the individual resident, the medical profession, and community (Holm, 2002; Kochar et al., 2003; Leach, 2001). To facilitate postgraduate medical learning, this study used a diagnostic learning style instrument that revealed a positive relationship with the meaning directed and ITE percentiles and a negative relationship with the undirected learning style and ITE percentiles. Curry (1999) concluded that learners in medical education need useful feedback, which includes information about learning styles, to enhance learning (p. 412). Little research in anesthesia graduate medical education addressed learning styles and measures of cognitive achievement.

This study provided data that residents' learning styles can be used, in part, to predict ITE percentiles variability. The study results indicated that residents with the meaning directed learning style, across all postgraduate years, scored better on the ITE percentiles. The undirected learning style is negatively related with ITE percentile rank, so early identification of those residents can be used to provide educational information and interventions to improve coping strategies. That information benefits residents and faculty in the process of identifying learning strategies that are positively associated with academic achievement to enhance learning, to identify residents at risk for academic difficulties, and to adapt teaching to residents learning strategies.

Both residents and faculty physicians benefit from education about learning and learning strategies. If a resident can obtain this information relatively early in the residency, the student has the opportunity to learn how to learn more effectively and to benefit from the basic sciences of education. Curry (1999) concluded "that variations in academic performance within a select group, such as a medical school class, are related more to the congruence between the learning environment and students' learning and cognitive styles than to differences in abilities" (p. 410). The ILS provides information about learning styles and domain scales to analyze and interpret individual resident outcomes, to structure education and information, to develop residents, and to achieve behavioral changes. An understanding of the resident's learning strategies, motivations, and mental models of learning helps the faculty physician to present material at a level appropriate to encourage and facilitate learning strategies, and to improve congruence with the learning environment. Coffield et al. (2004) stated that the risk exists that the

need to maximize learning content becomes the focus rather than helping medical resident broaden their range of learning styles and strategies (p. 12).

The ILS is an instrument to guide thinking about how to think to become more meaning directed. The resident can benefit from receiving an individualized profile of learning styles with information presented by domain scales to help develop plans for learning growth based on learning strengths and weaknesses. In addition to information about the four learning styles, analyses by the domain scales provide deeper, more specific individualized information for the resident and about the context of the learning environment. The learning patterns identified in this study reflect, in part, the learning strategies preferred by anesthesiology residents with higher percentile ranks on the ITE. One learning style usually predominates; however, information about all the learning styles by scales is helpful for specificity of individual learning strategies and application. Faculty development programs designed interpret the depth of information available from the ILS may help enhance teaching strategies adapted for more effective development of learning how to learn. The intent is to utilize teaching opportunities more fully within resource constraints

As research with the ILS has contributed to a more comprehensive model of learning strategies, the study identified the meaning directed learning style as being positively related to higher scores on ITE percentile ranks with the undirected learning style being negatively related. Residents are programmed for learning. The learning styles and domain scales of the ILS offer specific information about more and less effective learning strategies of anesthesiology residents in relationship to cognitive achievement. The ILS, in part, can play a diagnostic role in detecting anesthesiology residents who may be at risk academically. The potential for early identification of residents at risk provides the residency director and faculty members an opportunity to offer residents individualized educational assistance during the anesthesia residency. Learning how to learn more effectively helps the resident, contributes to the residency program, and establishes the preparation and discipline for life-long learning.

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Appendix A - Acronyms

Acronyms

AAMC: Association of American Medical Colleges

ABA: American Board of Anesthesiology

ABS: American Board of Surgery

ABMS: Advisory Board of Medical Specialties

ABSITE: American Board of Surgery In-Training Examination

ACA: American College of Anesthesiologists

ACGME: Accreditation Council for Graduate Medical Education

ADLS: Application directed learning style

AMA: American Medical Association

ASA: American Society of Anesthesiologists

ASI: Approaches to Study Inventory (Lancaster Group)

CCC: Clinical Competence Committee

CME: Continuing medical education

DO: Doctor of osteopathy

ETS: Educational Testing Service, Princeton, New Jersey

GME: Graduate medical education

ILS: Inventory of Learning Styles, Vermunt (1992)

