DISSERTATION

LEARNING STYLES OF RADIOGRAPHY STUDENTS DURING CLINICAL PRACTICE

Submitted by

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In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Ft. Collins, Colorado

Fall 2009

COLORADO STATE UNIVERSITY

October 23, 2009

WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY L. PATRICE WARD ENTITLED LEARNING STYLES OF RADIOGRAPHY STUDENTS DURING CLINICAL PRACTICE BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

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ABSTRACT OF DISSERTATION

LEARNING STYLES OF RADIOGRAPHY STUDENTS

DURING CLINICAL PRACTICE

The purpose of this study was to identify and describe the common learning styles of radiography students during clinical practice. Quantitative, descriptive research methodology identified the learning styles of radiography students. A single self-report questionnaire, developed to assess learning styles in clinical practice, was administered electronically via a Web page. The sample included 350 radiography students from Joint Review Committee on Education in Radiologic Technology (JRCERT) associate degree programs in the United States.

There were six subscales of learning styles identified: structure, integration, experimentation, authority, orientation, and approach. Findings found three groups of radiography students with similar learning styles: task oriented (n = 101), purposeful (n = 134), and tentative (n = 114). Students identified with the task oriented learning style were characterized by preferences to test ideas and draw on intuition and feelings during clinical learning situations. Purposeful learning style students were distinguished by preferences to plan, actively integrate theory and practice, focus on results, and trust in theoretical concepts. The tentative learning style students were characterized by preferences for more prescriptive and results oriented clinical learning experiences and moderation in other learning style elements.

Radiography students as a group tended to plan more than improvise and actively rather than passively integrate theory and practice. During clinical learning experiences, they were inclined to focus on results more than process and were apt to rely on themselves rather than depend on experts for guidance. There were statistically significant differences in distribution for gender, level in program, and age among the three groups of common learning styles. Findings found males were more likely to identify with the purposeful learning style and females with the tentative learning style. First year students were more likely to identify with the purposeful learning style and second year students with the task oriented learning style. Traditional students were more likely to identify with the tentative learning style and nontraditional students with the purposeful learning style. There were no significant differences in distribution associated with learning styles and level of education.

Implications for practice include suggestions for students and clinical faculty to apply knowledge of learning styles to understand differences among students, to enhance discussion about learning, and to inspire creative techniques to facilitate learning during clinical practice. Findings offer possibilities for refining the questionnaire and directions for future research to improve teaching effectiveness and student achievement.

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DEDICATION

I dedicate this dissertation in memory of my Grandmother Augusta Bates, Grandmother Ethel Bain Kennamer, and Aunt Anne Wemple. Each in her way taught me teaching is a noble profession.

ACKNOWLEDGEMENTS

When I made the decision to pursue this degree, I anticipated the journey would be as important as the goal. Indeed it was. To share this journey with so many amazing people was an unexpected honor.

I would like to begin by thanking my committee of Rich Feller, Carole Makela, Linda Kuk, and Cathy Kennedy for their time, guidance, and feedback. Special thanks to Rich Feller for his patience and encouragement and to Carole Makela for her continued efforts to improve my writing and refine my data analyses.

I am grateful to program directors who agreed to provide students opportunity to participate in this study and students who took time to contribute their thoughts and feelings about their learning style. Without these efforts, this study would not have been possible.

No acknowledgement would be complete without thanking friends and colleagues who shared this experience with me. To Sonia Brandon and Kelly O'Connell special thanks for helping me gather and analyze data. To Leslie McAninch thank you for listening and providing emotional support and encouragement. With deep respect, I recognize Brigitte Sundërmann who enriched this journey. Thank you for the laughs, intense discussions, and for sharing your heart. There are too many others to mention here, but to each of you I am appreciative.

With admiration, I acknowledge the continual encouragement and support of my family. To my parents, Wayne and Marjorie Bain, thank you for teaching me perseverance and for loving me unconditionally. It was with joy I shared this journey with my daughters. Cassie led me to my first doctoral class and Bethany accompanied me

to my dissertation defense. Their faith in my ability was inspirational. I deeply appreciate my husband Dave who cheered, supported, and sacrificed from beginning to end. Finally, I acknowledge my Lord and Savior Jesus Christ Who sustained me throughout this experience.

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CHAPTER I: INTRODUCTION

Health science professions depend on practical experience to demonstrate and develop knowledge and skills from academic (didactic) and laboratory experiences. As a result, health science educational programs provide academic and clinical education. The purpose of the academic component is to provide students the opportunity to learn principles and concepts relevant for professional performance. Students gain knowledge of fundamental concepts and theories in the classroom, laboratory, and related homework prior to and concurrently with participation in clinical experiences. The foundation for clinical education is authentic, direct experience in a medical facility.

Radiologic technology is the largest of the allied health science disciplines (Bureau of Labor Statistics, 2007). Clinical education is an integral part of radiologic technology programs (Fortsch, 2007; Giordano, 2008). The American Registry of Radiologic Technologists (ARRT), a voluntary credentialing agency, currently certifies over 265,000 individuals (ARRT, 2008). Radiography is one of five disciplines of radiologic technology offered by the ARRT for primary certification. To receive certification in radiography that qualifies individuals to use ionizing radiation in medical imaging and to use the designation of registered technologist (RT), individuals must earn recognition by the ARRT (ARRT, 2007c). To qualify candidates must meet ethics standards, complete educational preparation standards, and pass the ARRT Radiography certification examination.

Typically, prospective radiography students must apply for acceptance into a program. According to the American Society of Radiologic Technologists (ASRT), first year enrollments for fall 2008 were 17,050 radiography students (ASRT, 2009). The ASRT determined program directors at full enrollment were turning away qualified students at a rate, which projects to an unmet national demand of approximately 27,650 students. Many radiography programs are limited in the number of students they may admit due to constraints associated with the number of available clinical facilities. Espen, Wright, and Killion (2006) investigated the common admission criteria of entry-level radiography programs in two states. Findings indicated there was no standard used by all programs, but they did find GPAs, successful completion of selected courses, interviews, and standardized tests were commonly used admission criteria.

Following admission, students begin classroom preparation that includes lectures and demonstrations (Gurley & Callaway, 2006). The time when a student first enters the clinical environment varies among programs. Initially, students mainly observe radiologic technologists and other healthcare workers performing daily activities in the clinical environment. Later students begin to apply theoretical principles and knowledge in the clinical environment through supervised performance of tasks. Typically, as students progress through the program the time spent in clinical practice increases.

To meet educational preparation standards, candidates must successfully complete a formal educational program approved by the ARRT (ARRT, 2007c). Hospitals, colleges and universities, and less frequently vocational-technical institutions, offer educational programs in radiologic technology. Education in radiologic technology, similar to most curricula in allied health professions, includes an academic component and a clinical component (ARRT, 2007a). The academic requirement for radiologic technology consists of specified coursework. The ARRT Examination in Radiography is the method used to assess candidates "knowledge and cognitive skills underlying the intelligent performance of the tasks typically required of the staff technologist at entry into the profession" (ARRT, 2007b, p. 37). Radiography students need to develop learning skills to meet the demands of clinical practice. The clinical requirement for radiography consists of demonstrated competency in general patient care activities and radiologic procedures (ARRT, 2007a). Clinical competence means candidates perform procedures "independently, consistently, and effectively" (ARRT, p. 31). Clinical education provides students learning opportunities within a hospital, clinic, or physician's office that produces radiographic images. Evaluation of competence requires the observation of students during their clinical practice.

Due in part to the ARRT clinical competency requirement, the curriculum for all radiologic technology programs includes clinical education. The ARRT however does not mandate the number of clinical hours for educational programs. A considerable number of hours are committed to clinical education despite variance in the number of clinical hours among programs. As indicated by a 1998 survey of 216 college based radiography programs, the required clinical education clock hours ranged from 1,200 to 2,400 hours (Van Valkenburg, Vealé, Caldwell, Lampignano, & Hairfield, 2000). While clinical education clock hours do not directly compare to credit hours, another way to assess the value programs place on clinical education is to examine the number of credit hours allotted for clinical practice. In the program where I teach, clinical education accounts for 51% of the total program credits. An informal examination of 20 randomly selected associate degree radiography programs found clinical education ranged from 19% to 60% of the total program credits. For these programs, clinical education credits averaged 36% of the total program credits. Based on my experience, clinical education is a valued component of the learning process.

In response to increased demands to conserve fiscal resources and respond to an increasingly diverse population of students, educators are pressed to create learning situations that are more effective (Sims & Sims, 2006). The desire to understand and improve the way individuals learn has created widespread interest in learning style theory and learning style assessment. However, educational theory about learning favors theoretical learning in academic and related homework conditions rather than within work-based situations (Hermanussen, Wierstra, de Jong, & Thijssen, 2000). In education, the academic classroom has been the venue for research in learning styles (Dunn, (n.d.a); Gregorc, 1982a; Kolb & Kolb, 2008a, 2008b; Witkin, Moore, Goodenough, & Cox, 1977). This is understandable because the nature of general and higher education is theoretical and highly abstract (Hermanussen et al.).

Although the contexts are quite different, instruments developed to measure learning styles in academic conditions are often used within work-based situations (Berings, Poell, Simons, & van Veldhoven, 2007). However, published research suggests the learning styles of most students differ in the academic classroom and in authentic work-based situations (de Jong, Wierstra, & Hermanussen, 2006; see also Coker, 2000). Research associated with the learning styles students used during work-based or practice-based experiences is limited (Berings et al., 2007; Hayes & Allinson, 1997; Hermanussen et al., 2000; Lasonen & Vesterinen, 2000). The instruments currently used to evaluate work-based learning styles are inadequate. They do not consider the context of the learning situation, are discipline specific, or have psychometric weaknesses. In situations where the discipline or course of study depends on theoretical and work-based learning, there is a need to understand learning style as it relates to both contexts.

Significance of the Study

For education to be successful, it is imperative that educators understand how learners gain understanding (Sims & Sims, 2006). Research on the learning styles of students has supported strategies to improve teaching and learning in classroom and related homework conditions (Chapman & Calhoun, 2006; de Jong et al., 2006; Diaz & Cartnal, 1999; Pithers, 2002; Raschick, Maypole, & Day, 1998; Terry, 2001). A review of published literature found limited research investigating the learning styles of radiologic technology students, and no research targeting the learning styles of radiography students during clinical practice. The need exists for research designed to understand the learning styles of radiography students specifically during clinical practice.

Understanding the different ways people learn is intuitively appealing to anyone interested in the facilitation of effective learning. Logic implies that if facilitators of learning know more about how individuals learn, they will be able to address the strengths and weaknesses of learners. This research adds to the field of study by helping students, affiliate clinical instructors, clinical faculty, and other educational program representatives in radiography programs gain understanding about the way students learn during authentic clinical practice conditions. While the findings are most valuable for radiologic technology educators and students, medical, nursing, and other allied health science educators and students who depend on work-based experience to demonstrate and develop knowledge and skills could potentially benefit from this research.

Statement of Research Purpose

The purpose of this study is to describe the common learning styles of radiography students and to describe the immersion, reflection, conceptualization, experimentation, and regulation styles of radiography students during clinical practice. The perspective is that of the student.

Research Questions

The research questions are:

1. What are the immersion, reflection, conceptualization, experimentation, and regulation styles of radiography students during clinical practice?
2. How are immersion, reflection, conceptualization, experimentation, and regulation styles interrelated?
3. What are the common learning styles of associate degree radiography students during clinical practice?

Assumptions

Following are assumptions for this study:

1. The sample of participating students was representative of the population of students enrolled in accredited, associate degree programs during the period of study.
2. Responses of participants accurately reflected their self-perceptions of learning during clinical practice.

Definition of Terms

For the purposes of this study, the following definitions apply.

Academic education refers to learning based on theoretical concepts. Academic methods include learning from textbooks, homework, or traditional classroom studies.

Accreditation is a voluntary, self-regulatory process that encourages program self-assessment and development of professional education. The Joint Review Committee on Education in Radiologic Technology (JRCERT) endorses educational programs that comply with stringent professional standards (JRCERT, 2007).

Certification in radiography is the preliminary recognition of individuals qualified to use ionizing radiation in medical imaging. Individuals who complete educational preparation standards, meet ethics standards, and pass the certification exam earn recognition by the ARRT (ARRT, 2007c).

Clinical education refers to learning from practical, relevant situations in the workplace. In radiologic technology, clinical education represents learning opportunities and experiences during clinical practice.

Clinical practice in radiography is direct work experience and performance in a medical facility that produces radiographic images. Medical facilities include hospitals, clinics, or physicians' offices. Students in educational programs must demonstrate competency in specified patient care tasks and radiographic procedures in a medical facility.

Learning style is a common term used to describe a number of different or overlapping concepts. For the purposes of this study, it was important to clarify the meaning of terms closely associated or used synonymously with learning style.

According to Entwistle (1991), the psychological term cognitive style describes individuals' learning personality or the way individuals typically deal with cognitive tasks. Typically, cognitive style is a relatively stable characteristic of an individual (Curry, 1983; Riding & Sadler-Smith, 1992). In the past, the terms learning style and cognitive style were used interchangeably (Riding & Cheema, 1991). Learning approach or learning strategy describes the method individuals use to deal with a learning environment, whether the situation matches their learning style or not (Curry). Strategies, which are more flexible in nature may be learned and developed (Riding & Cheema). Others have described learning approach as a general term to explain the characteristic learning behavior of individuals (Cuthbert, 2005; de Jong et al., 2006). Learning preference refers to the choice of one learning method over another. In this study, learning styles is a general term used to describe the different ways individuals gain knowledge.

Radiologic technologists are skilled healthcare personnel who perform diagnostic imaging examinations and administer radiation therapy treatments. They may specialize in a variety of modalities such as general radiography, mammography, magnetic resonance imaging, or sonography.

Registered technologist (RT) is the title given to individuals certified by the ARRT. Registration of the certificate must be in effect to continue to use the title (ARRT, 2007c).

Work-based experience is a general term that describes practical learning situations that take place in the workplace or field. As a component of higher education programs, it provides a "valuable way for students to apply theoretical (propositional) knowledge" (Brodie & Irving, 2007). Clinical practice is a type of work-based experience.

Study Delimitations

Following were the delimitations in the study, which directed the choice of programs from which students participated:

1. Accredited associate degree radiologic technology programs in the United States and Puerto Rico.
2. Certificate or baccalaureate degree programs and hospital-based, technical, military, proprietary, or consortium programs were not included.

Researcher's Perspective

> Learning and teaching should not stand on opposite banks and just watch the river flow by; instead, they should embark together on a journey down the water. Through an active, reciprocal exchange, teaching can strengthen learning how to learn (Malaguzzi, 1998, p. 82).

At the beginning of my career as a radiographer, I worked in a radiology department in a hospital and later in a private clinic. I enjoyed interacting with patients and performing tasks efficiently and proficiently. Not recognizing it at the time, I later realized I also took great pleasure in working with students involved in clinical practice at these facilities. Through a serendipitous turn of events, I entered the field of education. For nearly 20 years, I have been an educator in radiologic technology in both academic and clinical practice settings.

At the start of my career in education, I had no prior academic teaching experience and little clinical teaching experience. I chose to jump into the river of education with both feet. Initially I learned primarily through trial and error experiences with students. At first, I thought good teaching meant sharing theoretical concepts, personal perceptions, my own professional experiences, as well as designing classroom and laboratory exercises. Later, I began to understand the techniques I used were not beneficial for every student. As I talked to students about their perceptions of the learning experience, I began to understand that students learn in a variety of ways and good teaching, at a minimum, requires understanding the general approaches individuals use to acquire knowledge. I set off to investigate learning style. It became apparent that the more individuals understand how they learn, the better they are able to maximize learning opportunities and improve the overall learning experience. For me this meant understanding and sharing the concepts of learning style could improve my teaching approach and foster students' efforts to facilitate their own learning experiences. This is when my interest in learning style developed into a passion.

As I became acquainted with literature related to learning style, I searched for ways to incorporate a wider variety of learning opportunities for students in academic and clinical environments. Over the years, I observed other colleagues who shared my interest in improving education in the traditional classroom through an understanding and use of individual learning styles. However, I also discovered some people did not support the use of learning styles, because they believed learning style assessment categorizes or types individuals and denies the unique character of the individual. I believe the intent of learning style theory is not to pigeonhole individuals, but to provide a foundation for people to explore and appreciate differences among individuals. Based on my experience, an understanding of different learning styles can serve as a catalyst to the development of new and innovative ways of teaching and learning. Helping students develop insight concerning the differences in the ways people prefer to learn can help them become better learners.

As I explored the use of learning style assessment to improve teaching and student learning outcomes I discovered the literature was slanted toward academic and independent study conditions. As a member of a profession that depends on learning and skill building through practical experience, to me the limited amount of research conducted on learning preferences in work-based education was baffling. I believe it is important to understand students' approaches to learning in different learning conditions.

If learning and teaching are to strengthen each other, it is important to understand how students approach learning in all learning environments. It is my desire to contribute to this body of knowledge and particularly to the way radiography students approach learning during clinical practice. I am grateful to all the learners who have shared their perceptions of learning with me.

CHAPTER II: LITERATURE REVIEW

Individuals learn in unique, multifaceted ways. Considerable research has investigated the impact of personality, cognitive ability, cognitive style, learning style, learning strategy, and preferred learning environment on the learning process. Clinical practice plays an important role in the curriculum of healthcare programs. To maximize learning opportunities it is valuable to understand the way students learn during clinical experiences. However, little research has investigated the styles healthcare students use to learn under these conditions. The purpose of this study is to examine learning styles of students during clinical practice. For this study, selection of the appropriate learning style theory and assessment should be in accordance with learning in a clinical environment. To capitalize on what learning style models contribute to the educational process there must be linkage among a particular learning style theory, its assessment, and the purpose for using it.

The purpose of this chapter is to discuss the literature related to the styles students in healthcare education use to learn. The background for the study includes two conceptual integration models of learning styles and descriptions of prominent learning style models and instruments. A review of research literature related to learning style assessment in allied health science, medical, and nursing education and in work-based situations is included.

Frameworks for Conceptualizing Learning Styles

Available literature confirms theoretical and pragmatic problems associated with learning styles. One difficulty is a lack of consensus regarding terminology. Part of the problem occurred because of the independent development of various learning style models. Riding (1997) observed that between the early 1940s and 1980s when individuals began to speculate about individual differences in learning, many worked independently with little reference to the work of others. Consequently, varieties of theoretical models of learning emphasizing different facets of the way people learn and different learning style types were developed. Adding to the complexity, the limited exchange of ideas resulted in a variety of style labels. Despite these problems, extensive empirical research with many of the models has provided insights into the complex domain of learning styles. Most of the current work involves conceptual integration of previous work, proposals of new styles, or research probing relationships between different style labels (Zhang & Sternberg, 2005).

Due to the complex and diverse perspectives regarding learning style theory and assessment, several authors and researchers have attempted to develop conceptual frameworks of learning style theories to explain relationships among different style labels (Coffield, Moseley, Hall, & Ecclestone, 2004; Curry, 1983; Miller, 1987; Riding & Cheema, 1991; Sadler-Smith, 1997; Zhang & Sternberg, 2005). Each conceptual framework explicitly or implicitly addresses the familiar state-or-trait debate observed in human psychology. It is important to understand whether a researcher considers learning styles as stable traits we inherit or shifting states that can change over time. Three perspectives of learning styles (structure, process, or both) relate to the debate and have implications for the way style impacts learning (Riding & Cheema). Viewed as a structure (trait), learning style is stable over time for an individual. From this standpoint, customized learning situations can meet the needs of the individual once her/his style is identified. Viewed as a process (state), style can change with each experience or task. From this perspective, modified learning situations can promote change to compensate for or strengthen weaknesses. Viewed as both a structure and process, styles are adaptable but retain style structure. From this point of view, styles fluctuate moderately according to the learning situation.

This section will examine two major frameworks used to conceptualize learning style constructs and theories. Both frameworks explore the importance of the state-or-trait perspective as it relates to the discussion of learning styles. The first is Curry's (1983) model, selected because it serves as an example of one of the earliest attempts to explain relationships among different style labels. The second is Coffield et al.'s (2004) families of learning styles, selected because it includes an extensive examination of current literature on learning styles.

Curry's "Onion" Model of Learning Style Theories

In a paper presented to educational researchers, Curry (1983) proposed a model to explain differences between aspects of learning that are easily changed and those that are more resistant to change. She reviewed research that used learning style assessments for education or professional occupational choice purposes. The review for psychometric adequacy included 21 models of learning styles. Using a systems approach, Curry organized nine of the learning style assessments into a model to explain how individual style constructs relate to each other. Drawing on the analogy of an onion Curry identified three levels of learning: cognitive personality style, information-processing style, and instructional preference style as in Figure 1, which illustrates how each of the three levels represents a different aspect of an individual's style and vulnerability to outside influences.

