

ABSTRACT

ORDERS, AMY BUCHANAN. How Rising Senior Radiologic Science Students Reflect in Practice: A Narrative Analysis. (Under the direction of Tuere Bowles, Ph.D.)

The purpose of this basic qualitative research study was to explore how rising senior radiologic science students learn to reflect in practice to make informed clinical decisions. The primary source of data for this study was obtained via semi-structured interviews of 10 purposefully selected radiologic science students who were all rising senior students in the same baccalaureate degree program. Participants ranged in age from 21-33 years and were interviewed after completing an intensive summer clinical internship. Secondary data obtained for this study included participant observations, review of documents, critical incident narratives and researcher field notes. The research questions that guided this study included: 1) How do rising senior radiologic science students learn to reflect in practice? 2) What application do rising senior radiologic science students make of reflective practice in clinical settings? 3) How do rising senior radiologic science students learn to negotiate knowledge from classroom and clinical instruction to make informed clinical decisions?

Data were analyzed and interpreted using the constant comparative method that revealed several findings. Learning reflective practice for rising senior radiologic science students requires engaging patients, interacting with communities of practice and sharing information for logical reasoning. Next, the processes students use to reflect in clinical practice include learning through simultaneously engaging and reflecting and applying mature practice epistemologies. Furthermore, rising senior radiologic science students learned to negotiate knowledge from classroom and clinical instruction to make informed clinical decisions that included decision enabling resources, assimilating information from

classroom to clinical, the impact of informed clinical decisions via clinical experiences and navigating uncertainty and complexity.

Three conclusions were drawn from the findings. The process of learning to reflect in practice and the application of reflective practice are interrelated learning journeys for students. Further, learning events that promote reflexivity stimulate and deepen learning of clinical reflective practice and its application. Finally, experiences within health care communities of practice sustain, cultivate and structure the development of reflective practice and complex problem solving in students.

How Rising Senior Radiologic Science Students Reflect In Practice: A Narrative Analysis

by
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DEDICATION

This is dedicated to my daughter Parker and son Caidan, for their wit, innocent candor and inspiration throughout this journey. My love to Parker for letting me borrow her definition of courage: Never let my fears stop me. My love to Caidan for understanding that mommy's doctorate is not the same as Dr. Doom.

BIOGRAPHY

Amy Buchanan Orders was born in Raleigh, North Carolina in 1975. She graduated from Freedom High School in Morganton, NC in 1993 and moved back to the triangle to attend UNC Chapel Hill, where she graduated in 1997 with a Bachelor of Science degree in Radiologic Science. Since completing her undergraduate degree, Amy has worked in radiation-related occupations in medical, industrial and academic settings in North Carolina, New York and Texas. She attended NC State University and Midwestern State University, attaining Master's degrees in Health Occupations Education and Radiologic Science, respectively. Additionally, she holds a graduate certificate from UNC Chapel Hill in Emergency Preparedness. With a decade of experience working in regulatory safety at NC State, Amy has become increasingly involved in various professional safety organizations, holding several volunteer leadership positions. She is keenly active in commission work that shapes perspectives of safety culture and regulatory oversight.

In 2008, Amy began her doctoral studies at NC State University. This dissertation is the cross roads of both academic research and subject matter passion. Amy's research interest in reflective practice stems from her enthusiasm to nurture all students' ability to critically question and formulate autonomous, informed decisions. Challenging perceptions in order to truly understand occupational safety in a diverse, academic environment, is the proving ground for this charisma.

Amy currently lives in Apex with her husband, Jason, daughter Parker and son Caidan. Outside of professional endeavors and school, she participates in several civic organizations and volunteers for non-profit events and at her children's schools. In her spare time, Amy loves crafts, cooking, sharing time with family and a healthy, stress-free jog.