ITE: In-Training Examination

IMG: international medical graduate

LASSI: Learning and Study Strategies Inventory (Weinstein et al., 1987)

LPQ: *Learning Process Questionnaire* (secondary students)

LSI: Learning Style Inventory (Kolb)

MCQ: Multiple choice questions

MD: Doctor of medicine

MDLS: Meaning directed learning style

MSOP: Medical School Objectives Project

MSLQ: Motivated Strategies for Learning Questionnaire (Pintrich et al., 1991)

NBME: National Board of Medical Examiners

RRC: Residency Review Council

RASI: Revised Approaches to Study Inventory (Lancaster Group)

RDLS: Reproduction directed learning style

RIS: Resident index score

SCOPE: The Standing Committee on Postgraduate Medical and Dental Education

SPQ: Study Process Questionnaire (Biggs)

UDLS: Undirected learning style

Appendix B - Educational and Demographic Questionnaire

Assigned Research Number:

Educational and Demographic Questionnaire

Directions: This is a questionnaire designed to gather information about your postgraduate year and your background. Please answer all the questions completely and honestly. The results of this survey are confidential and will be used for the reporting of aggregate data only. Please mark the box that most correctly answers the question and/or completely fill in the blanks.

1 What is your age? _____

2 What is your gender?

☐ Male

☐ Female

3 What is your postgraduate year in anesthesiology residency?

☐ Graduate year 1

☐ Graduate year 2

☐ Graduate year 3

☐ Graduate year 4

4 Which best describes your status?

☐ Single

- ☐ Married
- ☐ Divorced
- ☐ Widowed
- ☐ Separated
- ☐ Domestic Partner
- ☐ Other

5 Are you a parent?

- ☐ Yes
- ☐ No

Assigned Research Number:

6 How many children do you have?

☐ None

☐ Expecting

☐ 1

☐ 2

☐ 3

☐ 4 or More

7 The age(s) of the child(ren)? ____/____/____/____/____/____/____

8 How do you describe yourself?

☐ African-American

☐ Asian

☐ Caucasian

☐ Hispanic

☐ Mixed or Interracial

☐ Native American

9 My relationship with a faculty mentor is

- ☐ Effective
- ☐ Neutral
- ☐ Ineffective
- ☐ I do not have a mentor

10 My relationship to fellow residents is

- ☐ Positive
- ☐ Neutral
- ☐ Negative

Assigned Research Number:

11 My social support system is

☐ Positive

☐ Neutral

☐ Negative

☐ I don't have time for one.

12 My medical specialty is _____.

*Individual data will not be reported in the study or to the residency. A random number has been assigned to each participant and will be used as the identifier for this study.

Appendix C – Vermont ILS Permissions

Vermunt Initial Permission

From: Vermunt, prof. dr. J.D.H.M. (Jan) [J.D.H.M.Vermunt@ivlos.uu.nl]
Sent: Thursday, October 20, 2005 11:22 AM
To: Sara Lloyd
Subject: RE: Order Information for ILS

Dear Sara,

Thank you for your interest in our work. Attached you find the ILS and scoring key, both the original 120-item version and a shortened 100-item version. I also attached a recent review article on ILS-related research and theory.

You can use the ILS for your research as you wish. There are no costs involved.

Success with your studies, and if you have any more questions or remarks, please do not hesitate to let me know.

Best wishes,

Jan Vermunt

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Homepage:
<http://www.ivlos.uu.nl/deorganisatie/wiewatwaar/medewerkers/vermont/englishversion/34142mair>

Vermunt Permission For Changes

From: Vermunt, prof. dr. J.D.H.M. (Jan) [J.D.H.M.Vermunt@ivlos.uu.nl]
Sent: Tuesday, October 03, 2006 10:02 AM
To: Sara Lloyd
Subject: RE: Permission for Use of ILS in Dissertation Research

Dear Sara,

Thank you for your kind and colorful message, it was a pleasure to read it. I went through all the items and the changes you proposed to better fit your study, and I agree with all your suggested adaptations.

I wish you all the best for your research and broader life, and I look forward to see some of your results or paper on the study in due course.

Best wishes,

Jan Vermunt

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Appendix D - Study Explanation

STUDY EXPLANATION

Sara H. Lloyd

Introduction

Thank-you for your interest and willingness to learn about this study.