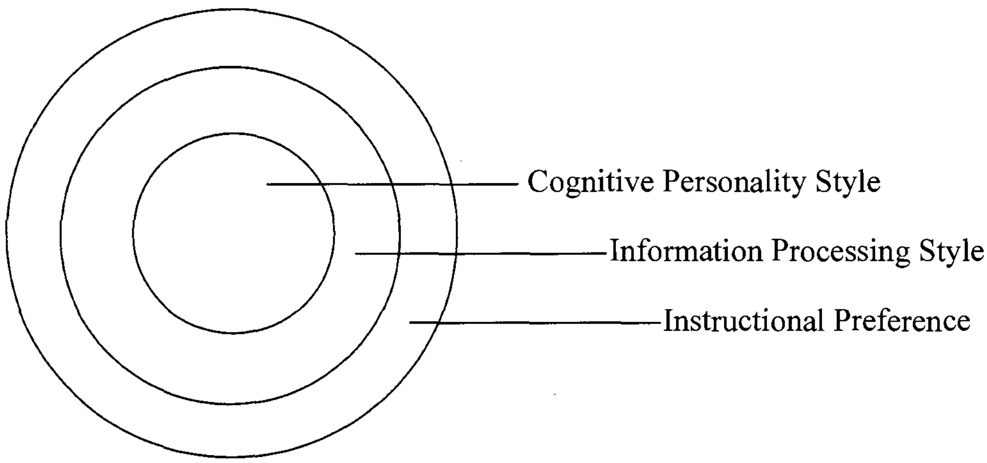

Figure 1 Curry's Onion Model of Learning Style Theories

According to Curry (1983), cognitive personality style, represented by the center portion, recognizes the influence of personality on the way an individual modifies and integrates information. Curry contended personality is the most static dimension and explained in a comparison of inventories that the internal consistency for this construct is higher than the other two groups. Instruments that represented the cognitive personality style include those of Witkin (Witkin, Goodenough, & Karp, 1967), Myers-Briggs (as cited in McCaulley, 1978), and Kagan (as cited in Yando & Kagan, 1970). The information processing style, characterized by the intermediate layer, involves one's intellectual approach to learning. Curry argued that manifestations of this construct, while more fixed than instructional preference, were modifiable by learning strategies. Measures that represented the information processing style include those of Kolb (1981), Tamir, Elstein, and Molidor (as cited in Tamir & Cohen, 1980), and Schmeck, Ribich, and Ramanaiah (1977). Instructional preference, represented by the outer layer, comprises the favored type of learning environment. It is the most vulnerable to outside influences, because it includes changeable situational factors and choices dependent on the learner. Instruments selected by Curry that represented the instructional preference were those of Friedmen and Stritter (1976), Rezler and Rezmovic (1981), and Riechmann and Grasha (1974).

Chapman and Calhoun (2006) studied the construct validity and concurrent validity of Curry's three proposed levels. Three learning style inventories were administered to post-second year medical students (*n* = 97). The Group Embedded Figures Test (GEFT) (Witkin, Goodenough, & Karp, 1967) measured cognitive personality, the Learning Style Inventory (LSI) (Kolb, 1971) measured information processing, and the Learning Preference Inventory (Rezler & Rezmovic, 1981) measured learning preference. The data partially confirmed construct validity of the three-level learning style hypothesis and confirmed construct and concurrent validities for the behavioral constructs.

Findings of Chapman and Calhoun's (2006) study indicated five bipolar learning style constructs. Student versus teacher-structured construct suggests a learning preference for student self-direction as opposed to teacher direction. Concrete versus abstract construct denotes a learning preference based on experience rather than a conceptual approach. Passive versus active learning construct characterizes a learning preference for passive lectures rather than active experimentation. Individual versus group learning construct represents a preference for learning independently rather than with others. Field dependence versus field independence construct reflects a learning or personality-based tendency to be socially influenced rather than influenced by others or surroundings.

Curry's (1983) proposition and the findings of Chapman and Calhoun (2006) suggested the need to be very clear on the characteristics and reasons for identification of learning styles, instructional preferences, learning strategies, and cognitive personality.

Coffield, Moseley, Hall, and Ecclestone's Families of Learning Styles

The second chosen framework to conceptualize learning styles also organizes styles according to aspects of learning that are easily changed and those that are more resistant to change. Coffield et al. (2004) identified 71 models of learning styles published between 1909 and 2002. The authors organized 51 of the models into five families partially based on the extent to which developers of the learning styles models appear to believe learning styles are resistant or susceptible to change. The five families are arranged in a continuum that progresses from more stable types on the left to more flexible models on the right. Coffield et al. selected 13 prominent or promising models for further study. Table 1, a modification of a figure created by Coffield et al. (p. 9), identifies the 13 major models. The models represented in bold type are described in depth later in this chapter.

Table 1

Continuum of Families of Major Learning Style Models with Theorists Identified

Constitutionally Based	Cognitive Structure	Stable Personality Type	Flexibly Stable Learning Preferences	Learning Approaches and Strategies
Dunn and Dunn	**Riding**	Apter	Allinson and Hayes	Entwistle
Gregorc		Jackson	Herrmann	**Sternberg**
		Myers-Briggs	Honey and Mumford	Vermunt
			Kolb	

Learning style instruments based on models classified within one of the first three families of Coffield et al.'s model "measure individual characteristics that are not amenable to change through interventions based on educational processes" (Bedford, 2006, p. 25). According to Coffield et al. (2004), theorists from the constitutionally based family, located at the far left side of the continuum, believe learning styles and preferences are primarily fixed, innate traits. Next along the continuum, are theorists from the cognitive structure category who consider learning styles "reflect deep-seated features of the cognitive structure, including patterns of ability" (Coffield et al., p. 9). Centered along the continuum, in the stable personality family, are theorists who value the influence of personality as an aspect of learning styles. Models represented in the two families to the far right focus on change and development. Theorists categorized in the flexibly stable learning styles agree learning styles are "based on the idea of dynamic interplay between self and experience" (Coffield et al., p. 10). Theorists from the final family, learning approaches and strategies, step beyond learning styles to consider factors that underlie the way learners approach a learning situation.

The review of literature did not identify any research that compared inventories from each of Coffield et al.'s (2004) five families of learning styles. However, Leonard, Scholl, and Kowalski (1999) tested the interrelationship among three of the families: cognitive based, personality, and flexibly stable learning preference. Participants included 138 undergraduate students enrolled in marketing and management courses. Assessments, administered individually over four separate occasions, included the Myers-Briggs Type Inventory (MBTI) (Myers, 1962), GEFT (Witkin, 1967), LSI (Kolb, 1985), and a decision-making style inventory. Results indicated there were no "simple, strong interrelationships" among the measures (Leonard et al., p. 418). This study is important because it provides some evidence that instruments from different families measure distinct characteristics of learning styles.

Prominent Learning Style Theories and Instruments

The families of learning styles developed by Coffield et al. (2004) serve as the framework for a review of prominent learning style theories and instruments. While Curry's (1983) work is beneficial for conceptualizing the impact of outside influences on learning, the advantage of the Coffield et al. model is more recent style types are included. Another improvement is the families of style types reflect how each developer views their model in relationship to the state-or-trait aspect of the ways individuals learn. This section will review six learning style models represented in the Coffield et al. five families of learning style including Dunn and Dunn, Gregorc, Riding, Myers-Briggs, Kolb, and Sternberg. A seventh theory developed by Witkin is included because it represents one of the earliest attempts to examine individual psychological patterns. In Coffield et al.'s classification of 51 models, Witkin was placed in the cognitive structure based family. An eighth learning style model developed by Hermanussen et al. (2000) is included because it embraces learning in the workplace. Coffield et al. classified this model under the category of flexibly stable preferences, because it is similar to the work of Kolb.

Family of Constitutionally Based Learning Styles and Preferences

Models from the family of constitutionally based learning styles and preferences draw from more stable biologically based traits, such as genetically influenced personality traits, particular sensory or perceptual channel dominance, or cognitive functions related to brain hemisphere dominance (Coffield et al., 2004). This section includes discussion of the Dunn and Dunn model and Gregorc model.

Dunn and Dunn Learning Style Model

Development of the Dunn and Dunn Learning Style Model began in 1967 when Rita Dunn responded to a request by the New York State Education Department to direct a program to help teachers educate students who were unsuccessful in traditional classrooms (Dunn & Dunn, 1978; see also Dunn & Burke, 2006). Following evaluation of teaching techniques and extensive investigation of research concerning how children and adults learn, learning differences were grouped into 18 categories under four classifications. In 1979, a fifth classification was added (Dunn & Burke). The Dunn and Dunn model recognizes the influence of the external environment, yet embraces the general idea that learning styles and preferences are rather fixed. Dunn suggested, "learning style represents each person's biologically and experientially induced characteristics that either foster or inhibit achievement" (Dunn, 1984, p. 17) and further acknowledged, "three fifths of learning style is biologically imposed" (Dunn, 1990, p. 15). The framework for the Dunn and Dunn Learning Style Model (Dunn & Dunn, 1978, 1993, 1999, see also Dunn, n.d.b.) focuses on five categories of stimuli that affect an individual's ability to learn new and difficult information.

1. Environmental stimuli include preferences for sound, light, temperature, and seating arrangement.
2. Emotional stimuli include degree of motivation, persistence, responsibility, and need for structure.
3. Sociological stimuli include preferences for learning alone, in pairs, with peers, as part of a team, with authoritative versus sociable instructors, or in varied versus established approaches.
4. Physiological stimuli include perceptual tendencies (visual, auditory, tactile, or kinesthetic), time-of-day energy levels, and the desire for intake and mobility.
5. Psychological stimuli include preferences for global versus analytic information processing and impulsive versus reflective practices.

According to the theory, an individual may or may not have a particular preference in style. The absence of one preference does not necessarily mean the presence of the opposite preference.

Noting significant improvement in student achievement and motivation, Dunn and Dunn (1979) advocated matching teaching styles to student learning styles. Dunn, Griggs, Olson, Beasley, and Gorman (1995) described a meta-analysis of studies of the Dunn and

Dunn model reported between 1980 and 1990. Analysis was limited to experimental and quasi-experimental studies. Findings indicated increased academic achievement for students when the teaching method matches the preferred style of learning. Lovelace (2005) performed a meta-analytic study of experimental and quasi-experimental studies reported between 1980 and 2000 and compared their investigation to the previous study. Results supported the proposition that matching students' learning style preferences with complementary teaching styles improves academic achievement and student attitudes about learning.

In collaboration with Kenneth Dunn and Gary Price, the Learning Style Inventory (LSI), based on the Dunn and Dunn Learning Style Model, was developed in 1974 (Lovelace, 2005). The LSI served as the template for several age appropriate versions for grades K-12 and the Productivity Environment Preference Survey (PEPS), which specifically addresses adult learning styles (Lovelace). These assessments are unique in they are based on a 5-point Likert scale, rather than either or choice options employed with most learning style inventories (Davis & Franklin, 2004).

Research using inventories based on the Dunn and Dunn model is well documented. St. John's University's Center for the Study of Learning and Teaching Style's website lists a bibliography of research with over 900 entries (Dunn, n.d.a.). Extensive data have been collected on learning styles in relationship to academic achievement, age, cultural and gender groups, and corporate training. Grades K-12 comprise the majority of studies. In higher education, a number of studies have investigated achievement in terms of matching and mismatching of learning preferences and instructional strategies and improved academic quality (Burke & Doolan, 2006;

Davis & Franklin, 2004; Dunn, Sklar, Beaudry, & Bruno, 1990; Harrelson, Leaver-Dunn, & Wright, 1998; Rochford, 2003).

Gregorc Mediation Ability Theory

According to Gregorc (1984), learning style is more than a learning preference. Rather, he suggested styles are characteristics reflected by the 'mindsets' used by an individual to guide decisions or to interact with the environment. Based on phenomenological research conducted in 1974, Gregorc drew three conclusions.

1. Mindsets are innate, yet to some extent, it is possible to learn or acquire other qualities.
2. Mindsets develop from deep psychological qualities of the mind related to space, time, mental processing, and relationships.
3. Individuals are prone to relate most effectively to conditions that align with the mindsets they possess.

Gregorc (1979) contended education places demands on the student to align learning style and teaching methods. Students with adaptive abilities are the most successful, because they are able to adapt learning style to align with the teaching method. Gregorc suggested alignment depends upon the abilities of both the student and teacher to adapt.

Building on these premises, Gregorc (1982a) developed the Mediation Ability Theory. This four-factor learning style model builds on the premise that the mind has two basic qualities individuals use to relate to the environment: perception and ordering. The perception dimension describes the way individuals receive and transmit information. Mediation abilities used to perceive information range from abstract to concrete. The ordering dimension describes the way individuals "authoritatively arrange, systematize, reference, and dispose of information" (p. 5). Mediation abilities individuals use to order information vary from sequential to random. Four pathways, which Gregorc referred to as mind styles (often referred to as learning styles), arise from combinations of these abilities: concrete sequential (CS), concrete random (CR), abstract sequential (AS), and abstract random (AR). Gregorc proposed individuals share a basic capacity in each area; however, most innately function better using one or two pathways.

The Gregorc Style Delineator (GSD) (Gregorc, 1982b) is the instrument designed to measure mediation ability. The self-scoring, self-assessment consists of ten sets of four words. Participants rank each set on a scale of most descriptive (4) to least descriptive (1) relative to preferences for perceiving and ordering information. Only an adult version of the GSD exists, because the instrument requires an improbable level of self-analysis for younger age groups (Gregorc, 2008).

Interest in Gregorc's learning style theory has been mainly in the United States. Most published research occurs in education, although the GSD is popular in counseling and business settings as well. In higher education, studies using the GSD have compared type patterns of teachers to students (Gould & Caswell, 2006; Wakefield, 1993) and students by discipline (Duncan, 1996; Orr, Park, Thompson, & Thompson, 1999). It has been used to examine computer mediated education (Butler & Pinto-Zipp, 2006) and type patterns in relation to students' academic achievement (Drysdale, Ross, & Schultz, 2001; Ouellette, 2000; Ross, Drysdale, & Schultz, 2001).

Family of Cognitive Structure Based Learning Styles

The family of cognitive structure based learning styles is represented by theorists who view learning styles as "consistent individual differences in modes of organizing and processing information and experience" (Messick, 1996, p. 359). Sternberg and Grigorenko (1997) described cognitive styles as a bridge between cognition and personality, which further supports the placement of this family between the constitutionally based and stable personality type families. This section presents theories by Witkin and Riding.

Witkin's Theory of Field Dependence-Independence

One of the earliest contributors to individual learning styles targeted cognitive style related to psychological development. Witkin, in collaboration with others, contributed significantly to the development of the field dependence-independence dimension of cognitive style (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962/1974). A citation analysis performed by Desmedt and Valcke (2004) recognized Witkin as the most cited author in the cognitive style literature.

Interest in developing the construct resulted largely through Witkin's recognition of differences in individuals' perception that began in the 1940s (Witkin & Goodenough, 1981). Witkin observed some people could spatially locate themselves as upright when the surrounding field of view was not upright. Field independent is the term used to describe those who primarily use internal sensory perception for orientation. Field dependent is used to describe those who primarily use external surroundings for orientation. These lines of investigation eventually led to the realization that perceptual orientation is associated with mental processes.

Witkin, Moore, Goodenough, and Cox (1977) identified four characteristics that distinguish the field dependence-independence model.

1. Cognitive styles relate to the process as opposed to the content of an activity. They describe differences in how individuals "perceive, think, solve problems, learn, relate to others, etc." (p. 15).
2. Cognitive styles encompass aspects of personality.
3. Cognitive styles are relatively stable over time.
4. Cognitive styles are bipolar, which means individual styles fall somewhere on a continuum between two opposite qualities.

In the context of mental processing Witkin, Dyk et al. (1962/1974) described the extent to which individuals are able to differentiate a part from a whole as field dependent or field independent. Field dependent describes individuals with a global style who tend to perceive items as a whole and who are socially oriented. Field independent describes individuals with an analytic style who tend to perceive the part from the whole and possess a more impersonal approach (Witkin, Moore, Goodenough et al., 1997).

The body adjustment test, rod and frame test, Embedded Figures Test (EFT), and GEFT are assessments developed to measure field dependence-independence constructs (Witkin, Moore, Goodenough et al., 1977; see also Witkin, Dyk et al., 1962/1974). In each test, a visual field or framework surrounds a pictorial item. Measures involve the ability of an individual to separate the item from its surrounding field.

Extensive research with field dependence-independence cognitive style includes a variety of contexts: relationship to career differentiation (Chapman & Calhoun, 2006; Quinlan & Blatt, 1972), academic development (Witkin, Moore, Oltman et al., 1977), gender difference (Kelleher, 1997; Murphy & Casey, 1997; Vernon, 1972), nursing education (Noble, Miller, & Heckman, 2008), and teaching (Rittschof & Chambers, 2005). A summative evaluation by Pithers (2002) concluded field dependence styles relate to lower academic achievement for students. Field dependent teachers prefer more social interaction and two-way communication with students. A mismatch between teacher and students demonstrated improved academic performance for field dependent students, while a match revealed improved academic performance for field independent students.

Some have argued the field dependence-independence construct is a measure of cognitive ability rather than a measure of cognitive style (MacLeod, Jackson, & Palmer, 1986; McKenna, 1990; Richardson & Turner, 2000; Widiger, Knudson, & Rorer, 1980). Witkin, Moore, Oltman et al. (1977) suggested the bipolar nature of this style is what sets it apart from cognitive ability or levels of intelligence. The rationale is cognitive ability is value biased because more ability is better than less ability. Cognitive style, on the other hand, is value balanced because each pole has value in particular situations or tasks. Zhang and Sternberg (2005) identified whether a construct is value-laden versus value-free as one of the continuing controversial issues concerning learning styles.

Riding's Cognitive Control Model

Riding explored the concept of cognitive style as a valid construct separate from intelligence and personality. Riding and Cheema's (1991) integrative model of cognitive styles attempts to explain how mental processes influence learning. Riding and Rayner defined cognitive style as "the way the individual person thinks" (1998, p. 7). After recognizing common threads among many independently developed cognitive and learning styles, Riding and Cheema reviewed descriptions, correlations, assessment measures, and relationship to behavior of over 30 style labels. Three primary groups emerged. Two groups were cognitive style models, which formed two dimensions: wholist-analytic and verbal-imagery. The wholist-analytic dimension recognizes whether an individual processes information in wholes or in parts. This dimension is similar to Witkin's field dependence-independence style (Price, 2004). The verbal-imagery style recognizes whether an individual represents information by thinking in words or pictures. The cognitive style model that emerged is orthogonal because the two dimensions are independent of each other. The third group includes learning style models associated with learning strategies. Riding and Cheema defined a style as "a fairly fixed characteristic of an individual" and strategies as the "ways that may be used to cope with situations and tasks" (p. 195). The model suggests cognitive learning styles are not vulnerable to outside influences.

Riding (1997) modified the Curry onion model and offered the Cognitive Control Model as a way to explain the relationship between cognitive styles and learning styles. Four levels characterize the structure of the model: primary sources, cognitive control, cognitive input and output, and the external world.

1. The inner level represents primary sources including an individual's experiences and knowledge, basic personality, and gender. According to Riding, experiences and knowledge interact with cognitive control. Riding and Wigley (1977) noted personality and gender are independent of cognitive style, but temper behavior.
2. The cognitive control level consists of the wholist-analytic and verbal-imagery dimensions discussed earlier (Riding).

3. The next level includes cognitive input and output. Riding described input in terms of individuals' approaches to processing and analyzing information and suggested cognitive input might represent measures of intelligence. Cognitive output represents individuals' learning strategies, which influence behaviors.
4. The outermost level includes observed behavior and external conditions characterized by experiences, which influence cognitive control (Riding).

Riding developed the Cognitive Styles Analysis (CSA) to measure an individual's position on the wholist-analytic and verbal-imagery dimensions (Riding, 1997; Riding & Cheema, 1991). The CSA is a computerized test that assesses both ends of the dimensions by measuring performance on simple tasks. Riding documented many studies using the CSA to explore the concept of cognitive style as a valid construct separate from intelligence and personality. He determined that while the construct dimensions are independent of one another, they do interact with personality and relate to observed behaviors.

A number of other empirical studies have examined the wholist-analytic and verbal-imagery dimensions including cognitive style in relationship to personality (Riding & Wigley, 1997) and education (Adams, 2001; Riding & Mathias, 1991; Riding & Watts, 1997) and more specifically to computer mediated education (Riding & Sadler-Smith, 1992; Russell, 1997).

Family of Learning Styles Based on Personality

The family of learning styles based on personality focus on learning styles models within the context of stable personality traits that affect how the individual interacts with the world (Coffield et al., 2004). This section discusses the Myers-Briggs model.

Myers-Briggs Type Indicator

Personality traits have long been examined in relationship to learning styles. Isabel Myers and Katharine Briggs studied Jung's theory of psychological types, which eventually led to development of the MBTI (Myers & McCaulley, 1985). Jung (1921/1971) developed a theory of psychological types based on two attitude types and six functional types. The two attitude types (introversion and extroversion) describe how individuals prefer to deal with the world. The introverted type describes individuals who focus on the inner world of ideas and feelings, while the extroverted type describes individuals who focus on the outer world of people and things. The six functional types (sensing and intuiting, thinking and feeling, and judging and perceiving) describe unique differentiated functions. The sensing-intuiting dimension describes how individuals prefer to perceive information. The thinking-feeling dimension describes how individuals prefer to make decisions and the judging-perceiving dimension describes how individuals prefer to orient toward the world.

In 1962, the MBTI was published for research use and in 1975 for practical use (McCaulley, 1990). It is a forced choice, self-report inventory. Four bipolar scales measure each type: extroversion versus introversion, sensing versus intuiting, thinking versus feeling, and judging versus perceiving. Four basic scores from each scale result in one of sixteen possible type styles. Currently there are five versions of the instrument differing in its scoring or use (Myers & Briggs Foundation, n.d.). The instrument is purported to measure preference rather than trait, ability, or character and one style type is not superior to another (Myers & McCaulley, 1985).