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CHAPTER ONE

Introduction

According to the International Council on Medical and Care Compuetics, over two billion radiographs are taken each year in the United States, not including specialty radiography studies or dental x-rays (Bos, Blobel, Marsh, & Carroll, 2008). Further, the National Commission on Radiation Protection and Measurement (2007) reports that the radiation dose per person from medical x-ray examinations has increased over 500 percent over the past 20 years. The increasing demands on healthcare from the US population and the potential for guaranteed health insurance and access to care will substantially increase the number and complexity of radiographic examinations performed each year. Evolving technologies associated with medical imaging allow for increased management of disease processes and the impacts of aging. As access to diagnostic and therapeutic resources increases, more patients undergo treatment and conquer ailments before a critical level is necessary.

With the discovery of x-rays in 1885 by Wilhelm Roentgen, radiographic possibilities evolved from merely scientific interest to a medical lynchpin. By the early twentieth century, radiographic technicians emerged as a specialized profession and The American Association of Radiological Technicians was formed so technicians could share thoughts and information on radiographic techniques (American Society of Radiologic Technologists [ASRT], n.d.). As the profession grew and evolved, so did its scope and application in medicine and holistic care.

“One of medicine's most remarkable achievements is the use of X-rays to see inside the body without having a surgeon wield a scalpel” (U.S. Food and Drug Administration,

2009). The evolution of x-ray equipment has progressed from production of static, individual images to sophisticated, real time imaging of metabolic processes. However, along with the tremendous value of these imaging phenomena, there is a substantial drawback: patients are exposed to radiation in order to achieve the diagnostic and therapeutic value of the procedure. The need exists to build smarter imaging devices, then better educate personnel on newer imaging processes, safety information, to limit unnecessary examinations and minimize repeat radiographs of patients.

Today, radiography is formally defined by the American Society of Radiologic Technologists (2007b) as:

Radiography is the use of x radiation to produce images of objects or anatomical structures. Radiography integrates scientific knowledge and technical skills with effective patient interaction to provide quality patient care and useful diagnostic information. A radiographer performs radiographic procedures and related techniques, producing images for the interpretation by, or at the request of, a licensed independent practitioner. (R2)

The educational curriculum necessary to become a practicing radiologic technologist is referred to as Radiologic Technology or Radiologic Science. Riding the continuing waves of technological advances and emerging technologies, radiologic sciences are leading the way as an evolving, expanding and sought after part of clinical medicine (UNC Ch, n.d.).

In the 2008 annual report published by the Joint Review Committee on Education in Radiologic Technology, 624 domestic radiography programs graduated 12,433 students. While it may seem that the profession is replenished with experientially diversified graduates, only 29 of those 624 programs offered a baccalaureate degree. Moving past the

misnomer that radiologic science students graduate to become technical operatives or button pushers, these radiography students are expected to master a technical knowledge base paired with a host of cognitive and emotional assumptions (Baird, 2008). The demand to produce technically competent, reflective radiologic science graduates will continue to escalate in response to the expanding volume and increasingly sophisticated technological complexities of diagnostic and therapeutic services.

Radiologic science professionals can graduate from several different types of accredited educational programs in radiologic technology: two year certificate programs, two-year associate degree programs, four-year baccalaureate degree programs, specialized training and graduate level degree programs (ASRT, n.d.). Graduates of accredited certificate, two and four-year degree programs in Diagnostic radiologic technology are all eligible to complete the same certification examination and perform the same roles as radiologic technologists in medical settings. These radiologic technologists conduct routine patient care imaging and can pursue additional specialized training in associated imaging modalities, including Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and Mammography (U.S. Bureau of Labor Statistics, 2009).

Additional, graduate level training leads to advanced radiography roles that fall between a radiologic technologist and a radiologist, acting as a radiologist-service extender that help meet increased imaging demands and decreased career pursuit of radiology by physicians. These roles that require prior radiography program graduation and radiography certification are referred to as Radiologist Assistants (RA) and Radiology Practitioner Assistants (RPA).

Other advanced level imaging practitioners hone their expertise in advanced diagnostic or therapeutic modalities and are required to complete additional certification or professional licensure before practicing. These advanced practitioners often function in clinical roles within radiation oncology, nuclear medicine and imaging options (Thomas Jefferson University, n.d.). However, these advanced level practitioners, with their professional certification in radiologic technology, can also practice in routine clinical radiology settings.