The topic of learning how to learn more effectively and efficiently has the potential for enhancing your learning during your residency and beyond.

The term learning styles is widely used and not clearly defined. This research looks at learning styles in the practical learning situation—that of the individual learner and the learning environment (Merriam, Caffarella, & Baumgartner, 2007, p. 407).

In anesthesiology post-graduate education little is reported in the literature about the learning styles of residents using psychometrically sound instruments.

The purpose of this study is to look at learning styles, their relationship with In Training Examination (ITE) scores, and to identify learning styles and patterns that occur within and between post-graduate years.

Can the information gained be used to help residents learn how to learn more effectively? The literature reports that medical students and residents usually do not lack for discipline and dedication, but the learning outcomes vary, some of which are attributable to learning strategies and styles.

Some learning styles are more effective than others; however, we do not know in this situation what those are and how they may be correlated with ITE Scores.

For this purpose we will be using the Vermont Inventory of Learning Styles

Vermont Inventory of Learning Styles

Dr. Jan Vermunt developed his Inventory of Learning Styles instrument as a part of his Ph.D. dissertation and continues this work today. The instrument demonstrates validity and reliability, is gaining in use in the United States and internationally, is designed for use with university students, including medical students, and is a diagnostic learning style instrument (Vermunt, 1995, p. 331).

Learning style is too often associated with unchangeability, which is not supported by research. In 2005 Dr. Vermunt changed the term learning styles to the more neutral Learning Patterns: “the temporal interplay between personal and contextual influences”. For the purposes of this study, we will still use Learning Styles consistent with the title and accommodating for later interpretations (Vermunt, 1996).

Learning is a highly individual process and has several domains. The 4 domains studied include:

Cognitive Processing Strategies: “thinking activities that students use to process learning contents and to attain their learning goals by doing so” (Vermunt, 1998, p. 151)

Metacognitive regulation activities: “directed at regulating the cognitive activities and therefore lead to learning results indirectly” (Vermunt, 1998, p. 151)

Conceptions of learning (mental models of learning): “a coherent system of knowledge and beliefs about learning and related phenomena (e.g., knowledge and beliefs about oneself as a learner, learning objectives, learning activities and strategies, learning tasks, learning and studying in general, and about the task division between students, teachers, and fellow students in learning processes) (Vermunt & Vermetten, 2004, p. 362)

Learning orientations: “the whole domain of students’ personal, goals, intentions, motives, expectations, attitudes, concerns, and doubts with regard to their studies (Vermunt & Vermetten, 2004, p. 362)

The four domains each contain 5 sub-factors. The factor analysis has resulted in four Learning Styles: Meaning-directed, reproduction directed, undirected, and application-directed learning styles.

Dr. Vermunt defines learning styles as “a coherent whole of learning activities that students usually employ, their learning orientation and their mental model of learning; a whole that is characteristic of them at a certain period” (Vermunt, 1996, p. 29)

In what manner can information about these learning styles contribute to anesthesiology education?

Purpose of the Study

This study explores the relationship between ITE scores and Learning Styles to discover if differences exist within and between PGY, and, if so what. How do learning styles relate to resident ITE scores?

Potential Outcomes for Anesthesiology Resident Learning Styles

The purpose is to determine if any differences exist, and if so, can these be used to help residents improve their learning styles.

The following potential exists

- 1) Improve learning through Individual coaching of anesthesiology residents using the results of the ILS
- 2) Identify learning strengths and weaknesses
- 3) Help Faculty understand various learning styles and potential ways to help residents learn more effectively

- 4) Provide Residency Directors with data based on the aggregate findings of this study to assist with Program Planning and Instruction.

Study Design

This study is a double blind and results will be presented in aggregate form. The Sub Investigator will have no access or connection of individual names and ITE scores, and the Residency Directors will have no access to your Inventory of Learning Style scores.

Residency Directors have expressed an interest in your getting individual feedback on your Learning Styles, if you are interested. In order to do this, please record your Random Number on your personal copy of the signed Consent Form provided by an Anesthesiology Residency Staff Member.