Extensive research with the MBTI includes a variety of uses in higher education including the type patterns of students (Folger, Kanitz, Knudsen, & McHenry, 2003; Salter, Evans, & Forney, 2006), student achievement (Borg & Shapiro, 1996; Filbeck & Smith, 1996; Hardigan & Cohen, 2003; Ziegert, 2000) and career development (Martin, & Bartol, 1986; Stilwell, Wallick, Thal, & Burleson, 2000).

Family of Flexibly Stable Learning Styles

According to Coffield et al. (2004), theorists categorized within the family of flexibly stable learning styles do not consider learning styles as fixed traits, but rather as flexible personal and environmental preferences. Theorists representing this type believe preference for learning can change somewhat. Supporters of these ideas accept individuals possess characteristic and consistent preferences for learning that "can be influenced by culture, experience, or a particular context" (Coffield et al., p. 60). This section discusses models developed by Kolb (1984) and Hermanussen et al (2000).

Kolb's Experiential Learning Theory

Kolb is one of the most well known advocates of experiential learning. A citation analysis performed by Desmedt and Valcke (2004) identified Kolb as the most cited author in learning style literature. Kolb (1984) developed his theory of learning and development based on the works of Dewey, Lewin, Piaget, and Jung. Experiential learning theory, in contrast to constitutionally based trait-type and cognitive learning theories, suggests a holistic view of learning "that combines experience, perception, cognition, and behavior" (p. 21). According to Kolb, six basic concepts characterize experiential learning theory:

1. Learning is best conceived as a process, not in terms of outcomes (p. 26).

2. Learning is a continuous process grounded in experience (p. 27).

3. The process of learning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world (p. 29).

4. Learning is a holistic process of adaptation to the world (p. 31).

5. Learning involves transactions between the person and the environment (p. 34).

6. Learning is the process of creating knowledge (p. 36).

Kolb summed learning by defining it as "the process whereby knowledge is created through the transformation of experience" (p. 38). Experiential learning centers on the assumptions that one of the ways people learn is from experience and people learn differently.

Based on these assumptions Kolb (1984) identified two dimensions of learning: prehension (perception) and transformation (process) (Figure 2). Prehension concerns the way an individual perceives or takes hold of knowledge by apprehension or comprehension. Apprehension describes an involved approach to learning. Learning takes place through direct concrete experiences such as sensations, feelings, and intuition. Comprehension describes an analytical approach to learning. Learning involves indirect abstract mental conceptualizations and symbolic representation of experience. Transformation relates to the way an individual processes an experience through intention or extension. Intention describes an impartial approach to learning. Learning is by means of internal processes such as observation and purposeful reflection on previous learning. Extension describes an active approach to learning. Learning takes place through external processes such as acting on or testing previous learning.

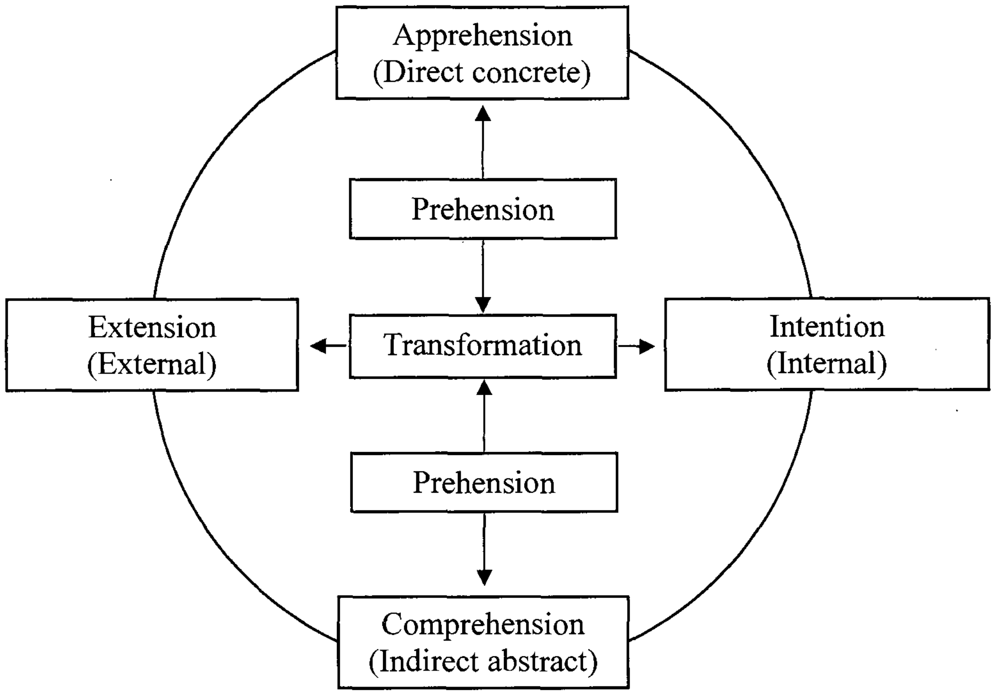

Figure 2 Kolb's Learning Dimensions

In the experiential learning model Kolb (1984) labeled apprehension as concrete experience (CE), comprehension as abstract conceptualization (AC), intention as reflective observation (RO), and extension as active experimentation (AE). Figure 3 is an adaptation of work by Kolb, which illustrates the dimensions underlying the process of experiential learning and resulting learning orientations or styles (p. 42). The four modes of learning share similarities to Jung's (1921/1971) psychological types. The active experimentation and reflective observation dimension relates to Jung's extroversion and introversion dimension, while concrete experience relates with the sensing approach to perception and the feeling approach to judging. In addition, abstract conceptualization relates to the intuition approach to perception and the thinking approach to judging. This dimension is also similar to Gregorc's (1982a) perception dimension.

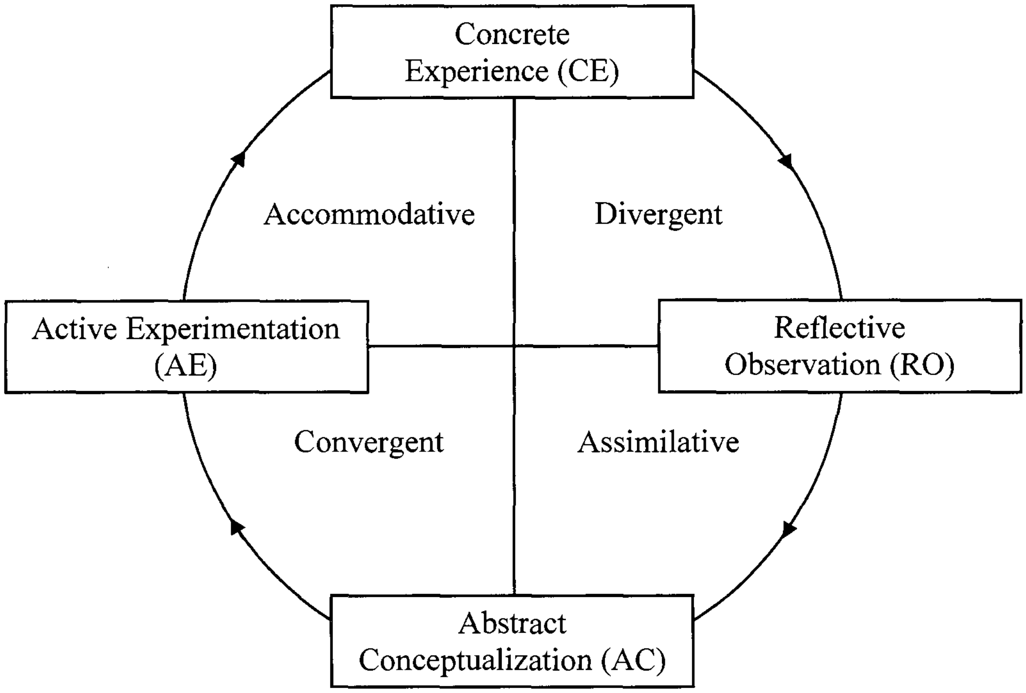

Figure 3 Kolb's Learning Styles

Kolb (1984) conceptualized learning as both a cycle or stage model of learning and a learning styles model. As a cycle of learning, each mode (CE, RO, AC, and AE) represents a stage in experiential learning. As illustrated in Figure 3, the cycle of learning proceeds in succession from a concrete experience, which leads to observation and reflection, to the development of new theories from which new action is realized, and so on. Kolb maintained the "combination of all four of the elementary learning forms produces the highest level of learning" (p. 66). Some have criticized the cycle because it attempts to combine and then simultaneously measure three unrelated cognitive elements: style, level (abilities), and process (De Clantis & Kirton, 1996; Hermanussen et al., 2000).

Kolb (1984) held that over time individuals consistently resolve tensions between the two interdependent dimensions of prehension and transformation in characteristic ways. This concept provided the basis for the learning styles model. However, Kolb did acknowledge genetic factors, prior experiences, and learning context influence the development of learning preferences, and successful learners vary the styles they use in different learning situations rather than rely only on their preferred style. Based on research and clinical observations Kolb delineated four orientations or styles of learning behavior arising from the two dimensions: divergent, assimilative, convergent, and accommodative learning styles (Figure 3).

1. The accommodative learning style differentiates preferences for AE and CE. Accommodators prefer to gather information from immediate experience and process experience through active testing. Kolb (1984) used the term accommodator to describe individuals who function better in situations that call for adjustment to immediate circumstances. Accommodators are risk takers. Strengths include the ability to get things done and lead others.
2. Preferences for CE and RO describe the divergent learning style. Divergers prefer to perceive through immediate experience and adapt to experience through observation. Kolb (1984) used the term diverger to describe individuals who operate better under circumstances that benefit from innovative ideas. Strengths of divergers include the ability to understand people, recognize problems, and generate new ideas.
3. The assimilative learning style differentiates preferences for AC and RO. Assimilators prefer to grasp information by using inductive reasoning and processing it through observation. The term assimilator describes individuals who are able to integrate different ideas into a unified and logical whole.

Strengths of assimilators include the ability to plan, define problems, create models, and develop theories (Kolb, 1984).

4. Preferences for AC and AE identify the convergent learning style. Convergers prefer to perceive information using deductive reasoning and process it by means of active testing. Kolb (1984) used the term converger to describe individuals who function better in situations that require a single right answer to a problem. Strengths of convergers include the ability to define problems, make decisions, and solve problems in a practical way.

In addition to determining individual learning styles, Kolb (1984) suggested learning styles are associated with disciplines. Part of the rationale is students tend to gravitate toward disciplines where their learning style harmonizes with the type of knowledge sought. Involvement with the disciplines' procedures and processes enhances the association, so strength of the learning preference may increase. Kolb (2005) theorized humanities and social sciences are associated with the divergent style (concrete experience and reflective observation), natural science and mathematics with the assimilative style (reflective observation and abstract conceptualization), science-based professions with the convergent style (abstract conceptualization and active experimentation), and social professions with the accommodative style (active experimentation and concrete experience). Researchers may examine combined subscale scores for the two dimensions: AE-CE and CE-RO to differentiate concrete and abstract learners and RO-AC and AC-AE to distinguish reflective and active learners. Kolb suggested concrete learners tend to choose people-oriented professions while abstract learners are likely to favor science-based professions.

Kolb created the original LSI to help students understand experiential learning and individual styles of learning from experience (Kolb & Kolb, 2005). Five versions of the LSI have been published: Version 1 in 1971 and 1976, Version 2 in 1985 and 1993, and Version 3 in 1999 and 2005 (Kolb & Kolb). Concerns about the internal reliability of the LSI 1 led to a revision in 1985. Scale alphas increased to an average .81, ranging from .73 to .88. The LSI 3 is a product of several modifications including a randomized format, revised self-scoring and interpretation booklet, and new norm charts used to convert raw LSI scores (Kolb & Kolb). The LSI 3.1 is a forced choice, self-report inventory consisting of 12 scored items on four primary scales to measure concrete experience, reflective observation, abstract conceptualization, and active experimentation. Two combination scales measure individual preferences for abstractness over concreteness and action over reflection.

There is considerable documented research based on various versions of Kolb's experiential learning theory. Volume 1 of the *Experiential Learning Theory Bibliography* from 1971 to 2005 contains 2,235 entries (Kolb & Kolb, 2008a), while Volume 2 from 2006 to 2008 lists 208 references (Kolb & Kolb, 2008b). As these bibliographies attest, broad interest in Kolb's experiential learning theory has included a variety of fields including education, management, computer and information science, psychology, medicine, nursing, accounting, and law. In higher education, studies using Kolb's LSI have investigated learning preferences as they relate to personality types (Luh, 1990), teaching practice (Anderson, 2007; Loo, 2004; Raschick, Maypole, & Day, 1998), technology and computer mediated education (Diaz & Cartnal, 1999; Liegle & Janicki, 2006). Other studies have examined the relationship between learning styles and age or gender group (Demirbas & Demirkan, 2007; Heffler, 2001; Luh, 1990; Magolda, 1989; Philbin, Meier, Huffman, & Boverie, 1995; Severiens & ten Dam, 1994) and relationships across disciplines (Jones, Reichard, & Mokhtari, 2003). A review of literature conducted with the LSI in the disciplines of nursing, medicine, and allied health education appears later in this chapter.

Questionnaire Practice Oriented Learning

Drawing from Kolb's (1984) experiential learning theory and 1985 LSI, Hermanussen et al. (2000) developed a new instrument, the Questionnaire Practice-Oriented Learning (QPL), specifically to measure learning approaches in vocational education. Hermanussen et al. defined learning style "as a coherently used combination of learning activities that a student usually employs in a particular type of teaching-learning situation, a combination that is characteristic of him/her in a certain period" (p. 446). This definition helps explain Coffield et al.'s (2004) placement of this model in the more flexible family of styles.

Hermanussen et al. (2000) attempted to integrate aspects of Kolb's model that suited work-based education and discard aspects that were not pertinent. Developers of the QPL were not interested in the cyclical nature of Kolb's model and did not incorporate it into the questionnaire. Hermanussen et al. criticized the dimensionality of the prehension (CE and AC) and transformation (RO and AE) dimensions of Kolb's model, citing "insufficient empirical evidence of the existence of the two dimensions" (p. 449). A final criticism was the model failed to acknowledge external social influences. Hermanussen et al. did accept Kolb's (1984) four learning modes of concrete experience, reflective observation, abstract conceptualization, and active experimentation and used them as a starting point for describing styles in work-based learning. The developers of the QPL added regulation as a fifth construct in response to the criticism external social influences were not taken into account. Table 2, an adaptation of a work by Hermanussen (p. 453), compares Kolb's four experiential learning modes to the five subscales illustrated in the QPL.

Table 2

QPL Bipolar Subscales Related to Kolb's Experiential Learning Modes

	QPL		
Kolb's Experiential Learning Mode	Subscale	First Pole (Left)	Second Pole (Right)
Concrete Experience (CE)	Immersion	Immersed	Detached
Reflective Observation (RO)	Reflection	Insight-oriented	Results-oriented
Abstract Conceptualization (AC)	Conceptualization	Strategic	Pragmatic
Active Experimentation (AE)	Experimentation	Inquiring	Prescription-oriented
	Regulation	External	Internal

To develop the QPL, Hermanussen et al. (2000) attempted to create opposite poles for the five learning subscales without involving one of the other subscales.

1. The first subscale immersion (immersed versus detached) describes the student's level of engagement in experiences. Students with an immersed orientation are intellectually and emotionally close to the learning experience, while students with a detached orientation are more distant.
2. The second subscale reflection (insight-oriented versus results-oriented) describes student's post-action reflection. Students with an insight or learning

orientation try to understand and learn from experiences. Students with a results or performance orientation are interested in successful performance with minimal effort. They are satisfied with performing well, even if they do not understand how it occurred.

3. The third subscale conceptualization (strategic versus pragmatic) describes breadth of involvement. Students with a strategic orientation tend to gather information from a variety of sources and base actions on theoretical concepts. Students with a pragmatic orientation are more interested in usefulness and efficiency of actions.

4. The fourth subscale experimentation (inquiring versus prescription-oriented) describes student's pre-active reflection. Students with an inquiring or experimenting orientation are inquisitive and open to testing ideas during the learning process, while students with a prescriptive orientation tend to follow directions and rules.

5. The fifth subscale regulation (internal versus external) concerns strategies students use to manage or organize the learning process. Students with an internal orientation initiate their own strategies to regulate learning. Student with an external orientation depend on outside resources, such as instructors, to regulate learning.

The QPL (Hermanussen et al., 2000; J. S. de Jong, personal communication, March 19, 2007) is a 55 item self-report questionnaire consisting of 8 to 13 pairs of opposite statements for each of five scales. Respondents select from a 1 to 5 response scale. The selection of (1) indicates agreement with the statement on the left, while the selection of (5) indicates agreement with the statement on the right. In the initial study, the QPL demonstrated modest reliability (Cronbach's α between 0.62 and 0.70). There was significant low correlation between the scales conceptualization and immersion ($r = -0.30$). Findings demonstrated relatively high correlation between conceptualization and reflection ($r = 0.51$) and experimentation and regulation ($r = 0.50$).

Family of Learning Approaches and Strategies

The family of learning approaches and strategies includes theorists who generally reject the term 'style' in favor of the terms 'approach' and 'strategy' (Coffield et al, 2004). For these theorists the influence of prior experiences and the specific learning task are important. The focus is on the learner's perception of the learning situation and cognitive strategies to be undertaken. This section discusses Sternberg's Theory of Mental Self-Government.

Sternberg's Theory of Mental Self-Government

Sternberg developed the theory of mental self-government based on the premise "what happens to us in life depends not just on *how well* we think, but also on *how* we think" (1997, p. 18). Sternberg defined thinking styles as individuals' preferred ways of using abilities and specified there is no one style, but a profile of styles individuals possess. According to Sternberg, styles are changeable, depending on the demands of the task. His model uses an analogy of different forms of government to reflect different ways individuals organize their thinking. The theory describes 13 thinking styles arranged along a continuum of five dimensions. The five dimensions include function (legislative, executive, and judicial), form (hierarchical, monarchic, oligarchic, and anarchic), level (global and local), scope (internal and external), and leaning (liberal and conservative). Table 3 which condenses the work of Zhang and Sternberg (2005, p. 12) provides a brief description of each thinking style.

Table 3

Sternberg's Profile of Thinking Styles

Dimension	Thinking Style	Description
Function	Legislative	Prefer a creative approach; Like to make independent choices; Desire unstructured problems
	Executive	Prefer a structured approach; Like to follow and apply rules; Favor prestructured problems
	Judicial	Prefer an evaluative approach; Desire to assess rules, procedures, and people; Prefer problems to evaluate and analyze
Form	Monarchic	Driven; Focus on one task at a time; Get things done
	Hierarchical	Set priorities; Focus on several tasks at a time; Goals based on personal view
	Oligarchic	Unsure of priorities; Focus on several tasks at a time; Goals compete for attention
	Anarchic	Random; Reject structured tasks; Creative potential
Level	Global	Focus on the big picture; Prefer abstract ideas
	Local	Focus on details; Prefer concrete issues
Scope	Internal	Introverted; Prefer to work alone
	External	Extroverted; Enjoy working with others
Leaning	Liberal	Like to push the rules; Capitalize on change
	Conservative	Like to follow rules; Limit change

In 1991, Sternberg and Wagner developed the Thinking Styles Inventory (TSI), which remained unpublished until 1997 (Sternberg, 1997). The TSI is a 104-item self-report inventory consisting of eight statements for each style. The response scale ranges from not at all well (1) to extremely well (7). In 2003, Sternberg, Wagner, and Zhang created an unpublished version of the TSI the TSI–R (Zhang, 2008; Zhang & Sternberg, 2005). In the revised version, there are five items for each of the 13 styles types (total of 65). The response scale remains unchanged. Few studies have yet to use the revised version.

Studies with the TSI or TSI–R have explored thinking styles in nonacademic settings (Zhang, 2005, 2006; Zhang & Higgins, 2007). In the academic area studies include thinking styles as they relate to academic achievement (Zhang, 2001), thinking styles of student teachers (Fer, 2007), students' thinking styles and teaching preferences (Zhang, 2004), and the relationship between teachers' teaching styles and thinking styles (Zhang, 2008).

Research Related to Learning Styles in Health Professions

Review of theories and assessments from Coffield et al.'s (2004) five families of learning styles underscores the complexity created by inconsistent terminology and overlapping styles. It is evident different theories support different aspects of learning, which may have pedagogical implications.

A comprehensive search of radiologic technology education literature published between 1990 and 2007 found several research studies of interest to this study. A number of published studies have included learning styles research in allied health, nursing, medical, and work-based education programs. A review of the literature grouped according to three broad categories based on Coffield et al.'s five families of learning styles follows. Research involving learning styles and preferences with more stable trait-type characteristics include constitutionally based and cognitive structure based models. Studies approaching learning styles as a component of personality include personality-centered models. Lines of investigation involving learning styles that focus on change and development include models based on flexibly stable learning preferences and learning approaches and strategies.

More Stable Trait-Type Learning Styles

Shaver (2000) and Davis (2001) selected stable trait-type assessments to answer questions about radiography students. Shaver used the 1991 Dunn, Dunn, and Price Productivity Environment Preference Survey (PEPS) to describe and compare the learning styles of first and second year radiography students (n = 572). Findings indicated both groups preferred structured learning activities, the presence of authority figures during learning situations, interactions with peers, and morning class times as well as perceptual preferences for auditory and tactile learning. Data demonstrated tactile preference was the single trait most often found among radiography students.