Finally, non-clinical graduate level education is available for radiologic technologists interested in extending their scope of practice. Masters level education opportunities are available for focused instruction in administration and education, to naturally transition from practicing radiography to higher levels of professional practice in both clinical and non-clinical settings (Midwestern State University, n.d.).

Radiologic technologists can be found in a variety of health care settings with the majority practicing in hospitals or medical campuses. The diverse practice opportunities include, but are not limited to, ambulatory care settings, urgent care centers, sports medicine facilities, assisted living facilities, skilled nursing facilities, physician offices and dedicated specialty imaging centers. Additionally, the increased portability of devices allows for increased use of shared or contracted resources. Radiologic technologists are often employed as mobile technologists and travel with the equipment to various contracted locations for examinations. This is a key cost-saving practice for many health care facilities that are not able to sustain expensive, specialty equipment onsite.

Since its emergence as a medical foundation, radiography has experienced an identity crisis. Irrespective of the degree program or level of education which radiologic

technologists complete, these individuals struggle to move away from the stigma associated with titles including technician, technical operative or button pusher (Baird, 2008). The role of the radiologic technologist in clinical settings is diverse. This individual must perform the fundamental imaging procedures, however, there are many steps involved in creating a successful radiograph. Radiologic technologists discuss the examination with patients; attain a modicum of patient history that has bearing on the procedure; instruct the patient on the requirements of the exam and the role the patient must play; protect the patient from unnecessary radiation exposure; perform the highly-technical positioning/imaging/processing components of the exam; and maintain respect for both the patient and the multi-disciplinary health care involved in the care cycle.

While the obvious roles of a radiologic technologist are easily identifiable, the understated roles have bearing on the clinical practices as well. This profession administers a drug, in the form of x-rays, with each ionizing radiation procedure performed. As an imaging professional, the radiologic student technologist becomes the patient advocate, educating him or her about judicious imaging practices while protecting him or her from unnecessary radiation. Having a strong core of academic knowledge combined with refined technical skills for determining the utmost patient care, the student technologist can manipulate the imaging factors to minimize the patient exposure while completing the requested task. It is this synergy that culminates in what is eventually defined as reflective practice.

The idea of becoming a critically reflective student has two components: academic growth and intellectual development. Academic growth can be attributed to an increase in a student's knowledge base over a variety of topics. Further, in the progression of

undergraduates, academic growth can be represented through the successful completion of coursework, allowing the student to advance in year classification as well as class ranking. Intellectual development is much broader in its application. As explained by Pascarella and Terenzini (1991), intellectual development or cognitive competencies may also be referred to by terms including, but not limited to, critical thinking (Glaser, 1985; Lipman, 1988) reflective judgment (King & Kitchener, 1994), and conceptual complexity (Harvey, Hunt, & Schroder, 1961; Miller, 1981). This development starts with learning to make meaning, heightening tacit knowledge and advancing learning to the next level with a deep repertoire of thought processes that can be universally applied. Students are expected to discern, as critical thinkers, what passes for useful knowledge.

Reflective practice, according to Schön (1985), is the ability to reflect in a professional manner upon your work or focus. It is a “. . . dialogue of thinking and doing through which I become . . . more skilful” (Schön, 1987, p. 31). Reflective practice is essential to engage both students and practitioners in mindful review of situations and actions. Dobson (2008) summarizes Schön’s work by stating, “to improve, they must not only learn more theory, professionals must also think about the ways they have previously responded to situations, and by engaging theory, develop new ways to respond to similar situations” (p. 3). The transition to a reflective student engages diverse skills in a clinical setting that are first taught in professional school and honed with increased clinical experiences. Students have to successfully define the nature of what they are attempting to solve before a successful endpoint can be reached. Schön (1987) refers to this interactive process as a ‘naming and reframing’ of a problem that allows for application of technical expertise, intuitive insight and reflection.