The individual feedback will include the following:

- 1) Your Learning Style as identified by the ILS
- 2) The relationship of that Learning Style with ITE scores by Post-Graduate Year
- 3) Potential suggestions for ways to study and learn more effectively

Questions

Study Process

- 1) Please complete the Consent Form if you are interested in participating. You are able to withdraw at any time.
- 2) You will be given a copy of your signed Consent Form by a University of Pittsburgh Anesthesiology Staff Member following this. There will be no notation or reference to your Random Assigned Packet Number on your original signed Consent Form.
- 3) The signed Consent Forms will be placed in an envelope and mailed to Dr. Robert S. F. McKay, Principal Investigator by a member of the University of Pittsburgh Anesthesiology Residency Staff.
- 3) Please complete the ILS and the Educational and Demographic Survey. Circle only 1 number for each question as there are no provisions for 3.25, etc.
- 4) If you are interested in receiving feedback on your Learning Style, please note your Random Number on your personal copy. Your copy with the Random Number is the only one that can be used for the individual feedback following the completion of this study and a signed Consent Form agreeing to individual feedback.
- 4) The Sub Investigator will receive a copy of the de-identified ITE scores by Post-Graduate Year from the Residency Director.

Questions

I will be available during the assessment and after to answer any questions.

Thank-you for your interest and participation.

References

Merriam, S.B., Caffarella, R.S., & Baumgartner, L.M. (2007). *Learning in adulthood*, 3rd ed. San Francisco: Jossey-Bass.

Vermunt, J.D. (1998). The regulation of constructive learning processes. *British Journal of Educational Psychology*, 68, 149-171.

Vermunt, J.D., & Vermetten, Y. (2004). Patterns in student learning: relationships between learning strategies, conceptions of learning, and learning orientations. *Educational Psychology Review*, 16, 359-384.

Appendix E - Dissertation Recruiting Summary

Dissertation Recruiting Summary

Introduction

Medical residency is advanced experiential learning, both formal and informal, which occurs predominately in the workplace. Schein (1972) addressed the vision of more effective professional education that included “new modes of learning modules built on better theories of how students learn.” These “new modes” would incorporate the flexibility to accommodate students with different learning styles and levels of competence at progressive stages of the learning process (p. 129). The growth of technological, medical and societal expectations adds pressure to increase the learning of post-graduate medical education. Academic performance is strongly related to the learning activities used during the learning process. Learning activities are cognitive activities that a student uses. Learning strategies are combination of learning activities which are relatively consistent, but somewhat open to change (Vermunt, 1996, p. 25). Teaching faculty need to be able to motivate residents in the use of these learning strategies. However, to do so, specific learning strategies and approaches need to be identified and related to cognitive outcomes as measured by the In-Training Examination (ITE), an examination given during each year of residency training. These strategies can then be used to identify and track any changes from post-graduate year one to four and the effects and changes, if any, on academic performance.

Empirical evidence about learning styles and strategies as related to cognitive knowledge is lacking in anesthesia graduate medical education. Three potential practical application opportunities exist: 1) to help the resident learn to customize his/her learning strategies, 2) to help medical faculty understand theory and application of various resident learning strategies, 3) to provide practical resources about learning strategies and approaches to assist residency directors in learning process development.

The conclusions of existing research are that students learn differently and are influenced by the context of the learning situation, assessments, and teaching styles and

requirements. Their learning strategies applications are often influenced by the situation, and the learner largely controls the learning in an active, constructive process served by learning strategy selection.

Past research on learning strategies is limited and has been centered on residents not meeting performance expectations. The purpose of this study is to expand information about learning strategies and approaches to include anesthesiology residents performing at all performance levels. The research questions addressed by this study include:

Primary Research Question

Does a relationship exist between the ITE scores of Anesthesiology Residents in the UKSM-W Residency Program (and other Anesthesiology Residency programs to be recruited) from July 1, 2006, to June 30, 2007, and components of cognitive processing, metacognitive regulation, mental learning models, and learning orientation as measured by Vermunt's Inventory of Learning Styles? If so, what is the nature of the relationship?