Shaver (2000) identified the cornerstones of radiography education as lecture, lab, and clinical education. However, suggestions for curricular changes based on the findings focused almost exclusively on interventions for the classroom and lab. For example, suggestions included study guidelines to maximize learning in the dominant style and environmental classroom adaptations. The only reference to clinical education was the suggestion "it is also important to maximize clinical education to benefit the tactile/kinesthetic learners" (p. 64). Shaver indicated educators should work with students to develop skills in learning in ways other than their preferred style. Unfortunately, it was not explained how this would be accomplished. This raises the possibility educational interventions in the clinical setting based on innate learning characteristics might be limited or impossible because innate qualities are not easily changed.

Davis (2001) investigated the effect of teaching students to study using their preferred learning style on the academic achievement of radiography students ($n = 52$). Over a 16-week period, 20 students in the experimental group were informed how to study and carry out homework in their preferred learning style. The 1996 Price version of the PEPS originally developed by Dunn, Dunn, and Price measured learning styles and a standardized final examination measured academic achievement. Unfortunately, there was no report of individual learning styles to compare to the study conducted by Shaver (2000). Results indicated no difference between the experimental group taught to study using their preferred learning style and the control group not taught to do so. However, students in the experimental group who observed the guidelines had higher academic scores than those who did not. This study is important because it demonstrates how assessment of stable trait-type learning styles can provide students with techniques to improve learning without attempting to change stable trait-type learning styles.

Studies conducted by Shaver (2000) and Davis (2001) illustrate how learning style assessment, measuring primarily constitutionally based characteristics, can be used to enhance education in radiography programs. It is important to note both studies associated learning styles almost exclusively with learning in the context of classroom, laboratory, or related homework conditions.

Personality Centered Learning Styles

Gordon (1995) studied the relationship of cognitive and noncognitive variables in relationship to academic success of students in allied health programs. Cognitive variables included high school grade point average and program academic, clinical, and cumulative grade point averages. Noncognitive variables included temperament type, learning preferences, and noncognitive questionnaire scores. The 1978 Keirsey Temperament Sorter measured temperament and learning preferences. This assessment, developed by Keirsey and Bates (1984) describes four temperament types based on the MBTI associated with learning style preferences: intuitive, feeling (NF); intuitive, thinking (NT); sensing, judging (SJ); and sensing, perceptive (SP). An adaptation of Sedlacek's Noncognitive Questionnaire measured noncognitive constructs (Tracey & Sedlacek, 1984). Participants (n = 169) included radiologic technologists, respiratory therapists, and surgical technology and medical records technicians from hospital based and community college programs.

Data from Gordon's (1995) study demonstrated both cognitive and noncognitive variables correlate with student academic success. The SJ preference for learning style for all allied health students was found to be a statistically significant contributor to academic achievement ($\chi^2 = 7.639$, $df = 3$, $p < .05$). The SJ learning preference represented 76% of the students, which is twice that of the general population. This preference was 82% for radiography students (n = 68). The relationship between clinical grade and learning preference types for radiography students was not reported. However, the large percentage of SJ radiography students suggests this aspect of learning style may have some bearing on academic success in the clinical setting. SJ students prefer to learn by demonstration and "accept that the teacher is there to teach and they are there to learn" (Gordon, p. 34). This study suggests radiography students in clinical practice may depend on external rather than internal self-regulation.

Learning Styles Focused on Change and Development

Educators and researchers interested in the learning styles of individuals associated with professions that include practical experience often turn to Kolb's (1984) experiential learning theory as it recognizes learning by experience. As mentioned previously considerable documented research based on Kolb's theory exists. One of the difficulties in evaluating research with the Kolb LSI is that some studies report only learning style types while others report only subscores. In the following studies, the context was either the classroom or it was not specified.

Two studies in the literature permit a comparison of learning styles of student radiographers and practitioners. Wright (1998) drew on Kolb's 1985 LSI and a researcher created instrument to assess learning style preferences and computer readiness of first year radiography students (*n* = 185). Data demonstrated nearly equal distributions across Kolb's four style preferences. Results indicated the preferred learning styles were 30% assimilator (reflective-abstract), 28% converger (abstract-active), 22% accommodator (active-concrete), and 20% diverger (concrete-reflective). Converger and assimilator subscores (58%) indicate the majority of radiography students perceive new information through abstract representation of experience, emphasizing thinking rather than feeling and prefer working with concepts and abstract ideas rather than people. Wright suggested educators should adapt instruction to accommodate a variety of learning preferences.

In a similar study Fowler (2002) investigated the learning styles of practitioners in radiologic technology in the United Kingdom (*n* = 224) using Kolb's 1985 version of the LSI. Results indicated the preferred learning styles were 33% each for assimilator (reflective-abstract) and converger (abstract-active), 21% accommodator (active-concrete), and 13% diverger (concrete-reflective). The converger and assimilator subscores (66%) indicate the majority of practioners prefer abstract rather than concrete perception of information. Fowler concluded there is a need to help radiographers develop skills in reflection and learning from direct experience and to build on existing skills in problem solving in practical ways and forming abstract concepts. Fowler suggested educators involved in professional development should adapt teaching styles to accommodate learning styles.

Wright (1998) and Fowler (2002) found similar preferences of students and practitioners in radiologic technology to perceive new information through abstract representation of experience. In both studies, there were indications participants were likely to respond according to the way they prefer to learn in a classroom environment. In the Wright study, the assumption is students would relate responses to learning in the classroom. The Fowler study indicated the learning condition was continuing professional development, which typically takes the form of formal presentations or home study. Without further evidence, it is unclear whether the findings would be different for learning new information specifically in the clinical environment. These studies highlight the importance of specifying the context of the learning situation when assessing learning styles.

Similar to Wright's (1998) study of radiography students, a number of studies involving students in other health professions have found nearly equal distribution of Kolb's learning styles. Hauer, Straub, and Wolf (2005) used the 1985 version of the LSI to study learning styles of students enrolled in five allied health programs. Results indicated nearly equal distribution of learning styles for students in nursing, physician assistant, occupational therapy, and speech-language pathology programs. Only students in the physical therapy program reported a preference for the converger type, with a strong tendency toward active experimentation.

Cavanagh, Hogan, and Ramgopal (1995) found similar results. They used the 1985 LSI to investigate learning styles of nursing students ($n = 192$) at the start of their studies. Data revealed learning preferences were fairly evenly distributed across each style type. Examination of subscores identified 53% were concrete learners and 46% were abstract learners. Other studies using 1976 and 1985 versions of the LSI have found the majority of nursing students prefer concrete learning styles (Hodges, 1988; Laschinger & Boss, 1984).

In a more recent study, Suliman (2006) examined the difference between critical thinking dispositions and learning styles of two streams of baccalaureate nursing students ($n = 130$). Stream I were high school graduates in a conventional program and Stream II were university graduates in an accelerated program. The 1985 LSI measured learning styles. Data indicated the preferred learning styles of Stream I participants were mainly diverger (concrete-reflective). Learning styles of Stream II participants, demonstrating the opposite preference, were primarily converger (abstract-active). However, the difference between groups was minimal, which indicates learning styles in general are balanced and nursing students are nearly as likely to be divergers (concrete-reflective) as convergers (abstract-active).

Some studies in specific healthcare professions have found differences in learning styles among students in the same profession. DeCoux (1990) reviewed 19 nursing research studies conducted with the LSI reported between 1981 and 1988. The review revealed representation of each learning style type. Overall, however there was little agreement as to the most common learning style for assimilator, diverger, and accommodator types. The converger style type was uncommon.

Other studies have found differences between students and practitioners in the same healthcare profession. Katz and Heiman (1991) used Kolb's 1976 LSI to examine learning styles of students and practitioners (n = 629) in five health professions: occupational therapy, social work, nursing, physical therapy, and clinical psychology. Findings suggested greater variance in learning styles among students compared to practitioners for all professions except clinical psychology.

Research Associated with Learning Styles in Work-Based Experience

Research associated with the styles students use to learn specifically during work-based experiences are limited (Berings et al., 2007; Hermanussen et al., 2000). However, one study involving radiography students and three studies in other health related professions investigated aspects of learning in clinical practice. Three other studies specifically examined learning style as it relates to work-based or clinical experience.

In a recent qualitative study, Fortsch (2007) examined how clinical settings of radiography programs affect students' and clinical instructors' learning perceptions. Participants included nine students and three clinical instructors selected from three different models of clinical programs. Collection of data was through observations and interviews. This study identified four aspects of the clinical environment that influence the quality and perception of the students' learning experiences: (a) learning opportunities and integration of knowledge; (b) trust and fairness; (c) attitudes and socialization to clinical sites; and (d) supervision, evaluation, and recognition. While the purpose of the study was to examine learning perceptions, the influence of learning style was evident. Findings indicated students were treated differently based on aspects of their learning style behavior. For example, clinical instructors reported that more actively engaged students received more attention, while those with passive, yet effective learning styles were judged as uninterested or lazy. Students indicated preferences for practical applications to real problems and technologists or clinical instructors who accommodated students' learning styles. This study draws attention to the impact of learning styles on education in clinical practice.

Smits et al. (2004) measured several factors, including learning styles, as potential predictors of successful knowledge and performance outcomes in postgraduate medical education. Participants included 118 doctors training for specialization in occupational medicine. Measures of learning outcomes included scores on knowledge tests and performance in practice based on a self-report. Knowledge was assessed four times: three months prior to the start of the educational program, at the beginning of the program, on completion of the program, and as a follow up of 12-17 months. Performance was assessed twice: three months prior to the start of the program and six months following the program. The 1976 LSI was administered three months before the program began. The preferred learning styles of medical doctors were 40% assimilator (reflective-abstract), 23% accommodator (active-concrete), 19% diverger (concrete-reflective), and 18% converger (abstract-active). Findings indicated learning styles slightly influenced knowledge scores. Participants with an accommodator style had lower knowledge scores, particularly at follow up, than participants with other learning styles. Learning style was not associated with performance. While learning was measured in terms of academic knowledge and performance in practice, learning situation was never specified for the learning styles assessment. Again it must be questioned whether the results would be different if the learning situation was specified.

Lynch, Woelfl, Steele, and Hanssen (1998) investigated the relationship of learning styles to measures of clinical performance and objective multiple-choice tests. Participants included third-year medical students ($n = 227$). The 1985 Kolb LSI measured learning styles, computer simulated clinical cases measured clinical performance, and two multiple-choice examinations measured academic performance. Results indicated significant correlations among the three performance measures. The association between the two multiple-choice tests was strongest ($r = 0.70$, $p \leq 0.05$). Correlations between clinical measure and the two multiple-choice tests were 0.37 and 0.51, respectively. There was correlation between abstract thinking and performance on both examinations (0.33 and 0.20). There was no relationship between learning style and clinical performance.

Findings in Lynch et al.'s (1998) study that the majority of medical students were converger (abstract-active) (45%) differs from Smits et al.'s (2004) study of medical doctors where convergers (18%) accounted for the smallest portion. However, subscales for the two studies showed similar preferences for grasping new experiences in the abstract conceptualization style. The abstract orientation accounted for 58% of the medical students and 71% of the medical doctors. This study suggests performance on multiple-choice tests and clinical simulations, while related, measure different abilities and achievements. The lack of relationship between learning style and clinical performance indicates the LSI does not measure skills, abilities, and experience inherent in clinical performance.

Martin, Stark, and Jolly (2000) examined the relationship between clinical activity, learning style, and clinical performance in medical students ($n = 150$) at the end of their first clinical year. Measures included self-report scores of clinical activity during the first clinical year, the Entwistle Learning Style Inventory, and scores from the Objective Structured Clinical Examination (OSCE). Coffield et al. (2004) classified the Entwistle model in the learning approaches and strategies family. The OSCE consists of 24 stations to assess a broad range of clinical skills. Performance in the OSCE was related to well-organized study methods and a desire to achieve ($r = 0.34$, $P < 0.001$). There was no association between clinical activity and performance in the OSCE ($r = 0.02$, $P = 0.78$). Students with well-organized study methods and deep approaches to learning reported significantly higher levels of clinical activity ($r = 0.19$, $P = 0.04$) and ($r = 0.32$, $P = 0.001$), respectively. This study was unable to demonstrate a direct link between clinical activity and clinical performance. However, the relationship between learning styles and clinical activity and performance may explain that students with positive learning styles seek and take fuller advantage of learning opportunities.

Two research groups recognized the need for an instrument designed specifically to measure learning styles in the workplace. Drawing in part from Kolb's model Hermanussen et al. (2000) developed and tested the Questionnaire Practice Oriented Learning (QPL) to examine the work-based learning styles of students. Participants included 407 senior secondary students from healthcare and engineering departments in a Dutch vocational school. Findings resulted in the identification of three groups of work-based learning styles. The first style describes students who learn incidentally. They focus on tasks and seldom attempt to reflect or relate experiences with theoretical knowledge. The second type characterizes students who learn by virtue of external regulation. They moderately reflect and relate experiences to theory. The third group distinguishes students who regulate their own learning. They gain understanding by testing and reflecting theoretical and conceptual knowledge. The questionnaire reported modest reliability with Cronbach's alphas between 0.62 and 0.70.

A second study incorporated data from Hermanussen et al.'s (2000) study. de Jong et al. (2006) investigated the relationship between academic (school-based) and professional field (work-based) learning situations in vocational education. To avoid confusion and emphasize the dynamic nature of characteristic learning behaviors investigated, the term 'approaches' was substituted for 'style.' Participants included 899 secondary vocational students of which 758 provided data on academic-based learning and 407 provided data on work-based learning. An overlap of 266 students provided data for both learning situations. The Inventory of Learning Styles for Senior Secondary Vocation Education (ILS-SVE), developed by Slaats and Roosendall, measured school-based learning (de Jong et al.). The ILS-SVE is based on Vermunt's Inventory of Learning Styles, which appears in the learning approaches and strategies family of Coffield et al.'s (2004) continuum of learning styles. The QPL (Hermanussen et al.) measured work-based learning. For students ($N = 266$) who provided data for both learning situations findings indicated a weak relationship between academic-based and work-based situations. Work-based learning could not be predicted on academic-based learning for 54% of the students. This study is important because it provides evidence that the way the students learn in academic situations may be different from the way they learn in work-based situations.

Recognizing a need in nursing for an instrument suitable for evaluating learning styles in working environments, Berings et al. (2007) developed and tested an instrument to measure work-based learning styles of nursing professionals. Interviews with nurses, supervisors, and educators supported the development of the On-the-Job Learning Styles Questionnaire for the Nursing Profession (OLSQN). The questionnaire consists of a situation-response design with 42 statements participants rank on a scale ranged from 'very bad', 1, to 'very good', 6. Participants included 372 nurses working in 13 hospitals. The OLSQN reported satisfactory psychometric properties. Berings et al. concluded the instrument was appropriate for describing nurses' learning styles in the workplace. The research supports the value of an assessment tool expressly for learning during work-based experience. However, the specificity on nursing practices may make it impractical for use in other disciplines.

Conclusion

The review of literature revealed the importance of learning styles in healthcare education, yet the debate about how to identify learning styles and address differences remain. It was clear the domain of learning styles is multifaceted and encompasses a variety of forms that often intersect. The review of literature demonstrated interest in research related to learning styles and disciplines, student achievement, career, cultural and gender groups, and age.

A number of studies identified unique learning styles of students in healthcare disciplines such as medicine, nursing, allied health, and radiologic technology. However, the review reflected a deficit of research in learning styles related to clinical education in these disciplines and indicated the need to specify the context of the learning situation when administering assessments. Few studies investigated the learning styles of radiography students from the academic perspective. No available published research probed the learning styles of radiography students specifically during clinical practice. Development and validation of an instrument to measure learning styles in clinical practice holds promise to benefit both students and educators in radiologic technology.

To capitalize on what learning style models contribute to the educational process there must be linkage among a particular learning style theory, its assessment, and the purpose for using it. Clinical education differs from other learning situations as the classroom, laboratory, and related homework. An assessment appropriate for measuring learning styles of radiography students during clinical practice would need to include components of learning found in clinical experience. Kolb's (1984) model clearly rises above many others in this regard, as it reflects the essence of clinical practice with integration of cognition, practical application, and clinical skill (Fowler, 2002).

An assessment appropriate for measuring learning styles of radiography students would also need to consider the purpose. If the intent were to use findings from an assessment to understand and improve clinical education in radiography, the assessment would need to evaluate aspects of learning that would permit educational interventions. Clearly, it would be unfruitful to examine learning styles without being able to initiate some action to improve learning or make it more effective.

Theorists from Coffield et al.'s (2004) constitutionally based, cognitive structure, and stable personality families often recommend matching teaching method with learning styles of students. Instruction in the academic classroom offers some opportunity to accommodate different learning styles of students. However, authentic learning environments, such as clinical practice, do not provide the flexibility necessary to modify many of the learning situations recommended by theorists from these groups. For example, it is impractical in the clinical environment to modify many of the preferences suggested by Dunn and Dunn (1978) such as environmental preferences for sound, light, or temperature or sociological preferences for learning alone, in pairs, with peers, or as part of a team. During clinical practice, students must learn and practice skills within an environment that demands a variety of environmental, emotional, sociological, physiological, and psychological situations.

Kolb's (1984) experiential learning theory is an attractive model for this study because it describes characteristics of learning that allows modification of the learning method by the student and clinical instructor. However, dimensionality of the model fails to support the complex negotiations typical in work-based learning situations. The instrument developed by Hermanussen et al. (2000), based on Kolb's work, offers promise for use in radiography if the psychometric properties are improved.

CHAPTER III: METHODOLOGY

The purpose of this chapter is to describe the methodology and research design for this study. The method to describe quantitatively the learning styles of radiography students in clinical practice includes the research design, population and sample, instrumentation, pilot study, data collection and procedures, and data analysis. The purpose of this study is to examine common learning styles of associate degree radiography students during clinical practice. This study examines students' self-perceptions of their immersion, reflection, conceptualization, experimentation, and regulation styles during clinical practice.

Research Design

Descriptive research methodology was used to identify the learning styles of radiography students during clinical practice. The descriptive design "determines and reports the way things are" (Gay, Mills, & Airasian, 2006, p. 11). It is an appropriate means to provide an accurate description of commonalities found in the way students learn in a particular setting. This research design follows the approach used by Hermanussen et al. (2000), which served as a model for this study.

A single self-report instrument assessed learning styles. The Learning Styles during Clinical Practice Questionnaire (LSCPQ), so named for this study, was adapted from the QPL (Hermanussen et al., 2000). The questionnaire was administered electronically via a Web page. The sample was randomly selected programs from a known population. Prospective participants received a hardcopy or e-mail cover letter that explained the purpose of the study with the URL link to the LSCPQ.

Population and Sample

A population is the group of interest from which the researcher wants to collect data (Gay et al., 2006). The target population for this study was radiography students enrolled in JRCERT associate degree college/university and community college programs in the United States and Puerto Rico. Students were accessed through programs selected for inclusion, which were JRCERT accredited, because they share similar standards of practice. For 2007, the JRCERT reported total enrollment within these programs as 16,165 (T. Cruz, personal communication, January 13, 2009). Students enrolled in a radiography program who had not completed a minimum of 30 hours of clinical practice were excluded, because they would be unable to draw upon experiences to respond appropriately to the questionnaire.

Since the population was geographically diverse and access to students was dependent on program affiliation, recruitment of participants was through individual program directors. Sampling involved a two-stage process. The first stage was to determine the appropriate number of programs to contact. The second stage was to include all potential participants from selected programs.

A sample is the part of the population from which data are actually collected. A good sample characterizes the population from which it is chosen (Gay et al., 2006). Probability sampling, based on groups of students by program, was selected to achieve high population external validity. However, even with random sampling, it was important to evaluate the actual sample of participants who completed the questionnaire. To select a representative sample it was necessary to determine the size of the sample, while considering the recruitment method.

Determining the sample size involves consideration of confidence intervals and confidence levels. The confidence interval indicates the reliability of an estimate, while the confidence level indicates the risk level. If a sample is too small, findings may not be generalizable to the population. Rea and Parker (1997) provided an equation to calculate sample size. The equation assumes normality of the sample and a 95% level of confidence in the results. It was determined that information from 1,000 students could be extrapolated to the larger population based on the conservative estimate provided by the equation.

$$N = \frac{Za^2(.25)N}{Za^2(.25) + (N-1)\ Cp^2}$$

Za = 1.96 for confidence levels of 95%

Cp = .03 margin of error that does not exceed +/- 3%

$$N = \frac{(3.84)\ (.25)\ (16{,}165)}{(3.84)\ (.25) + 16{,}164(.0009)} \qquad N = \frac{15{,}518.40}{.96 + 14.55}$$

$$N = \frac{15{,}518.40}{15.51} \qquad N = 1{,}001$$

As the population increases, however, a smaller percentage may adequately represent the population (Gay et al., 2006). Gay et al. suggested that for populations over 5,000 a sample size of 400 is adequate.

The most recent data reported by the JRCERT identified 308 associate degree college/university and community college programs, with an average of approximately 52 students per program (T. Cruz, personal communication, February 3, 2009). To access 1,000 students, approximately 20 programs would be included in the sample. However, the nonresponse rate for comparative types of Web-based surveys is often high (Cole, 2005; Fricker & Schonlau, 2002). To account for the nonresponse rate and because recruitment depends heavily on the agreement of program directors, 30 programs were initially invited to participate. Simple random sampling from a sampling frame of all JRCERT associate degree college/university and community college programs determined the programs. Due to slow response from program directors, 100 programs were invited to participate. The potential number of student participants (n = 1,441) was estimated based on program directors response to the number of eligible students in their programs. Data were collected from 350 respondents who completed the questionnaire. Theses 350 students represented 24% of the sample.

Instrumentation

The LSCPQ (Appendix A), adapted from the QPL (Hermanussen et al., 2000), assessed the self-reported learning styles of radiography students. The QPL, based on Kolb's 1985 LSI, was developed to assess the manner in which vocational students learn during work-based experiences. The QPL was appropriate as a model for this study, because it incorporates theoretical concepts of experiential learning and addresses unique aspects related to learning outside the classroom environment.

The LSCPQ consisted of the same five subscales of immersion, conceptualization, reflection, experimentation, and regulation found in the QPL (Hermanussen et al., 2000). Modifications to the original instrument included the substitution of terms more appropriate for student radiographers. For example, 'procedure' replaced 'tasks in the workbook'. The QPL, originally administered to students in the Netherlands, contained some terms and phrases that might be confusing to students in the United States or Puerto

Rico. For example, in the QPL the term 'postmortem' referred to a discussion following a learning experience. The substituted term was 'follow up'. Another example was the phrase 'tables and charts and pictures' which replaced 'tables and schemes'.

The LSCPQ included 55 bipolar statements that flank a response scale. Each statement pair has first and second designated poles. The type of response was a 1 to 5 scale. The selection of (1) indicated agreement with the statement on the left, while the selection of (5) indicated agreement with the statement on the right. Statements in the five subscales were randomized, with some reorganization if similar statements were close to each other. To help make certain the arrangement of statements did not influence responses some first and second poles were reversed. Each page of the questionnaire included the response scale at the top to reduce respondent error. Demographic questions included students' level in the program, highest level of education, hours spent during the most recent week in clinical practice, gender, and age. Since fatigue might be a factor in responding, these more easily answered demographic questions were included at the end of the questionnaire.

When using assessment instruments it is important to evaluate measurement reliability and measurement validity. Measurement "reliability is the degree to which a test consistently measures whatever it is measuring" (Gay et al. 2006, p. 139). It refers to consistency of scores on an instrument. Internal consistency measured through Cronbach's alpha on subscales (subscale score = average of item scores) were employed to evaluate evidence of measurement reliability. Minimum correlation coefficient varies among types of tests (Gay et al., 2006). Generally an acceptable minimum correlation coefficients around +0.70 is acceptable for group comparison (Polit & Beck, 2008). The

QPL (Hermanussen et al., 2000), from which the LSCPQ was adapted, reported Cronbach's alphas between 0.62 and 0.70 for subscales.

Measurement reliability is necessary for measurement validity, but does not assure validity. Measurement "validity is the degree to which a test measures what it is supposed to measure and, consequently permits appropriate interpretation of scores" (Gay et al., 2006, p. 134). The measure of validity is determined for each test, not for the instrument.

During development of the LSCPQ, evidence based on the content of the assessment provided support for measurement validity. First, a jury of experts determined that all statements of the LSCPQ represented the five learning styles subscales and did not include irrelevant statements. Second, an expert provided with definitions for each subscale, was able to match all statements to the corresponding subscale.

Other methods that provided evidence for measurement validity of the LSCPQ included factorial analyses. Factor analysis is useful for reducing a large set of items into a smaller set of items with a common dimension. Confirmatory factor analysis and exploratory factor analysis provided evidence, based on internal structure, that grouping of statements supported the theory-based subscales. Negative intercorrelations of subscales would provide evidence that they discriminate among each other.

Pilot Study

A pilot study was conducted. Pilot testing included a convenience sample from one JRCERT accredited radiologic technology program. After receiving Institutional Review Board approval from the involved institution, first and second year radiography students received a printed cover letter (Appendix B). The cover letter explained the purpose of the study, provided the study dates, and included directions to access the Web link to the LSCPQ. In addition to completing the questionnaire and demographic section, participants were asked to indicate the length of time it took to complete the questionnaire. Participants had an opportunity to express concerns or comments on any difficulties experienced during the process.

The response rate from the pilot study was 28.5%. It took participants (n = 10) an average of 17 minutes to complete the questionnaire. No student's time exceeded 30 minutes. Three participants included written comments on the questionnaire. Each of them expressed concern that they did not understand the term 'theory'. One participant indicated not understanding the terms 'practice,' 'theory,' or 'strategy' as they apply to clinical experience. Additionally, one participant repeatedly mentioned the desire for an example to serve as a reference. One participant seemingly, at random, chose not to respond to 14 of the 55 statements. Due to the low response rate and high number of missing responses to statements, it was not possible to validate the LSCPQ. Considerations of comments led to the incorporation of some changes. Modifications to the questionnaire included the addition of definitions for the terms theory, practice, and strategy.

Data Collection and Procedures

The Institutional Review Board of Colorado State University granted approval to conduct the research. In spring 2009, program directors of the 30 programs selected to participate in the study were contacted by e-mail. The introductory e-mail message (Appendix C) invited program directors to provide students with the opportunity to participate in the study. The message asked program directors to reply to the e-mail and to indicate whether they would or would not provide opportunity for students to participate. To determine the accessed population, those program directors who accepted were asked to provide the total number of first and second year students in their programs who had completed 30 or more hours of clinical experience. Three attachments accompanied the introductory message. A cover letter to program directors (Appendix D) included the purpose and description of the study and directions for distributing information to students. A cover letter to students (Appendix E) explained the purpose of the study, provided the URL link to the questionnaire, and gave the completion date for the study. The Website consent (Appendix F) and LSCPQ (Appendix A) were attached as a single document to allow program directors the opportunity to examine the questionnaire.

Due to slow returns from the first 30 program directors, a second group of 35 program directors was contacted approximately two weeks after the beginning of the study and a third group of 35 program directors approximately three weeks after the beginning of the study (see Table 4). Each week during the data collection period, program directors who agreed to participate received an e-mail reminder for potential participants to complete the questionnaire. Program directors, who had not responded within one week following the initial request to participate, received a follow up e-mail.

Table 4

Response from Program Directors

Program Director Group	Number Contacted	Results of Request to Participate: Agree	Decline	No Response	Response Rate
Group 1	30	12	2	16	40%
Group 2	35	14	2	19	40%
Group 3	35	12	1	22	34%
Total	100	38	5	57	38%

With one exception, raw data collected from the questionnaire were immediately stored electronically in a data file. Students from one program completed hardcopy versions of the questionnaire, which the program director returned by postal mail. These data were entered on the Website version of the questionnaire and the data immediately stored electronically in a data file. Data from participants in the pilot study were not included in the sample for the study. Following data analysis and discussion of the findings, participating program directors received a summary of findings and notification that the complete study was available from the Colorado State University library.

Analysis of Data

Prior to analysis, some manipulation of data was necessary. Data were examined for duplication and identical submissions removed. Table 5 lists the bipolar statements related to each subscale and the range of possible scores for each subscale. Paired statements with reversed first and second poles were scored so the statement selected by participants corresponded to the appropriate pole statement numerical values. For example, the poles of statement one were reversed. In this case, the score for a participant who identified with external regulation (first pole) would be five. Because the paired statements were reversed on the questionnaire, the score for a participant who selected the external regulation pole was scored one when he/she had selected five.

Table 5

Summary of Codes and Subscale Scoring

		Statement		
Subscale	Statement Identifier	First Pole (left)	Second Pole (right)	Subscale Scoring
Immersion (IM)	4*, 7*, 10, 13, 16*, 20, 23, 29, 31*, 33, 39, 44, 53	Immersed	Detached	13 to 65
Reflection (RE)	3*, 6, 11, 17, 21*, 26, 38, 42, 45*, 47, 50, 54	Insight-oriented	Results-oriented	12 to 60
Conceptualization (CO)	2, 12, 14*, 18, 22*, 24*, 28, 30, 34, 36, 49*, 52	Strategic	Pragmatic	12 to 60
Experimentation (EX)	5, 8, 9*, 19, 25, 35, 40*, 46	Inquiring	Prescription-oriented	8 to 40
Regulation (RG)	1*, 15, 27*, 32, 37*, 41, 43, 48*, 51, 55*	External	Internal	10 to 50

* indicates reverse scoring

Descriptive analyses of student demographic data included frequencies, means, and standard deviations for level in program (two levels), level of education (five levels), time in clinical practice (four levels), gender (two levels), and age in years (seven levels). Levels and categories when collapsed for analysis are described with the relevant findings. Appendix G includes student comments pertaining to learning during clinical practice, which are used to illustrate findings in later chapters.

Table 6 summarizes the analysis of data for the three research questions. The first research question sought to describe statements and subscales. Factor analysis determined how the 55 statements grouped on subscales. Cronbach's alphas indicated how well subscale statements correlated with one another.

Table 6

Summary of Analysis of Data from Research Questions

Research Question	Analysis
1. What are the immersion, reflection, conceptualization, experimentation, and regulation styles of radiography students during clinical practice?	Factor analysis of statements Cronbach's α for subscales
2. How are immersion, reflection, conceptualization, experimentation, and regulation styles interrelated?	Correlation of subscales Factor analysis
3. What are the common learning styles of associate degree radiography students during clinical practice?	Cluster analysis on subscales One-way ANOVA of subscales Cross tabulations with demographic data Chi-square tests

The second research question sought to describe subscale interrelations. Pearson's correlation examined the relationships between subscales. Low correlations between two subscales would indicate weak relationships. If correlations are high, it could indicate subscales may measure similar constructs.

The third research question investigated the common learning styles of students. Cluster analysis, a method to identify clusters with patterns of similar responses, served to identify groups of students with similar learning styles and characteristics. One-way analysis of variances (ANOVA) examined if there were differences among the learning style clusters on each of the subscales. Cross tabulations of learning style clusters with demographic data described students within groups. Chi-square statistic investigated goodness of fit of distributions of students by learning style clusters based on gender, level in the program, age, or education.

Conclusion

This study described the common learning styles of radiography students during clinical practice. Although the review of literature indicated a large volume of research examining learning styles of students, there was no evidence of research investigating learning styles of radiography students during clinical practice. While there are many instruments for identifying learning styles in academic settings, no instrument was found to adequately evaluate radiography students in clinical practice settings. Therefore, the LSCPQ, based on the work of Hermanussen et al. (2000), was developed to assess self-reported learning styles of radiography students during clinical practice. The questionnaire was administered and data collected electronically. Descriptive and inferential analyses were completed.

CHAPTER IV: FINDINGS

This study examined learning styles of radiography students during clinical practice and reported findings in this chapter. The first section presents demographic data about the radiography students. Analyses of the three research questions posed in Chapter I are reported in three sections dealing with confirmatory analyses of the LSCPQ, exploratory analyses of the LSCPQ, and a profile of radiography students learning styles. The fifth section reports the findings from analyses of gender, level in program, education, and age among those grouped by learning style clusters.

Profile of Radiography Students

Data were collected from 350 radiography students enrolled in JRCERT associate degree college/university and community college programs in the United States in spring 2009. Demographic data described the sample (see Table 7). The numbers in the table reflects those who responded and the percentages for each variable total 100. The majority of respondents (51.2%) were under age 26. There were more second year (53.3%) than first year (46.7%) students. Most students (57.6%) had completed some college, while 34.9% had completed an associate degree or higher. A plurality of students (40.5%) spent 11 to 20 hours and 32.4% more spent 21 to 30 hours in clinical practice during the most recent week not including a holiday, vacation, release time, or sick time. Less than three percent of the students spent less than 11 hours in clinical practice during the most recent week.

Table 7

Profile of Radiography Students

Variable	Number	Percent
Gender		
Male	84	24.9
Female	254	75.1
Age group (years)		
20 or younger	54	15.6
21-25	123	35.5
26-30	56	16.2
31-35	40	11.6
36-40	21	6.1
41-50	41	11.8
51 or older	11	3.2
Highest education level completed		
High school or GED	25	7.5
Some college	193	57.6
Associate degree	75	22.4
Baccalaureate degree	40	11.9
Graduate degree	2	0.6
Level in program (year)		
First	163	46.7
Second	186	53.3
Clinical hours during prior week		
10 or less	9	2.6
11-20	142	40.5
21-30	113	32.4
31-40	85	24.4

Confirmatory Analyses of the LSCPQ

To answer research question one regarding the immersion, reflection, conceptualization, experimentation, and regulation learning styles of radiography students and research question two concerning the interrelation of these styles, confirmatory factor analyses of statements and reliability analyses of subscales were performed. Confirmatory factor analysis (principal component factors) of the 55 paired LSCPQ statements explored statement relationships to the five underlying identified subscales. Five factors explained thirty-four percent of the variance. Factor analysis of subscale statements demonstrated lower factor loadings than expected. Reliabilities of the subscales were not high with Cronbach's alphas of .37, .62, .74, .60, and .67.

To improve subscales, a statement was removed if it demonstrated low loading (< .40) on the factor. With one exception there were no statements (>.35) that loaded on two factors. One statement (>.40) loaded positively on one subscale and negatively on another. Following evaluation of the statement, the factor with the higher loading appeared to be a good fit and the statement remained. Following removal of 28 statements, Cronbach's alphas of subscales (subscale score = average of statement scores) were calculated (see Table 8). Reliabilities of the subscales were not high. When compared to the QPL, four of the five LSCPQ subscales demonstrated equal or lower Cronbach's alphas with fewer statements. These analyses indicated weak loading and low reliability for the five original factors. This analysis was therefore put aside and exploratory factory analysis was done on the original 55 statement pairs.

Table 8

Comparison of Statements Loading and Reliability between the QPL and LSCPQ

	Number of Statements		Cronbach's α	
Subscale	QPL	LSCPQ	QPL	LSCPQ
Immersion	13	3	.63	.56
Reflection	12	7	.62	.70
Conceptualization	12	6	.70	.63
Experimentation	8	5	.69	.64
Regulation	10	6	.64	.64

Exploratory Analyses for New LSCPQ Subscales

Exploratory factor analysis served as a selection procedure to replace lower than desired factor loadings and reliabilities. After working with the data, it was discovered that in the original QPL the poles of subscales were reversed. Prior to analyses, all LSCPQ scores were reversed. Analyses included factor analysis of the 55 statements and reliabilities of subscales.

Factor Analysis of LSCPQ Statements

Factor analysis of the 55 paired LSCPQ statements, based on initial eigenvalues > 1.5, found 40% of variance explained by seven factors. Following varimax rotation, statements $\geq$ .40 (+ or -) loading were maintained. A statement was removed if it demonstrated low loading (< .40) on the relevant factor. Eight statements loaded > .40 on one scale and > .35 on another. Following evaluation of all statements, the factors with the higher loading appeared to be a good fit and the statements remained. Nine statements

(2, 4, 6, 14, 16, 17, 26, 29, and 37 < .40) were removed. The statements removed were from four of the five original subscales, except experimentation.

Measurement Reliabilities of LSCPQ Subscales

Following removal of the nine statements, Cronbach's alphas of the seven subscales (subscale score = average of statement scores) were calculated. All negative loadings were converted to positive to run reliabilities so high negative pole statement scores could be used to explain different learning styles. Statement 15, which loaded .40, did not appear to be a good fit and was removed from the study. Removal of three statements (3, 50, and 53) improved reliability for subscale five (from .57 to .62). Subscales one, two, three, four, five, and six demonstrated satisfactory reliabilities. Subscale seven (statements 13, 20, 21, and 55) showed poor reliability (.31) and was removed from the study. Table 9 presents the number of statements and Cronbach's alpha reliabilities for the seven subscales. In the remaining 38 paired LSCPQ statements there were 10 statements from subscale one, 6 statements from subscale two, 7 statements from subscale three, 6 statements from subscale four, 3 statements from subscale five, and 6 statements from scale six.

Table 9

Number of Statements and Measurement Reliabilities for LSCPQ Subscales

Subscale	Number of Statements	Cronbach's α
Subscale 1	10	.79
Subscale 2	6	.72
Subscale 3	7	.71
Subscale 4	6	.64
Subscale 5	3	.62
Subscale 6	6	.62
Subscale 7	4	.31

Factor analysis of the remaining 38 paired LSCPQ statements found 45% of variance explained by the six new factors, more than the 34% of variance explained by the five original factors. It is important to recognize that explained variance increased by 11 percentage points and the factors (6) are truer to the original QPL scale because it uses more statements. More statements relate to a more thorough evaluation of learning styles. Appendix H lists statements associated with each subscale.

Six LSCPQ Subscales

Evaluation of common themes of the statements within subscales resulted in new labels and descriptions to the resulting clinical learning styles (see Table 10).

Table 10

LSCPQ Subscales, Bipolar Statements, and Subscale Scoring

Subscale	Statement: First Pole (left)	Statement: Second Pole (right)	Subscale Scoring
Structure	Plan	Improvise	50 to 10
Integration	Active	Passive	30 to 6
Experimentation	Investigative	Conventional	35 to 7
Authority	Expert	Self	30 to 6
Orientation	Results	Process	15 to 3
Approach	Insight	Theory	30 to 6

1. Structure (plan - improvise) addresses the method used to structure the learning process. Learners who prefer to develop a plan tend to ask questions before, during, and after a learning situation. Reflection on prior learning and experiences of others are helpful. Because they have a plan and think about standards to meet, they are able to judge their performance. Learners who improvise tend to focus on a task as it relates to the immediate environment. Viewing each experience as unconnected to prior experiences, they do little to sequence tasks, question, and learn from experiences of others. Learners who improvise depend on others to evaluate their performance.
2. Integration (active - passive) relates to effort to make sense of theory and practice. Active integration identifies learners who pursue cognitive understanding of connections between theory and practice. Those with a

passive style seem to be more interested in the practicality of a learning situation and are less concerned with making sense of theory and practice.

3. Experimentation (investigative - conventional) concerns tendencies to experiment during a learning experience. Learners with an investigative inclination explore and test ideas. Conventional style learners prefer reliable, detailed instructions and well-tested procedures.

4. Authority (expert - self) examines regulation of learning. Learners with preferences for experts depend on specialists to provide direction and evaluation as opposed to those who prefer self-reliance.

5. Orientation (results - process) involves the frame of reference for an experience or a task. Learners who are more results oriented prefer to focus on outcome rather than process. Process oriented learners are interested in the course of action involved in a task.

6. Approach (insight - theory) considers students' bases of reactions. Learners with a preference for insight trust feelings and intuition for guidance. Those with a theoretical preference rely on ideas, facts, and principles typically presented earlier in the classroom.

Profile of the Learning Styles of Radiography Students during Clinical Practice

The third research question asked what the common learning styles of radiography students are during clinical practice. Intercorrelations helped explain relationships among subscales. Cluster analysis identified groups of radiography students with similar learning styles and one-way ANOVA examined if there were differences among the learning style clusters on each of the subscales. Cross tabulations of learning style clusters with demographic data described students within groups. A chi-square statistic investigated whether distributions of students by learning style clusters differed based on gender, level in the program, age, and education.

Correlations between New LSCPQ Subscales

Table 11, which illustrates intercorrelations among LSCPQ subscales, indicated the discriminant validity of subscales was satisfactory. Effect sizes were interpreted as much larger than typical, $r \geq .70$; larger than typical, $r \geq .50$; typical, $r \geq .30$; and smaller than typical, $r \geq .10$ (Morgan, Leech, Gloeckner, & Barrett, 2004). The strongest correlation, which would be considered a typical to larger than typical effect size, was between structure and integration, $r\ (347) = .42, p < .01$. This suggests students who had moderately high preference for structure were likely to prefer integration of theory and practice. Structure correlated with orientation $r\ (347) = .32, p < .01$. This is a typical effect size, which means students who preferred to develop a plan were likely to focus on results. Integration correlated with orientation $r\ (347) = .31, p < .01$. This is a typical effect size and suggests students who preferred to integrate theory and practice were likely to focus on results. A smaller than typical to typical effect size was found between experimentation and approach $r\ (347) = .21, p < .01$). This indicated students who preferred to test ideas were somewhat more likely to rely on their feelings or intuition. Structure correlated with experimentation $r\ (347) = .11, p < .05$). This correlation is weak enough so that the relationship may not be explainable.

Table 11

Intercorrelations, Means, and Standard Deviations for LSCPQ Subscales (n = 349)

Subscale	1	2	3	4	5	6	*M*	*SD*
Structure		.42**	.11*	-.07	.32**	-.19**	38.55	6.12
Integration			-.01	-.06	.31**	-.31**	21.81	4.39
Experimentation				-.25**	-.10	.21**	20.81	5.23
Authority					-.21**	-.17**	16.25	4.03
Orientation						.05	12.05	2.30
Approach							18.28	3.80

$^{**}p < .01$, $^{*}p < .05$

The strongest inverse correlation, which would be considered a typical effect size, was between integration and approach (r (347) = -.31, $p < .01$). Students who characteristically preferred to understand connections between theory and practice were somewhat less likely to draw on their feelings and intuition than on theory. A smaller than typical to typical inverse relationship between experimentation and authority (r (347) = -.25, $p < .01$) indicated students who preferred exploration were less inclined to depend on expert opinion. Authority correlated inversely with orientation (r (347) = -.21, $p < .01$). This smaller than typical to typical relationship suggests students who relied on experts for guidance were less likely to focus on results. An inverse correlation between structure and approach (r (347) = -.19, $p < .01$) showed a smaller than typical relationship. Students who preferred more structure were slightly less likely to rely on feelings or intuition. There was a smaller than typical inverse relationship between authority and approach (r (347) = -.17, $p < .01$) which indicates students who depend on experts for guidance are more likely to trust theory.