Methodology

The instruments selected for this research were chosen based on the research questions and potential for operational use. Instruments used to evaluate outcomes of medical education must have content validity, high reliability, ease of administration, cost effectiveness, and acceptance by faculty and residents. For medical educational use, the instrument(s) chosen need to support "operational use for academic decision making." Data for this research will be scores on the ITE, a demographic and education questionnaire (Appendix H), and Vermunt's Inventory of Learning Styles (VILS) (Appendix B). The ILS was selected because it best measures the learning variable described in the research questions, has an established record nationally and internationally, and has psychometric properties equal to other instruments. The ILS has a constructivist orientation, an educational psychology base, emphasis on individual learning strategies, focus on application with adult students, research use with medical students, and usage in international research.

Assumptions

1. Residents are highly educated advanced learners.
2. Residents have identifiable learning strategies and approaches to learning.
3. Learning strategies and approaches affect cognitive information gleaned from learning activities.
4. The residents in the study will provide honest answers.
5. The sample of anesthesia residents is representative of the population of Midwest anesthesiology residency programs.

Participants

The participants from six to ten anesthesiology residency sites in the Midwest will number approximately 175 to 250. The residencies will be identified by October 31, 2006, by Dr. Robert S.F. McKay, Residency Director, University of Kansas, Wichita, Anesthesiology. These four year anesthesiology residency programs will be accredited by ACGME which requires a curriculum determined by the American College of Anesthesiologists and the American Board of Anesthesiology utilizing ACGME six core competencies. The participants will have received a Doctor of Medicine degree or a Doctor of Osteopathy degree and will be participating in a four year graduate medical program in anesthesiology. The study will take place during the 2006-2007 residency year which begins July 1, 2006 and ends June 30, 2007.

The measures used in this study include (a) the In-Service Training Examination, (b) Vermunt's Inventory of Learning Styles, and (c) a survey to gather demographic and educational data.

Dependent Variables

The dependent variables include the ITE scores and the factor scores from the Vermunt's Inventory of Learning Styles.

Independent Variables

The independent variables were selected based on findings in the adult education, educational psychology, and medical education and post-graduate medicine literatures and include the demographics of post-graduate Year, age, medical specialty and mentor relationships.

Data Collection Procedure

The survey instruments, ILS and Educational and Demographic Questionnaire, will be administered by the Sub-Investigator (Sara Lloyd) at each site. The residency directors will receive written information about the research project from letters sent from Dr. Frank Spikes, Professor and Director of Doctoral Programs in Adult and Continuing Education, Kansas State University, Manhattan, Kansas, and sub-investigator, Sara H. Lloyd, Ed.S. The residency directors will be provided the opportunity to contact either Dr. Spikes or the sub-investigator about problems, questions, or potential scheduling conflicts. The individual program directors will assign residents a number and supply blinded ITE scores to the UKSM-W coordinator. Individual residencies will supply each resident with the number assigned to be placed on the Educational and Demographic Survey and the ILS. No numbers will be placed on the Consent Form. The sub-investigator will administer the instruments, give the resident a copy of the Consent Form, collect the documents, and place them in a sealed envelope. The coordinating site (UKSM-W) will receive the blinded ITE, assuring that no names are given to the sub-investigator for ITE scores. The residency directors will not receive individual results on the instruments as no names will be used, assuring anonymous data.

Data Analysis Procedure

Descriptive statistics will be used to characterize the sample distribution across post-graduate years for mentor relationships, ITE scores, and Inventory of Learning Styles processing strategies, regulation strategies, conceptions of learning, and learning orientations. Correlations will be run following measures of central tendency and dispersion. A regression analysis using backward elimination of ILS factors as a function of ITE will follow. Selected significant factors will be utilized to predict learning styles and strategies by graduate years.

References

- Schein, E.H. (1972). *Professional education: some new directions*. New York: McGraw-Hill.
- Vermunt, J.D. (1996). Metacognitive, cognitive and affective aspects of learning styles and strategies: a phenomenographic analysis. *Higher Education*, 31, 25-50.