Cluster Analysis of Subscales

K-means cluster analysis was conducted on the 38 statements of the LSCPQ with the sample of radiography students (N = 349, data for one student were missing). Three clusters provided the best solution based on discrimination and interpretation. The three groups consisted of 101, 134, and 114 students, respectively. Figure 4 demonstrates profiles of the three learning styles based on the six subscales. The x-axis indicates the mean subscale scores and the y-axis denotes the learning style groups.

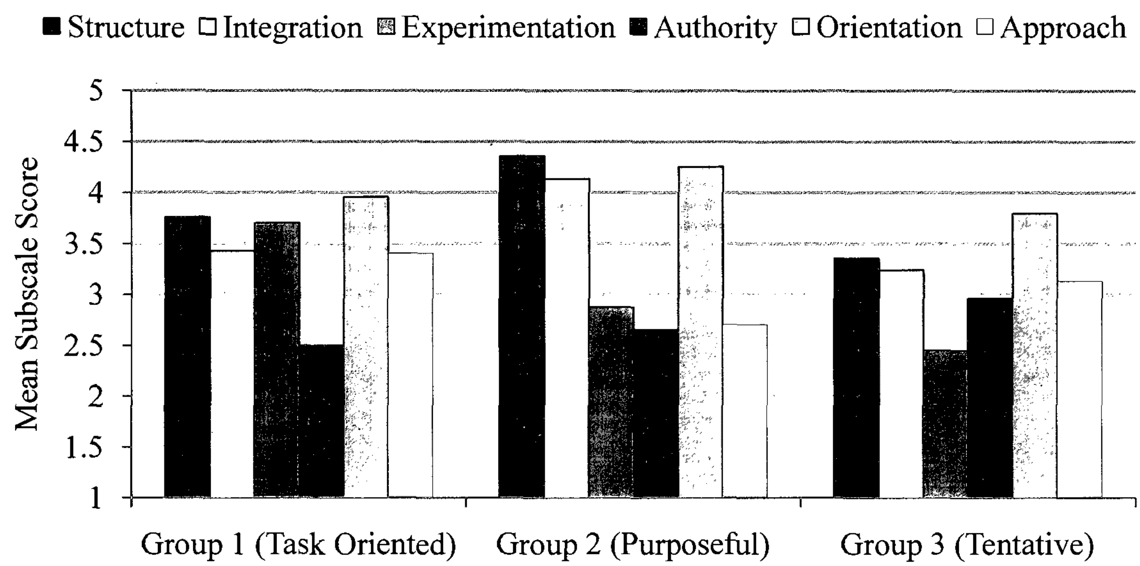

Figure 4 Profiles of LSCPQ Learning Styles

Profile of LSCPQ Learning Styles

Evaluation of common themes within subscales for the three clusters determined learning styles.

1. Task oriented learners described group one ($n = 101$). This clinical learning style is characterized by preferences for structure rather than to improvise in learning experiences. Integration of theory with practice is modest. Learners are likely to test ideas during practical learning experiences and are somewhat

more likely to oversee their own learning experiences than depend on experts. The focus is more on results than process. During practical learning experiences, reliance on feelings and intuition are preferred over theory to solve problems.

2. Purposeful learners marked group two ($n = 134$). This clinical learning style is characterized by preferences for structured learning experiences integrating theory with practice persistently. Reflecting and asking questions before, during, and after a task seem to be an integral part of efforts to integrate theory with practice. There is a balance between testing ideas and dependence on well-defined, well-tested procedures. Learners are somewhat more likely to prefer to manage their own performance and are more likely to focus on results rather than process. During practical learning experiences, they are more likely to rely on theoretical principles to guide decision-making.

3. Tentative learners identified group three ($n = 114$). Learners with this clinical learning style are slightly more likely to plan the learning experience than they are to improvise. Integration of theory with practice is modest. Learners are somewhat more likely to prefer explicit instructions and well-established strategies during practical learning experiences. They are as likely to depend on experts, as to rely on themselves. Learners with the tentative style focus more on results than process and slightly favor practice over theory.

Learning Style Components of Radiography Students as a Group

Figure 5 demonstrates the learning style components of radiography students as a group. Students scored structure, integration, and orientation toward the first pole and authority toward the second pole. This means radiography students as a group tended to plan more than improvise and actively rather than passively integrate theory and practice. During clinical learning experiences, they were inclined to focus on results more than process. As a group, they were apt to rely on themselves rather than depend on experts for guidance.

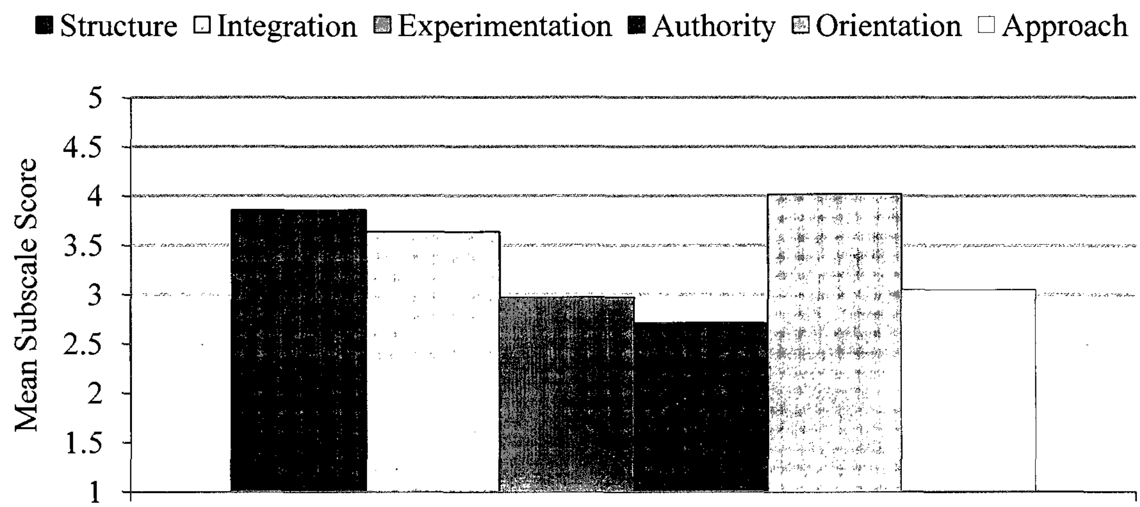

Figure 5 General Profile of Radiography Students Learning Style Components

Characteristics of Learning Style Groups

Inferential statistics helped further interpret groups. For each of the six subscales, scores of the students identified in each learning style cluster were compared using one-way ANOVA using a criterion value of $p < .05$. Table 12 shows the means and standard deviations of the six subscales by the three groups with highest mean scores in bold type. The highest mean scores for structure, integration, and orientation were for the purposeful learning style. The highest mean scores for experimentation and approach were for the task oriented learning style and the highest mean scores for authority were for the tentative learning style.

Table 12

Means and Standard Deviations of LSCPQ Subscales for Three Groups

	Task Oriented		Purposeful		Tentative	
	(n = 101)		(n = 134)		(n = 114)	
Subscale	M	SD	M	SD	M	SD
Structure	3.76	.45	**4.35**	.32	3.36	.55
Integration	3.43	.71	**4.13**	.50	3.24	.65
Experimentation	**3.70**	.44	2.87	.63	2.45	.58
Authority	2.50	.69	2.65	.66	**2.96**	.59
Orientation	3.96	.80	**4.25**	.65	3.79	.79
Approach	**3.41**	.58	2.70	.59	3.13	.51

One-way ANOVA determined whether subscale mean scores differed across the three groups. As indicated by Table 13, F-ratios were significant for every subscale. A statistically significant difference was found among the groups of learning styles for structure, F (2, 346) = 160.55, p = .00; integration F (2, 346) = 73.32, p = .00; experimentation, F (2, 346) = 137.02, p = .00; authority, F (2, 346) = 14.64, p = .00; orientation, F (2, 346) = 12.33, p = .00; and approach, F (2, 346) = 46.53, p = .00.

Table 13

One-Way Analyses of Variance Summary Comparing Three Learning Style Groups on LSCPQ Subscales

Subscale	*df*	SS	*MS*	*F*	*p*
Structure					
Between groups	2	6264.27	3132.14	160.55	.00
Within groups	346	6750.10	19.51		
Total	348	13014.37			
Integration					
Between groups	2	1995.86	997.93	73.32	.00
Within groups	346	4709.04	13.61		
Total	348	6704.89			
Experimentation					
Between groups	2	4208.02	2104.01	137.02	.00
Within groups	346	5312.88	15.36		
Total	348	9520.89			
Authority					
Between groups	2	439.83	219.91	14.64	.00
Within groups	346	5197.99	15.02		
Total	348	5637.81			
Orientation					
Between groups	2	122.54	61.27	12.33	.00
Within groups	346	1718.73	4.97		
Total	348	1841.27			
Approach					
Between groups	2	1064.41	532.20	46.53	.00
Within groups	346	3957.63	11.44		
Total	348	5022.04			

The appropriate post hoc test investigated where group pairwise differences existed. The post hoc test for structure, integration, experimentation, and orientation was Dunnett T3. The post hoc test for authority and approach was Tukey HSD (honestly significant difference). Appendix I reports numeric results for both Dunnett T3 (Table I1) and Tukey HSD (Table I2) tests.

Table 14 demonstrates group pairwise similarities and differences among learners by subscale. Post hoc tests indicated there were significant differences among all learning style groups (3) for structure, experimentation, and approach. There were significant differences in integration and orientation between task oriented and purposeful learners and between purposeful and tentative learners. There were no significant differences in integration and orientation between task oriented and tentative learners. Significant differences in authority existed between task oriented and tentative learners and between purposeful and tentative learners. There were no significant differences in authority between task oriented and purposeful learners.

For the task oriented learning style group, structure scores were significantly lower than the purposeful group and significantly higher than the tentative group. Similar to tentative learners, students identified with the task oriented group scored significantly lower for integration and orientation. Scores for experimentation and approach were significantly higher than the other two groups. Similar to the purposeful group, students who identified with task oriented learning styles scored significantly lower for authority. For the purposeful learning style group, structure, integration, and orientation scores were significantly higher than the other two groups. Scores for experimentation were significantly lower than task oriented learners and significantly higher than tentative learners. Purposeful learners scored approach significantly lower than the other two groups.

For the tentative learning style group, structure and experimentation scores were lower than the other two groups. Students who identified as tentative learners had significantly lower approach subscores than task oriented learners and significantly higher subscores than purposeful learners.

Table 14

Group Pairwise Similarities and Differences by Subscale

Subscale			Similar/Different	Higher/Lower
Structure				
	Task Oriented	Purposeful	D	L
		Tentative	D	H
	Purposeful	Tentative	D	H
Integration				
	Task Oriented	Purposeful	D	L
		Tentative	S	-
	Purposeful	Tentative	D	H
Experimentation				
	Task Oriented	Purposeful	D	H
		Tentative	D	H
	Purposeful	Tentative	D	H
Authority				
	Task Oriented	Purposeful	S	-
		Tentative	D	L
	Purposeful	Tentative	D	L
Orientation				
	Task Oriented	Purposeful	D	L
		Tentative	S	-
	Purposeful	Tentative	D	H
Approach				
	Task Oriented	Purposeful	D	H
		Tentative	D	H
	Purposeful	Tentative	D	L

Learning Styles and Demographic Characteristics

Analyses included cross tabulations with demographic data to describe students within each learning style group. Differences in the three groups of learning styles related to gender, age, education, and level in program were explored. Chi-square statistic investigated whether the three learning style groups differed by gender, level in the program, age, and level of education.

Profile of Radiography Students by Learning Style Type

Cross tabulations performed with demographic data, described radiography students within each learning style group (see Table 15). The numbers in the table reflects those students who responded and the percentages for each variable total 100. Traditional (25 years and under) (n = 177) and nontraditional (26 years and older) (n = 168) groups were created from the seven age levels to more easily interpret findings. Similarly, a non-degree group (n = 218) and degree group (n = 116) were created from the five levels of education.

The task oriented learning style had the greatest number of second year (18.7%) students followed by the tentative learning style (18.1%). The purposeful group had the most males (11.6%), second largest number of females (26.7%), and the most first year (22.1%) and non-traditional (23.8%) students. The greatest numbers of students without a degree were in the purposeful learning style (22.8%) and tentative learning style (22.5%) groups. The purposeful group had the most students with a degree (16.5%). The tentative learning style had the most females (27.6%) and traditional (20.6%) students of any other group.

Table 15

Profile of Radiography Students within Groups

	Learning Style					
	Task Oriented		Purposeful		Tentative	
Variable	Number	Percent	Number	Percent	Number	Percent
Gender						
Male	28	8.3	39	11.6	17	5.0
Female	70	20.8	90	26.7	93	27.6
Level in program (year)						
First	36	10.3	77	22.1	50	14.4
Second	65	18.7	57	16.4	63	18.1
Age group						
Traditional	55	15.9	51	14.8	71	20.6
Nontraditional	44	12.8	82	23.8	42	12.2
Highest education level completed						
Non-degree	67	20.1	76	22.8	75	22.5
Degree	30	9.0	55	16.5	31	9.3

Learning Styles Related to Gender, Level in Program, Age, and Education

Chi-square investigated whether actual and expected distributions of students by learning style differed by gender, level in program, age, or education. Pearson chi-square indicated differences of expected to actual distributions of male and female, first and second year, and traditional and nontraditional students. There was no significant difference in distributions of students by learning style based on education ($\chi^2 = 5.07$, $df = 2$, $N = 334$, $p = .08$).

For male or female students there was a significant difference in distributions related to learning style groups ($\chi^2 = 7.91$, $df = 2$, $N = 337$, $p = .02$). Table 16 shows the Pearson chi-square findings and indicates males were more likely than expected to identify with the purposeful learning style than females. Females were more likely than expected to identify with the tentative learning style than males. Phi, which indicates the strength of association between two variables, was .15 and, thus, effect size was smaller than typical according to Morgan et al. (2004).

Table 16

Chi-square Analysis of Prevalence of Learning Style among Male and Female Students

		Learning Style				
Variable	*n*	Task Oriented	Purposeful	Tentative	χ^2	*p*
Gender					7.91	< .02
Male	84	28	39	17		
Female	253	70	90	93		
Total	337	98	129	110		

For level in program, Pearson chi-square analysis indicated a significant difference in first and second year students related to learning style groups ($\chi^2 = 11.46$, $df = 2$, $N = 348$, $p = .00$). Table 17 shows the chi-square findings and indicates second year students were more likely than expected to identify with the task oriented learning style than first year students. First year students were more likely than expected to identify with the purposeful learning style than second year students were. Phi was .18 and, thus, effect size was smaller than typical (Morgan et al., 2004).

Table 17

Chi-square Analysis of Prevalence of Learning Style among First and Second Year Students

Variable	n	Learning Style: Task Oriented	Purposeful	Tentative	χ^2	p
Level					11.46	< .00
First year	163	36	77	50		
Second year	185	65	57	63		
Total	348	101	134	113		

For traditional and nontraditional students Pearson chi-square analysis indicated a significant difference in distribution related to learning style groups ($\chi^2 = 15.66$, $df = 2$, $N = 345$, $p = .00$). Table 18 indicates traditional students were more likely than expected to identify with the tentative learning style. Nontraditional students were more likely than expected to identify with the purposeful learning style. Phi was .21 an effect size smaller than typical to typical (Morgan et al., 2004).

Table 18

Chi-square Analysis of Prevalence of Learning Style among Traditional and Nontraditional Students

Variable	n	Learning Style: Task Oriented	Purposeful	Tentative	χ^2	p
Age					15.66	< .00
Traditional	177	55	51	71		
Nontraditional	168	44	82	42		
Total	345	99	133	113		

Conclusion

Statistical analysis of survey data, based on five theoretical subscales of learning style, demonstrated few statements loaded on the five factors and the reliabilities were low. Therefore research question one regarding immersion, reflection, conceptualization, experimentation, and regulation styles of radiography students and research question two regarding the interrelation of these styles were not addressed as originally asked but rather on the basis of the exploratory analysis. Exploratory analysis yielded six subscales of learning style that demonstrated better reliabilities with more statements. Analyses made it possible to answer the original research questions using new subscales.

Findings revealed three learning style groups of radiography students with statistically significant differences among all six learning style subscale components. The styles were characterized as task oriented, purposeful, and tentative. Students with the task oriented learning style explore and test ideas, rely on feelings and intuition, and moderately integrate theory with practice. In clinical practice, students with the purposeful learning style tend to structure the learning experience, integrate theory with practice, focus on the result, and rely on theoretical principles. Those with the tentative learning style are more hesitant to structure the learning experience, integrate theory with practice, and explore during clinical practice.

There were differences of expected to actual distribution of male and female students, first and second year students, and traditional and nontraditional students in two of the three learning style groups. There was no statistically significant difference in distribution by level of education for learning style group.

CHAPTER V: DISCUSSION

This chapter presents a summary of the study, discussion of findings, implications for radiography education, recommendations for future research, and final remarks. Important considerations drawn from the data presented in Chapter IV are interwoven.

Summary of the Study

Clinical practice is an important aspect of the curriculum in radiologic technology education. Educators in radiography depend on practical clinical experiences to demonstrate and develop knowledge and skills from academic classroom and laboratory experiences. Students demonstrate competency in general patient care activities and radiologic procedures in clinical practice settings. Research on the learning styles of students has supported strategies to improve teaching and learning in the classroom (Chapman & Calhoun, 2006; de Jong et al., 2006; Diaz & Cartnal, 1999; Pithers, 2002; Raschick, Maypole, & Day, 1998; Terry, 2001). Limited research has addressed learning styles in a work environment like clinical practice.

The purpose of this study was to describe common learning styles of radiography students and to describe the immersion, reflection, conceptualization, experimentation, and regulation styles identified by the students during clinical practice. Research question one regarding immersion, reflection, conceptualization, experimentation, and regulation styles of radiography students and research question two regarding the interrelation of these styles were not addressed as originally asked due to weak loading and low reliability of the subscales.

Consequently, the purpose of this study was to identify and describe common learning styles of radiography students. Further analyses made it possible to answer the original research questions using different subscales. Exploratory analysis identified six subscales of learning styles: structure, integration, experimentation, authority, orientation, and approach. The modified research questions were:

1. What are the structure, integration, experimentation, authority, orientation, and approach learning styles of radiography students during clinical practice?
2. How are structure, integration, experimentation, authority, orientation, and approach styles interrelated?
3. What are the common learning styles of associate degree radiography students during clinical practice?

Analyses examined whether there were gender, age, level in program, and level of education differences by learning style groups.

Quantitative, descriptive research methodology identified and described the learning styles of radiography students. A single self-report questionnaire, adapted from the QPL (Hermanussen et al., 2000), was administered electronically via a Web page. The sample included 350 radiography students from JRCERT associate degree programs in the United States.

Cluster analysis identified three groups of radiography students with similar learning styles: task oriented (n = 101), purposeful (n = 134), and tentative (n = 114). Students identified with the task oriented learning style were characterized by preferences to test ideas and draw on intuition and feelings during clinical learning situations. More than the other two styles the purposeful learning style was distinguished by preferences to plan, actively integrating theory and practice, focus on results, and trust in theoretical concepts. The tentative learning style students were characterized by preferences for more prescriptive and results oriented clinical learning experiences and moderation in the other learning style elements.

There were statistically significant differences in structure, experimentation, and approach across the three learning style groups. There were significant differences between two of three groups related to integration, authority, and orientation. Data revealed statistically significant differences in distributions of students associated with learning styles and gender, level in program, and age. More male students ($N = 39$) than expected identified with the purposeful learning style and more female students ($N = 93$) identified with the tentative learning style. First year students ($N = 77$) were more likely than expected to be associated with the purposeful learning style while more second year students ($N = 65$) favored the task oriented learning style. More traditional students (25 years and under) ($N = 71$) identified with the tentative learning style and more nontraditional students (26 years and older) ($N = 82$) than expected identified with the purposeful learning style. There was no statistically significant difference in distributions of students by learning style related to level of education completed.

Discussion of Findings

This study set out to identify and describe the learning styles of radiography students during clinical practice. Findings revealed similarities in learning style among radiography students, three common learning styles, and associations among learning styles and demographic characteristics. Contrasts are made with findings from other studies using flexibly stable types of learning styles.

Similarities in Learning Styles among Radiography Students

Similarities among radiography students emerged. Generally, during clinical practice radiography students preferred to plan more than improvise a learning experience and to focus on results more than process. During clinical practice, students are subject to established standards and protocols of the medical facility. Kolb (1984) found the skills necessary to perform a specific task effectively could influence learning style. This may account for students' preference to plan a task and focus on results.

In general, radiography students actively rather than passively integrated theory and practice. Research has indicated radiography students are aware of a relationship between theoretical principles taught in the classroom and application of principles and knowledge in clinical practice (Fortsch, 2007). Preferences to plan and focus on results relate to the integration of theory and practice. Comments of one student illustrated how components of planning (asking questions, reflection, and self-evaluation) and focusing on results related to integration of theory and practice:

> When I learn in class it gives me a general understanding. When I apply it in clinics it clicks and makes sense. I ask lots of questions in clinics because I want to be a good technologist when I am finished with the program. I evaluate myself when I finish an exam whether I had good results or bad. If bad I ask myself and a tech what did I do wrong and how do I correct it for next time.

Hermanussen (2000) described a similar learning style where reflection and use of theoretical concepts linked with more integration of theory and practice.

Common Learning Styles of Radiography Students during Clinical Practice

Findings showed radiography students have three identified learning styles during clinical practice: task oriented, purposeful, and tentative. There were statistically significant differences among the three learning styles groups related to structure, experimentation, and approach and significant differences between two of three groups related to integration, authority, and orientation. Table 19 demonstrates differences in learning style components among groups of learning styles. Each high, mid, and low designation indicates a significant difference when comparing subscale scores.