Appendix F - Kansas State University Informed Consent Form

AUTHORIZATION AND INFORMED CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Investigator: Robert S. McKay, MD

Sub-Investigators: Sara Haviland Lloyd, Ed.S
W. Franklin Spikes, Ed.D

Study Title: An Exploratory Study of the Relationship Between In-Service Training Examination Scores and the Vermont Inventory of Learning Styles

Study Sponsor: Kansas State University College of Education, Manhattan, KS

RESEARCH AND PURPOSE

This study will examine the relationships between In-Service Training Examination (ITE) scores of anesthesiology residents with their responses on the Vermont Inventory of Learning Styles. This research will contribute to the literature in adult education and graduate medical education by identifying approaches to learning cognition, metacognition, motivation, and orientation to learning. The purpose is to look for positive correlations between high level of achievement on the ITE and approaches to learning so that other residents can have focused data on effective strategies for learning how to learn. Participants will be able to have access to the results of this study through Dissertation Abstracts International.

ELIGIBILITY TO PARTICIPATE

Residents contracted to the WGME Anesthesiology Program will constitute the local sample population. There will be other Anesthesiology Residency Programs participating in other localities.

EXPLANATION OF SCREENING ACTIVITIES AND STUDY ACTIVITIES

Data will be gathered from the survey instrument developed by Jan D. Vermont entitled "Inventory of Learning Styles" (VILS) and will be correlated with data from your In-Service Training Examination which is developed and approved by the American Board of Anesthesiologists.

DISCOMFORTS AND RISKS

The only risk of this study is the potential loss of privacy for your ITE scores. In order to insure that this does not occur, the residency director(s), who already have knowledge of your ITE scores will be the only person(s) to view your individual scores and will be responsible for de-identifying the score.

BENEFITS

There will be no direct benefits to you.

HSC#: 220060985
Approval Period: 12/18/06-12/17/07
Assurance#: FWA00003411

COSTS TO PARTICIPANTS

There will be no cost to you for participating in this study.

ALTERNATIVE TREATMENTS

N/A

PERMISSION FOR REVIEW OF RECORDS and CONFIDENTIALITY

Your confidentiality will be kept by keeping all of your study-related information in a locked file cabinet or in a password protected database. Access to confidential data that identifies you by name will be restricted to:

- The PI, Robert McKay, MD

Only the above will have access to confidential data that identifies you by name. The only exception to the above would be if other disclosure is required by law. Absolute privacy cannot be guaranteed because the above parties may need to access your information.

PARTICIPATION/WITHDRAWAL

Participation in this study is entirely voluntary. You are not obliged to take part. Refusal to participate will not affect any benefits to which you are entitled. If you decide to take part, you will need to sign to say that you give your consent to participate.

AUTHORIZATION TO USE AND DISCLOSE MEDICAL INFORMATION

N/A

COMPENSATION STATEMENT

You will not be given any reimbursement for participating in this study.

**UNIVERSITY OF KANSAS SCHOOL OF MEDICINE-WICHITA INDEMNITY
CLAUSE**

Although the University of Kansas Medical Center does not provide free medical treatment or other forms of compensation to persons injured as a result of participating in research, such compensation may be provided under the terms of the Kansas Tort Claims Act. If you believe you have been injured as a result of participating in research, you should contact the Office of Legal Counsel; University of Kansas Medical Center, Kansas City, Kansas 66160-7700.

WHOM TO CONTACT with QUESTIONS

You have the right to ask any questions concerning this study at any time. You may discuss this study with Dr. McKay at any time. If you have questions about your rights as a research participant, you may also contact the chair of the KUSM-W Human Subjects Committee by calling 316-293-2617 or by writing to 1010 N. Kansas, Wichita, Kansas 67214-3199.

(Continue to next page for consent signatures)

HSC#: 220060985
Approval Period: 12/18/06-12/17/07
Assurance#: FWA00003411

AUTHORIZATION AND CONSENT SIGNATURES TO PARTICIPATE IN THIS STUDY

- **You have read and understand this 3-page consent form.** You have been given the opportunity to ask questions regarding this study and they have been answered to your satisfaction. You will not give up any of your legal rights by signing this form.
- **Participation in this study is voluntary and you may stop at any time.** The Principal Investigator may withdraw you from this study.
- **You will receive a copy of this 3-page consent document.**

Printed Name of Subject

Signature of Subject

Date

Time

Printed Name of Person Explaining the Consent

Signature of Person Explaining the Consent

Date

HSC#: 220060985
Approval Period: 12/18/06-12/17/07
Assurance#: FWA00003411