Table 19

Subscale Differences among Groups of Learning Styles

	Learning Style		
Subscale	Task Oriented	Purposeful	Tentative
Structure	M	H	L
Integration	L	H	L
Experimentation	H	M	L
Authority	L	L	H
Orientation	L	H	L
Approach	H	L	M

H = high, M = mid, L = low

In clinical practice, task oriented learners preferred to learn through self-discovery. As one student commented, "I like being able to try things on my own. It helps build my confidence. Even if I make the wrong choice, I learn from it." As task oriented learners favored opportunities to independently experiment and investigate different strategies, it is not surprising they reported modest effort to integrate theory and practice. Task oriented learners typically deal with practical experiences based on feelings and intuition, which likely explains a preference for practical experiences. These learners plan moderately and focus more on results probably because they are most interested in the task. Hermanussen et al. (2000) found a similar learning style where students focused primarily on task performance based on intuition and feeling. However, in Hermanussen et al.'s study learning seemed to be incidental while in the present study there was moderate integration of theory and practice indicated.

It appears the intention of purposeful learners during clinical practice was to integrate theory and practice by planning the learning experience, focusing on desired results, and using theory as a guide. Preferences to create and follow a plan, think about standards and theories, and understand how tasks relate to theory indicate patterns of abstract thinking. The following comments of a student seemed to summarize the purposeful learning style: "Most of the theory behind the practice is logical to me. If I know the theory behind the practice then I can visualize how to perform the task in order to accomplish the desired end results." A slight preference for well-defined tasks and detailed instructions further supports the idea purposeful learners structure the learning experience based on theoretical principles. However, because the preference was not strong, it suggests they might be comfortable prudently testing ideas in practice. A preference to depend on theoretical principles over feelings adds additional support to the idea purposeful learners are interested in taking what they learn in the classroom and applying it to skills learned during clinical experiences. Purposeful learners tended to self-monitor their performance, which may indicate self-confidence based on prior planning, benefits of a theoretical foundation, and pre-recognition of desired results.

In clinical practice, tentative learners were conservative in nearly every aspect of their learning style. Tentative learners showed a modest preference to plan learning experiences and to trust their feelings. However, they wanted well-defined tasks, well-tested procedures, and to know what to expect in advance. These reasons may explain why tentative learners, more than students in other groups, were more likely to depend on an instructor or technologist to monitor their performance. The following statement made by a student expressed the cautious outlook of the tentative learner.

> In clinic, until I am fully comfortable with the procedures I'm approaching and processes of the clinic, I prefer for the technologists to monitor my approach and assist me in the exams instead of throwing me into things with a `sink or swim` attitude. Once I feel confident in my abilities and comfortable with my clinical surrounding, I prefer to be given my own space to complete the exams with very minimal assistance and only critiques of my images after the exam in completed.

It is unclear why tentative learners reported moderate rather than high levels of integration of theory and practice. An explanation may be they were overwhelmed with the learning experience to make sense of theory and practice. Other possibilities might include lack of motivation or lack of confidence to pursue connections between theory and practice.

Associations among Learning Styles and Demographic Characteristics

Analyses of gender, level in program, education, and age by the three learning style groups indicated significant differences associated with learning style groups based on gender, level in program, and age. There were no differences associated with learning styles and level of education. Table 20 demonstrates differences in distribution for gender, level in program, and age among the three groups of common learning styles.

Table 20

Differences in Gender, Level in Program, and Age among Groups of Learning Styles

Demographic Variables	Task Oriented	Purposeful	Tentative
	Learning Style		
Gender			
Male		X	
Female			X
Level in program			
First year		X	
Second year	X		
Age			
Traditional			X
Nontraditional		X	

X = Expected frequencies exceeded observed

Gender

In this study, more male students ($N = 39$) than expected identified with the purposeful learning style during clinical practice, which favored abstract thinking. This finding is consistent with a number of studies using Kolb's LSI, which have found males more likely than females to prefer abstract conceptualization (Kolb, 2005; Philbin et al., 1995; Severiens & ten Dam, 1994). While gender differences were not significant, Heffler (2001) found more males preferred abstract conceptualization than concrete experience. Some researchers using various versions of Kolb's LSI have found no gender differences related to learning style (Demirbas & Demirkan, 2007; Jones et al., 2003; Luh, 1990; Magolda, 1989). The present study did not confirm the findings of Loo (2004) that males prefer practical experiences more than females.

In this study, more female students ($N = 93$) identified with the tentative learning style. It was difficult to compare the tentative learning style to the four learning modes of

Kolb's LSI. In particular, differences between abstract or concrete preference were not evident in the subscales of the tentative learning style. Some research using the LSI have found female's styles more concrete than abstract (Heffler, 2001; Kolb, 2005). While the findings were not significant, Magolda (1989) found more females preferred concrete experience than abstract conceptualization.

Level in Program

First year students ($N = 77$) in this study were more likely than expected to be associated with the purposeful learning style. Students reported similar preferences to plan, actively integrate theory and practice, and focus on results. Students with the purposeful learning style took what they learned in the classroom and applied it to skills learned during clinical experiences. It is reasonable to assume first year students were more consciously aware of making sense of theory and practice. Part of the awareness may stem from unfamiliarity with the practical setting and dependence on theoretical models or methods to perform in the clinical setting. However, it was somewhat surprising that first year students tended to self-monitor their performance rather than seek expert guidance. Inexperience in a learning situation is typically associated with dependence on expert opinion. It appears first year students associated with the purposeful learning style are comfortable assessing their own performance because they base decision making and the application of skills on recognized theoretical principles.

Second year students ($N = 65$) were more likely than expected to be associated with the task oriented learning style. Students reported similar preferences to investigate and discover during clinical practice, integrate theory and practice with moderation, and use insight or feelings to make judgments. It is understandable second year students would generally be more familiar with demands and expectations of clinical practice than first year students. This familiarity may explain why second year students reported moderate rather than strong integration of theory and practice. However, these findings raise some concern that second year students, in the transition from classroom to clinical practice, may depend less on theory and more on practice, particularly as the task oriented group scored highest for an insightful approach in which preferences for intuition and practice override preferences to rely on theory.

Age

Some research with Kolb's LSI has found differences in learning style were not related to the age of respondents (Heffler, 2001). Traditional students ($N = 71$) in this study were more likely than expected to identify with the tentative learning style. Nontraditional students ($N = 82$) were more likely than expected to identify with the purposeful learning style. The purposeful learning style is associated with a preference for abstract conceptualization. Research with Kolb's LSI has consistently shown preference for learning by abstraction increases with age (Kolb, 2005).

Implications for Radiography Education

The findings of this study have practical implications for students, affiliate clinical instructors, clinical faculty, and other educational program representatives in radiologic technology programs. Medical, nursing, and other allied health science educators and students who depend on work-based experience to demonstrate and develop knowledge and skills may benefit as well. The LSCPQ reflected flexible components of learning so recommendations include adaptable elements that retain the learning style structure. Implications for practice related to learning in the clinical setting are based on similarities among radiography students, differences in learning style, and variations in learning style based on gender, age, and level in program.

Implications Based on Similarities among Radiography Students

This study indicated generally radiography students preferred to plan more than improvise a learning experience, focus on results more than process, and actively rather than passively integrate theory and practice. Findings suggested students will achieve more when conditions exist to ask questions before, during, and after a learning experience, create a plan of action, and recognize the sequence of tasks. Clinical faculty can aid in the learning process by being available to answer questions, prompting students to determine a strategy prior to beginning a task, and helping them apply theoretical concepts to clinical practices.

Implications Based on Differences in Learning Style

This study indicated radiography students identified preferences, which fit with three distinct learning styles during clinical practice. Familiarity with differences in learning style provides a platform for clinical faculty and students to discuss how learning during clinical practice involves more than demonstrating and observing skills. Insight into clinical practice learning styles can help students understand how they learn and recognize ways to maximize learning. Heightened awareness of learning style differences and relevance to clinical practice education may broaden the way affiliate clinical instructors and other program faculty understand learning style differences in students. Knowledge of clinical practice learning styles can serve as a springboard for enhancing learning opportunities to improve effectiveness in teaching and student achievement.

Knowledge of learning styles provides a fresh perspective to examine ways students deal with tasks in the clinical environment. Clinical faculty can draw upon different learning style components to create innovative instructional tools and activities to strengthen learning. For example, clinical instructors and other program faculty can help students understand how to integrate theory and practice. Students can be encouraged to reflect on prior experiences, relate theoretical principles to clinical situations, and relate clinical experiences to theoretical principles. Prompted journaling can teach students how to reflect on prior experiences and relate them to knowledge gained in the classroom. Clinical instructors can encourage students to recall and explain theoretical principles when evaluating patient care experiences, images, or imaging procedures.

While this study showed radiography students in general integrate theory and practice, students identified with the purposeful learning style were significantly more likely to do so. Planning and focusing on results correlated with integration of theory and practice. These findings suggest educational interventions to encourage planning, focus on desired results, and use theory as a guide may improve the integration of foundational knowledge taught in the classroom with skills learned during clinical practice. To facilitate planning, students from each learning style group could benefit from the use of pocket handbooks, checklists, or other materials that help plan prior to direct involvement in a task. Planning also includes asking questions before, during, and after the learning experience. This suggests ready availability of a clinical instructor or technologist to answer questions.

Students who identified with the task oriented learning style were absorbed in learning tasks and trusted insight more than theory. Task oriented learners could benefit from situations that help them draw out the nuances of a prior experience and at the same time they could help students who are more reticent. For example, efforts that incorporate student sharing of experiences afford opportunities for task oriented learners to dissect a learning task and for tentative students to discuss experiences.

Findings suggested students who identified with the tentative learning style wanted well-defined tasks and well-tested procedures and wanted to know what to expect in advance. Affiliate clinical instructors and other faculty can provide clearly written policies, including expectations, assessment criteria, and timelines to facilitate learning for these students. Data demonstrated tentative learners depended on expert opinion more than other learning style groups. It is important for affiliate clinical instructors or other clinical faculty to be available to provide the support necessary to maximize learning opportunities for students. Clinical faculty can provide more informal prompting to help students apply theoretical basis to clinical practices.

Implications Based on Differences in Gender, Level in Program, and Age

Learning styles cover broad concepts, so clusters of learning styles may be similar in other populations. Differences in learning style related to gender, level in program, and age represent the sample for this study, so findings may be different with another sample. There were statistically significant differences associated with learning styles and gender, level in program, and age in this study. Interpretation of differences between two means additionally involves consideration of the value of the effect size, the impact of interpretation, and practical significance of the results (Patten, 2007). Smaller than typical effect sizes suggest practical significance may be minimal.

Males identified with the more abstract purposeful learning style. Clinical instructors might consider encouraging male students to apply abstract concepts to clinical tasks. For instance, an instructor might ask a male student to relate principles of the inverse square law to the source image distance required for imaging the chest. Data demonstrated females were associated most with the tentative learning style group. Clinical instructors could encourage female students to adapt strategies, which they are comfortable with to new situations. For example, a female student could be encouraged to modify routine examinations performed in the department for examinations performed in the emergency room.

First year students were more likely than expected to identify with the purposeful learning style. To improve learning clinical instructors can support first year student's efforts to plan, ask questions, and integrate concepts with practical experiences. Second year students were more likely to be associated with the task oriented learning style. To help second year students integrate theoretical concepts and practice, clinical instructors can prompt students to reflect and provide rationale for professional practice.

Traditional students (25 years and under) were more likely than expected to identify with the tentative learning style and nontraditional students (26 years and over) with the purposeful learning style. Providing traditional students with clear well-defined tasks and objectives is the challenge to clinical instructors. Nontraditional students can be encouraged to strategize using theoretical concepts. An example of a tactic might include asking a nontraditional student to explain the principles that support their selection of exposure factors prior to performing an examination.

Recommendations

Based on the review of literature and findings from this study it is clear there is need for further inquiry into the learning styles of students during clinical and other work-based practice if we are going to increase achievement. As noted in chapters one and two, few studies have examined the learning styles of students during work-based or clinical practice situations. Potential topics for research include improvements to the LSCPQ and recommendations for research involving different populations.

This study used the LSCPQ, an adaptation of the QPL, for the first time. The development of new and refined statements related to subscales could improve reliabilities for the LSCPQ. The development of additional subscales based on the ASRT radiography curriculum and further study of the literature on learning during clinical experiences could enhance the LSCPQ. Additionally, the LSCPQ could provide a basis for the creation of an inventory to assess individual learning styles during clinical practice.

Participants in this study were radiography students from JRCERT associate degree programs in the United States. They represent one specific group. Studies could investigate students in other programs such as baccalaureate degree programs and programs in other radiologic technology modalities. Also valuable would be a study of learning styles in other professions that utilize clinical practice including allied health science and nursing programs. Vocational programs that make use of on-the-job training, internships, and work-based experience could benefit from such studies to improve teaching effectiveness and student outcomes. A comparison of the learning styles of radiography students to the learning styles of other clinical or work-based groups would provide valuable information about the ways students learn in venues outside the classroom and provide understanding of characteristics relevant in guiding students' career choices.

Concluding Remarks

This study provides a useful platform for students, affiliate clinical instructors, and others to discuss learning behavior in the context of the clinical practice setting. An awareness of the learning styles used during clinical practice, on the part of students and clinical faculty, can enhance student success and teacher efficacy. Findings of the study present valuable information regarding learning styles of radiography students during clinical practice and numerous fresh directions for future study to improve teacher effectiveness and student achievement.

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APPENDIXES

Appendix A: Learning Styles during Clinical Practice Questionnaire

Directions
Please read and respond to each of the paired items as honestly as possible.

For each of the following pairs of sentences, click the numbered radio button associated with the paired sentence that best describes how you approach learning in clinical practice. Do not include the way you believe you learn during classroom, lab, or homework conditions. Consider the way you think you **learn and perform tasks during *clinical practice*.**

Definitions are provided for some of the terms used in the questionnaire:

Theory refers to ideas, facts, and principles presented during classroom, lab, or homework activities
Practice refers to performance during clinical experience
Strategy refers to the plan or method to accomplish a goal or task

The scale for the questions is as follows:
1 I completely agree with the sentence on the left
2 I generally agree with the sentence on the left
3 I agree with both sentences equally
4 I generally agree with the sentence on the right
5 I completely agree with the sentence on the right

1	I prefer open tasks with few, if any, instructions so I can determine my own strategy.	◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	I prefer to have detailed instructions about how a task should be performed.
2	Before beginning a task, I think out a step-by-step plan.	◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	Usually I begin a task without thinking about the sequence of steps to take.
3	Asking questions after performing a task is of no use once I have finished.	◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	If I do not understand something while performing a task, I will ask questions afterwards.
4	I believe a good strategy is consistent with theory.	◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	I believe a strategy that works well does not need to be consistent with theory.
5	I appreciate being allowed to try out how to best approach a task.	◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	I prefer well-defined tasks.
6	I compare my work strategies with those of others, so I can gain understanding.	◯ 1	◯ 2	◯ 3	◯ 4	◯ 5	Comparing work strategies with others is of no use to me, since each person has an individual style of work.

7	With difficult tasks, I consult theory rather than rely on my feelings.	○ 1	○ 2	○ 3	○ 4	○ 5	With difficult tasks, I rely on my feelings rather than theory.
8	I enjoy trying out things, even if I do not know how they will turn out.	○ 1	○ 2	○ 3	○ 4	○ 5	I would rather work according to a well-tested procedure.
9	I like to be told what I should and should not do.	○ 1	○ 2	○ 3	○ 4	○ 5	I like to make decisions about how to perform a task.
10	When I have to make a decision, I base it primarily on how I feel about the issue choices.	○ 1	○ 2	○ 3	○ 4	○ 5	When I have to make a decision, I base it on theoretical guidelines.
11	I like an elaborate explanation prior to performing a task, so I understand the purpose.	○ 1	○ 2	○ 3	○ 4	○ 5	I like to start as soon as possible, so I dislike elaborate explanations prior to performing a task.
12	I check whether the instructions or guidelines for a task are logical.	○ 1	○ 2	○ 3	○ 4	○ 5	I assume instructions or guidelines for a task are logical so I feel no need to check.
13	I perform much better when the moods of others are good.	○ 1	○ 2	○ 3	○ 4	○ 5	The moods of others do not significantly influence my performance.
14	In my experience, tables, charts, and pictures are not useful task aids.	○ 1	○ 2	○ 3	○ 4	○ 5	In my experience, tables, charts, and pictures are useful task aids.
15	I usually ask for help if I do not know how to continue with a task.	○ 1	○ 2	○ 3	○ 4	○ 5	I usually seek my own solution without asking for help if I am stuck while performing a task.
16	I like to work where I am not in direct contact with other people.	○ 1	○ 2	○ 3	○ 4	○ 5	I like to work where I can deal with other people directly.
17	The importance of a follow up discussion is that it helps me reflect on how I approached a task.	○ 1	○ 2	○ 3	○ 4	○ 5	The importance of a follow up discussion is that it tells me what I did right and wrong.
18	Usually, I follow the initial plan I made to approach a task.	○ 1	○ 2	○ 3	○ 4	○ 5	Usually, I determine how to approach a task while actually working at it.
19	If a strategy works well, I like to try it out with other tasks.	○ 1	○ 2	○ 3	○ 4	○ 5	I like to have detailed instructions about how to perform each task.

20	I learn most from the exchange of practical experiences with others.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I learn most from relating practical experiences to theory.
21	After I have a task completed, I go on with the next one.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	After I have a task completed, I think about what I learned from it.
22	I want to know whether a strategy works, not the theory behind it.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I want to understand the theory behind a strategy, not just whether it works.
23	If a procedure is demonstrated, there is little use to check if it compares to what I learned, since practice always differs from theory.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	If a procedure is demonstrated, I check whether it corresponds to what I learned, since practice and theory are consistent with each other.
24	If a strategy works well, I do not need to know why it does.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	If a strategy works well, I want to know why it does.
25	I prefer to discover the best strategy by experimenting.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I prefer to consider the best strategy to approach a task in advance.
26	If I am asked to work in a specific way, I want to know the reason why.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	If I am asked to work in a specific way, I do not want to know the reason why.
27	I prefer to monitor my performance during a task.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I prefer to have an instructor or technologist monitor my performance during a task.
28	What I learned earlier, I apply to new tasks.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	Because tasks are never the same, I seldom apply what I learned earlier.
29	I do not believe I need to follow the theoretical guidelines learned in class.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	It disturbs me if I act contrary to theoretical guidelines learned in class.
30	If I am stuck in a task, I look to theory for help to think of a solution.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	If I am stuck in a task, I can think of a solution without looking to theory.
31	I prefer theory to practice.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I prefer practice to theory.
32	If I do not understand something, I usually wait for someone to explain it to me or to learn it in class.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	If I do not understand something, I usually look for an explanation myself.
33	I enjoy getting new work tasks unexpectedly.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I prefer knowing my work tasks in advance.

34	I try to discover why tasks have a specific sequence.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	As I perform tasks, I do not bother about understanding the specific sequence.
35	If there are different approaches possible, I like to find out by myself the one that is best.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I like to be informed about different approaches, so I can select the best one.
36	Before I start a task, I think about the standards I should meet.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	As I begin a task, the standards I should meet become evident.
37	If I have to perform a new task, I determine whether I can use the knowledge and skills that I already have.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	If I have to perform a new task, I expect my instructor or a technologist to explain how to do it.
38	After a task is finished, I ask myself whether I could have done it another way.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	Once a task is finished, I see no reason to think about another way of doing it.
39	My intuition guides me rather than theory.	1	2	3	4	5	Theory guides me rather than intuition
40	In my opinion, the quality of a strategy can be evaluated without it being put into practice.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I can only evaluate the quality of a strategy after it is put into practice.
41	After finishing a task, I expect my instructor or a technologist to determine whether I understood things well.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	After finishing a task, I know whether I understood things well or not.
42	Before starting, I take time to ask questions about a task.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I start working on a task as soon as I can without asking questions.
43	I depend on others to tell me about different strategies to consider.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I want to consider my own strategies to use.
44	When beginning a task, I do not think about the result.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	When beginning a task, I try to visualize the result.
45	During a follow up discussion, I seldom consider what went well and what went wrong.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	During a follow up discussion, I usually consider what went well and what went wrong.
46	I am interested in theory if I observe it is useful in practice.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I am interested in theory, even before I know its practical application.

47	I learn from listening to other students tell about their experiences.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	Experiences of other students are not very educational to me.
48	When I am finished with a task, I am able to judge whether I performed the task well.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I only know whether I did a task well if my instructor or a technologist tells me so.
49	I am not concerned with the way tasks relate to theory.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I try to discover how tasks relate to theory.
50	Being able to account for how I worked is most important for me.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	Being able to show results of my work is most important for me.
51	Once I am finished with a task, I rely on my instructor or a technologist to tell me what I should do better next time.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	Once I am finished with a task, I consider on my own what I can do better next time.
52	Before starting a task, I consider what problems I can expect.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	I just start a task and in the process of working, I find what can go wrong.
53	The feeling I get is more important than the actual task I have to perform.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	The actual task I perform is more important than the feeling I get.
54	To improve my understanding, I ask many questions during follow up discussions.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	In follow up discussions, I do not need to ask questions to improve my understanding.
55	When I am stuck in a task, I try to find a solution on my own.	◎ 1	◎ 2	◎ 3	◎ 4	◎ 5	When I am stuck in a task, I depend on my instructor or a technologist to tell me how I should continue.

Please indicate the following about yourself. All findings are based and reported on the entire group and will not identify you.

1 Level in Radiologic Technology Program	First Year	◎
	Second Year	◎
2 Highest level of education	High School or GED only	◎
	Some college	◎
	Associate degree completed	◎
	Baccalaureate degree completed	◎
	Graduate degree completed	◎
3 Hours spent in clinical practice during the *most recent week* that did not include a holiday, vacation, release time, or sick time	10 hours or less	◎
	11-20 hours	◎
	21-30 hours	◎
	31-40 hours	◎
4	Male	◎
	Female	◎
5 Age	20 years or younger	◎
	21–25 years	◎
	26–30 years	◎
	31–35 years	◎
	36–40 years	◎
	41–50 years	◎
	51 years or older	◎

Thank you for taking the time to complete this questionnaire!

Please add comments about your learning approach in clinical practice:
The results of this research will benefit students, clinical faculty, and other program representatives in radiologic technology programs across the United States and Puerto Rico.

	Yes
Continue to final page?	◯

Not for redistribution.

Appendix B: Cover Letter to Students in the Pilot Study

I am requesting participants for my pilot study. There is no reward or penalty for completing or not completing the questionnaire. It will take you approximately 15 to 30 minutes to complete the entire questionnaire.

The actual research project, involving radiologic technology students across the United States and Puerto Rico, will take place in fall 2008. The purpose of the study is to investigate the learning approaches of radiologic technology students in clinical practice.

To participate, access the online questionnaire at
https://intranet.mesastate.edu/survey/radtec/radtech.htm

If you should have any questions or concerns, please feel free to contact me at (970) 248-1775 or pward@mesastate.edu.

Thank you for your time!
Patti Ward

Appendix C: Introductory E-Mail Message to Program Directors

Your program was randomly selected from JRCERT accredited associated degree programs in the United States and Puerto Rico to participate in research for a study entitled, "The Learning Styles of Radiography Students during Clinical Practice." As the Program Director, you are encouraged to allow first and second year students to voluntarily participate in the study that will begin February 17, 2009.

A "Cover Letter to Program Directors" is attached. This letter includes the purpose and description of the study and directions for distributing information to your students.

Your involvement only requires that you print and distribute the attached "Cover Letter to Students" directly to students (preferably in class or clinical) or send a copy of the letter to students electronically.

The participation of students is strictly voluntary. A copy of the questionnaire is attached for your examination. Please do not forward or distribute the questionnaire.

Please reply to this e-mail indicating whether you will or will not provide opportunity for your students to participate in this study. If you do agree, would you also please include the total number of first and second year students in your program who have completed 30 or more hours of clinical experience?

If you have any questions or concerns, please feel free to contact me. Thank you in advance for taking the time to participate in this research.

Patti Ward, MEd, RT(R)
Professor of Radiologic Technology
Health Sciences
Mesa State College
1100 North Ave.
Grand Junction, CO 81501

Voice Mail: 970-248-1775
Fax: 970-248-1133

Appendix D: Cover Letter to Program Directors

Colorado State University
Knowledge to Go Places

School of Education
1588 Campus Delivery
Fort Collins, Colorado 80523-1588

February 16, 2009

Dear Program Director,

We are conducting research for the study entitled, "The Learning Styles of Radiography Students during Clinical Practice." As educators, we are familiar with the use of learning style assessment in the classroom. While research has examined the learning styles of radiologic technology students, little research has examined learning styles specifically in clinical practice. To facilitate learning in clinical practice it is important for clinical instructors and other program representatives to understand how current radiologic technology students learn in clinical situations.

Your program was randomly selected from JRCERT accredited associated degree programs in the United States and Puerto Rico to participate in this valuable research. As the Program Director, we are asking you to allow first and second year students to voluntarily participate in the study that will begin February 17, 2009.

If you agree to participate, please print and distribute the student cover letter directly to students (preferably in class or clinical) or send a copy of the cover letter to students electronically. The cover letter includes a URL to link to the study Website. Students who access the Website and agree to the study conditions will automatically link to the questionnaire, which will take approximately 15 to 20 minutes to complete. Students will have 15 days to complete the questionnaire. For your examination, you will find a copy of the questionnaire attached. Please do not forward or distribute the questionnaire.

The Institutional Review Board committee at Colorado State University has approved this study. The participation of students is strictly voluntary. Information students provide for this study will be anonymous. No one, including the study team, will be able to identify information from an individual or program. Data will be reported in aggregate form.

Thank you for your interest in this research study. If you have any questions or concerns, please feel free to contact me at pward@mesastate.edu or 970.248.1775. Thank you in advance for allowing your students the opportunity to participate in this research.

Sincerely,

Patti Ward

Patti Ward, PhD(c), RT(R)	Richard W. Feller, PhD
Doctoral Candidate, Education	School of Education
Co-Principal Investigator	Principal Investigator

Appendix E: Cover Letter to Students

Colorado State University
Knowledge to Go Places

School of Education
1588 Campus Delivery
Fort Collins, Colorado 80523-1588

February 16, 2009

Dear Student Technologist:

You have been selected as a radiologic technology student enrolled in an associate degree program to participant in a research study. Radiologic technology students spend a significant amount of time in clinical practice. There are different ways to approach learning. The purpose of this study is to identify the learning style of first and second year radiologic technology students during clinical practice. Results from this study will help inform radiologic science clinical instructors, clinical faculty, and other program representatives concerning students' learning style in clinical practice.

This questionnaire is only for radiography students who have experienced a minimum of 30 hours clinical practice.

It will take approximately 15 to 20 minutes to complete the entire questionnaire. Your response will be anonymous. No one, including the study team, will be able to identify information from an individual or with the program. There is no impact on your grades or standing in the program for completing or not completing the questionnaire.

The Institutional Review Board committee at Colorado State University has approved this research study and your program has agreed to participate. Your program director will receive results of the study and the results will be available from the CSU library when completed.

To participate, access the questionnaire at

https://intranet.mesastate.edu/survey/radtec/radtech.htm

Please complete by Tuesday, March 3. If you have any questions or concerns, please feel free to contact me at pward@mesastate.edu or 970.248.1775. Thank you in advance for taking the time to participate in this research.

Sincerely,

Patti Ward

Patti Ward, PhD(c), RT(R)
Doctoral Candidate, Education
Co-Principal Investigator

Richard W. Feller, PhD
School of Education
Principal Investigator

Appendix F: Website Consent for Participants

Learning Styles during Clinical Practice Questionnaire

Description

- Radiologic technology students spend a significant amount of time in clinical practice. There are different ways to approach learning. The purpose of this study is to identify the learning styles of first and second year radiologic technology students in clinical practice.
- Findings will help inform radiologic science clinical instructors, clinical faculty, and other program representatives concerning students' learning styles.
- This survey is for radiologic technology students who have experienced a minimum of 30 hours clinical practice.
- DO NOT CONTINUE if you have not satisfactorily completed a minimum of 30 total hours in clinical practice. Click 'No' below to exit.
- This survey should take approximately 15 to 20 minutes to complete.
- Complete the survey online by clicking the appropriate radio button.
- Please try to answer all questions.
- Complete and submit only one questionnaire.

Conditions

- I understand all information is anonymous. That means no one, including the study team, will know the information I give comes from me.
- I understand I may change a response at any time or leave an item blank.
- I understand I can withdraw from participation at any time without negative consequences.

I have read the description of the study, satisfactorily completed a minimum of 30 total hours in clinical practice, and agree to participate.	◎ Yes	◎ No

Appendix G: Student Comments from the LSCPQ

The LSCPQ included space for participants to add comments about their learning approach in clinical practice. Appendix G includes student comments pertaining to learning during clinical practice. Remarks about the questionnaire or learning in the context of the classroom were not included. There were no attempts to correct spelling or typographical errors. Each • is one student's comments.

- We all learn from making mistakes - which is fine, as long as we are actually learning from each mistake and not continually repeating the same error. All our skills continue to build over time - we just have to keep at it.
- I love clinicas for it gives me a hands on learning experiance that will help me perform my job in the future or efficiently.
- I think I could learn better if I was put with a good, nice tech that knows what he/she is doing. I think the tech should be really good at what they do and have a positive attitude towards their students.
- Some of the Techs. help some of your classmates but not others and some of them do not want to teach you anything. They often hurt your feelings and don't think nothing of it.
- I feel I have gotten a good variety. You do have many different techs who want it certain ways and you have to do it that way to be right. I like that in the fact I can kinda find my own after seeing all of their's but it's harder to learn, trying to understand why each do this and that.
- I like being able to try things on my own. It helps build my confidence. Even if I make the wrong choice, I learn from it.
- In the clinical setting you never know what to expect. You always have to be ready for anything. Sometimes you know the answer and sometimes you find it along the way. I always ask questions and take the patients feelings first.
- I am a visual learner, and I like to discover things on my own rather than someone lecturing me.
- I learn better when the techs and or management is not hovering over me.

- I learn better hands on. When I learn in class it gives me a general understanding. When I apply it in clinics it clicks and makes sence. I ask lots of questions in clinics because I want to be a good technologist when I am finished with the program. I evaluate myself when I finish an exam whether I had good results or bad. If bad I ask myself and a tech what did I do wrong and how do I correct it for next time. I learn from my mistakes.

- I enjoy working on my own and figuring things out on my own.

- I like hands on training,we get plenty of that in our program.

- I learn better in the clinical environment with the hands on experience. But I also know that without the classroom part I would not know as much in detail about what I am doing in clinical.

- I always appreciate the technicians who take the time to explain WHY they take the actions they do. That way I can try to apply it to other situations. Earlier on in my clinicals I wanted more guidance, now into my second semester I want some autonomy but not yet complete freedom- I still like to have someone look over my shoulder but not be too quick to intervene so I can try on my own first. My greatest concern is to not overly cause repeat exposure to the patient and if it means the RT should intervene then so be it.

- Theories taught in the classroom should always be demonstrated in the clinical setting so the practical application can be seen and evaluated.

- I am the type of person that understands things by seeing them. I have and will always be a visual learner, but i do understand theory.

- I love having a lab on a particular thing in postioning that I am having trouble with in the clinical site. Actually using the clinical setting and their quipment and how it is actually that in that particular hospital.

- I find that actual positioning while learning a study, will help me to perform better.

- Mood of the employee is extremely important when first learning. Also, it helps to know what we are looking for in the radiograph, not just angle this way, tilt that way, push this button,...

- I enjoy clinical because it is hands-on. I feel I learn better when I can actually DO what I am taught rather than just read from a book.

- Some of my answers may be inconsistent because I had a hard time separating how I am in the clinic from how I approach learning when it is for my benefit. In general I have found that learning from experimentation is frowned upon in the clinic

- I do like the classroom because I can learn before I see it in clinic. But I feel I learn more hands on.

- I learn best in clinic by helping with everything I can and learning by watching others. I ask questions when I don't understand.

- In clinic, until I am fully comfortable with the procedures I'm approaching and processes of the clinic, I prefer for the technologists to monitor my approach and assist me in the exams instead of throwing me into things with a `sink or swim` attitude. Once I feel confident in my abilities and comfortable with my clinical surrounding, I prefer to be given my own space to complete the exams with very minimal assistance and only critiques of my images after the exam in completed.

- I'm a visual and a hands on learner who likes to have a constructed environment around me.

- The most valuable resource of a clinical setting is the opportunity to work with numerous technologists. Each individual has methods that work best for them, which provides the student with the opportunity to learn many techniquest, and choose what is best for them to complete a task efficiently.

- I gain confidence in myself and my work as exams become more routine to me. As a student I enjoy doing exams on a daily basis, so that I get more familiar with them.

- I like to be given a task, and then let to try and complete the task without technologist interference. Afterwards, then I can discuss the outcome and what I did wrong and right with the technologist.

- When there are technologist who are helpful and want to help you learn I enjoy the experience better. There are some who feel threatened, I suppose, and do not tend to be very helpful at all. They leave you to figure out things for yourself. It can be a little discouraging.

- Working with many different technologists you get exposed to many different approaches to achieve the same outcome. I try to mimic what they do when I'm with them. If it works for me I incorporated into my clinicals. If what they show me is not compatable with how I work, then I rely on what I know works for me.

- I think that going out to clinic and practicing what you are taught sometimes helps me more on my tests than studying.

- I enjoy learning my own strategies while also taking opinions from other technologists as well.

- Practice makes perfect.

- I like how our teachers slowly ease us into the program. We start with one day a week in clinic our first sememster so we can observe. Then, we get into clinic twice a week. Someone is usually around to assist us if we have any questions or if we need additional help!

- I'm more of a `hands on` learner in clinic. It's better for me to learn by doing rather than just someone telling me how to do it. I think it's important to help your technologist as much as possible when learning something new and then trying it yourself until you get comfortable with it. It's important to be confident and competent and what you do, but it's also important to ask questions and try exams on your own. I learn more that way.

- Hands on is more beneficial to me than anything.

- i find that watching and observing others first and then jumping in there and giving it a shot even though your not sure is the best way to learn something and remember it. you will make mistakes and you will never forget it when you make them.

- I always feel rushed. At times I feel unprepared for what I am required to do. There is a competitiveness among the students that I think is detrimental to performance.

- Most of the time if I do not understand, I ask questions while I'm involved in the task because your seeing and doing. If it's not appropriate at the time, then I wait until were finished, but if I'm not sure I get someone who knows what's going on.

- clinical practice has taught me alot. i know the book tells you how things should be in a perfect world, but nothing is perfect!

- I enjoy the hands on practice that comes with clinic. The clinical instructors I have worked with are very good and I have enjoyed the experience.

- I approach things with a lot of thought first and go from there.

- hands on is the best way to learn. it's easier to learn when the people around you are willing to teach and help you.

- I work best when not too closely supervisored and gain confidence in my skills when the patient thanks me

- Most of the theory behind the practice is logical to me. If I know the theory behind the practice then I can visualize how to perform the task in order to accomplish the desired end results. I also learn by seeing other techs perform task. Mostly, I am a hands on learner.

- like to hear it, see it, practice it, polish it and may be develop my own way.

- I learn the most by watching a task first and then applying what I watched to my own experiences. I learn the most by hands on experience.

- I learn from knowing the `theory` before starting a task then relating that to how it is performed in the clinical setting. Since every patient has different needs and conditions, the ability to modify the exam as needed is highly utilized. The textbooks do not explain how to use that ability well, making the clinical experience the most important part of the radiologic program.

- clinical is the best way you learn (hands on)

- I approach clinicals like I do life. I make the best of each situation. I learn from each person I am with. I try to find the positive in each person and situation. Some days are better than others. The good days I dive in and do what ever comes my way. On not so good days I am right there with each task I can be involved in watching and helping where I am able.

- Listen to everyone, follow no one.

- Clinical has taken everything we have learned in class and put it to use. It's a very good way to learn and become a good Rad. Tech.

- I'm glad there are so many different ways to perform a task. I do appreciate it when the techs give their reasoning on why they do it that way.

- I think theory is important, but I am a person that learns more in the clinical environment. I like to get my hands dirty. I like to also view my problems, or possible problems that I may have in the future, and adapt according to what I may theories. i also like to hear how other tech's do things and try to see if it may improve my way of doing things. it is important for me to get constructive criticism, but i also like to go through past events while they critique me.

- I really feel that cinic is where I really learn how to do the exams. For me seeing the exams in a book is not enough, i really like the hands on.

Appendix H: Subscale Statements

Appendix H includes subscale statements used in the final data analysis. Similar to the LSCPQ statements appear with the first pole statement on the left and the second pole statement on the right. Statements are organized into the relevant subscale. Unlike the LSCPQ pole statements include the numerical values associated with it.

Structure, Subscale 1

Plan (5)	Improvise (1)
Usually, I follow the initial plan I made to approach a task.	Usually, I determine how to approach a task while actually working at it.
What I learned earlier, I apply to new tasks.	Because tasks are never the same, I seldom apply what I learned earlier.
I try to discover why tasks have a specific sequence.	As I perform tasks, I do not bother about understanding the specific sequence.
Before I start a task, I think about the standards I should meet.	As I begin a task, the standards I should meet become evident.
After a task is finished, I ask myself whether I could have done it another way.	Once a task is finished, I see no reason to think about another way of doing it.
Before starting, I take time to ask questions about a task.	I start working on a task as soon as I can without asking questions.
I learn from listening to other students tell about their experiences.	Experiences of other students are not very educational to me.
When I am finished with a task, I am able to judge whether I performed the task well.	I only know whether I did a task well if my instructor or technologist tells me so.
Before starting a task, I consider what problems I can expect.	I just start a task and in the process of working, I find what can go wrong.
To improve my understanding, I ask many questions during follow up discussions.	In follow up discussions, I do not need to ask questions to improve my understanding.

Integration, Subscale 2

Active (5)	Passive (1)
I like an elaborate explanation prior to performing a task, so I understand the purpose.	I like to start as soon as possible, so I dislike elaborate explanations prior to performing a task.
I check whether the instructions or guidelines for a task are logical.	I assume instructions or guidelines for a task are logical so I feel no need to check.
I want to understand the theory behind a strategy, not just whether it works.	I want to know whether a strategy works, not the theory behind it.
If a procedure is demonstrated, I check whether it corresponds to what I learned, since practice and theory are consistent with each other.	If a procedure is demonstrated, there is little use to check if it compares to what I learned, since practice always differs from theory.
If a strategy works well, I want to know why it does.	If a strategy works well, I do not need to know why it does.
I try to discover how tasks relate to theory.	I am not concerned with the way tasks relate to theory.

Experimentation, Subscale 3

Investigative (5)	Conventional (1)
I prefer open tasks with few, if any, instructions so I can determine my own strategy.	I prefer to have detailed instructions about how a task should be performed.
I appreciate being allowed to try out how to best approach a task.	I prefer well-defined tasks.
I enjoy trying out things, even if I do not know how they will turn out.	I would rather work according to a well-tested procedure.
If a strategy works well, I like to try it out with other tasks.	I like to have detailed instructions about how to perform each task.
I prefer to discover the best strategy by experimenting.	I prefer to consider the best strategy to approach a task in advance.

I enjoy getting new work tasks unexpectedly.	I prefer knowing my work tasks in advance.
If there are different approaches possible, I like to find out by myself the one that is best.	I like to be informed about different approaches, so I can select the best one.

Authority, Subscale 4

Expert (5)	Self (1)
I like to be told what I should and should not do.	I like to make decisions about how to perform a task.
I prefer to have an instructor or technologist monitor my performance during a task.	I prefer to monitor my performance during a task.
If I do not understand something, I usually wait for someone to explain it to me or to learn it in class.	If I do not understand something, I usually look for an explanation myself.
After finishing a task, I expect my instructor or a technologist to determine whether I understood things well.	After finishing a task, I know whether I understood things well or not.
I depend on others to tell me about different strategies to consider.	I want to consider my own strategies to use.
Once I am finished with a task, I rely on my instructor or a technologist to tell me what I should do better next time.	Once I am finished with a task, I consider on my own what I can do better next time.

Orientation, Subscale 5

Results (5)	Process (1)
I can only evaluate the quality of a strategy after it is put into practice.	In my opinion, the quality of a strategy can be evaluated without it being put into practice.
When beginning a task, I try to think about the result.	When beginning a task, I do not think about the result.
During a follow up discussion, I usually consider what went well and what went wrong.	During a follow up discussion, I seldom consider what went well and what went wrong.

Approach, Subscale 6

Insight (5)	Theory (1)
With difficult tasks, I rely on my feelings rather than theory.	With difficult tasks, I consult theory rather than rely on my feelings.
When I have to make a decision, I base it primarily on how I feel about the issue choices.	When I have to make a decision, I base it on theoretical guidelines.
If I am stuck in a task, I can think of a solution without looking to theory.	If I am stuck in a task, I look to theory for help to think of a solution.
I prefer practice to theory.	I prefer theory to practice.
My intuition guides me rather than theory.	Theory guides me rather than intuition
I am interested in theory if I observe it is useful in practice.	I am interested in theory, even before I know its practical application.

Appendix I: Post Hoc Tests for Subscales

Dunnett T3 tests of structure, integration, experimentation, and orientation learning style components compared the three learning style groups.

Table I1

Post Hoc Tests for Structure, Integration, Experimentation, and Orientation Subscales

Subscale			Mean Difference	SE	*p*
Structure					
	Task Oriented	Purposeful	-5.95*	.53	.00
		Tentative	4.03*	.68	.00
	Purposeful	Tentative	9.98*	.58	.00
Integration					
	Task Oriented	Purposeful	-4.24*	.50	.00
		Tentative	1.13	.56	.13
	Purposeful	Tentative	5.36*	.45	.00
Experimentation					
	Task Oriented	Purposeful	5.78*	.49	.00
		Tentative	8.75*	.48	.00
	Purposeful	Tentative	2.97*	.53	.00
Orientation					
	Task Oriented	Purposeful	-.88*	.29	.01
		Tentative	.50	.32	.33
	Purposeful	Tentative	1.39*	.28	.00

*$p < .05$

Tukey HSD of authority and approach learning style components compared the three learning style groups.

Table I2

Post Hoc Tests for Authority and Approach Subscales

			Subset	
Subscale	*n*	1	2	3
Authority				
Task Oriented	101	14.99		
Purposeful	134	15.91		
Tentative	114		17.77	
p		.17	1.00	
Approach				
Purposeful	134	16.22		
Tentative	114		18.78	
Task Oriented	101			20.46
p		1.00	1.00	1.00