The challenge is to take ‘off the shelf’ academic knowledge and extend it with reflective, experiential knowledge derived from clinical practice settings as the student progresses through the learning process. Thus, senior level students, having completed their first professional year in the radiologic science program and an intensive, full time clinical internship during the summer semester between first and second professional year, are expected to have attained an advanced level of reflective practice and information integration in order to function semi-autonomously in a variety of clinical settings. To provide technically correct and quality care to patients, it is both necessary and desirable for radiography students to use reflective practices and critical thinking to comprehensively consider the numerous aspects associated with imaging decisions and how to respond in different patient care scenarios. Students should be able to explain why they selected a specific course of action, defend their position and critically examine the experience through inquiry (Baird, 1996).

Problem Statement

At this time, there is little empirical evidence and scholarly literature on radiologic science student application of reflective practice to solve complex problems in clinical settings. Outward indications of reflection and heightened problem solving skills are assessed with pre-determined competencies, mandated by accrediting agencies of radiologic science programs. Exploring rising senior radiologic science students’ reflective practice specifically offers insight into the assumed higher levels of synthesis and application of knowledge that advanced students should have developed.

In select allied health education programs, medical education and nursing education, the scholarly literature is riddled with studies of student reflective practices in clinical

settings, from novice to advanced levels. However, the presentation of information on radiologic science students is sparse and additional studies would provide a body of information on a profession that is critical in health care. In addition, aside from academic requirements and clinical competencies, assessing the ability of a soon-to-be new professional to synthesize and reflect on information in complex environments will have very positive implications for patient care costs, patient radiation exposure and advancing professional practice, including required licensure.

Statement of the Problem

In allied health scholarly literature, specifically radiography literature, a disconnect exists between the relationship of reflective practices and the technical application of knowledge in radiography clinical settings. The process of building an extensive knowledge base from new information and different clinical techniques hinges on students' reflective practices that create meaning for a gamut of situations.

The ultimate goal of this research is to illustrate how clinical decision making in rising senior, or second professional year students, can be impacted by reflective thinking, reflective practice and critical thinking. The findings from this study are meant to bolster the literature that informs reflective practices of radiologic science students.

Purpose of the Study

The purpose of this qualitative study was to explore how rising senior radiologic science students utilize reflective practice to make informed clinical decisions. The specific research questions that guided this study are as follows:

1. How do rising senior radiologic science students learn to reflect in practice?

2. What application do rising senior radiologic science students make of reflective practice in clinical settings?
3. How do rising senior radiologic science students learn to negotiate knowledge from classroom and clinical instruction to make informed clinical decisions?

This descriptive study includes semi-structured interviews, with a focus on critical incident theory. Further, the participants reflect on a significant past event that occurred in a clinical setting to illustrate how their technical knowledge and experiences were integrated in daily practice and decision making.

Conceptual Framework

Instead of rooting this research in a specific conceptual or theoretical framework, it is grounded in the literature. Reflection and reflective practice have been the focus of a wide array of studies, from general education to the increased need of medical/allied health students attaining these skills (Argyris & Schön, 1978; Boud, Keogh, & Walker, 1985; Epstein & Hundert, 2002; Moon 1999; Schön 1983, 1987). Reflection should be a way to sculpt student's development into autonomous, qualified and self-directed professionals. Models of reflection, presented by Schön (1983, 1987), Boud et al. (1985), Mezirow (1991), Dewey (1933), Hatton and Smith (1995), and Moon (1999), riddle the literature and form a foundation for application of theory in academics.

There is a clear gap in the literature exposing the need to study reflective practices of rising senior radiography students. Foundational work by Baird (1996, 2008), Hamilton and Druva (2010), and Kember (2001) began presenting reflective practice as it relates to radiologic science academic programs, however, the investigative depth does not provide supporting information on senior radiologic science students' reflective practice.

Additionally, the literature does not offer any studies on reflective practices of radiologic sciences students in the United States.

Study Significance

By exploring the ways rising senior radiologic science students reflect in practice, this study could provide a number of practical contributions to the literature. This work contributes to the literature on reflective practice, critical thinking and layers of learning, as well as the allied health science literature specific to radiologic science reflective practices. The current literature speaks to reflective practices in communities of practice encompassing medical practitioners, nurses and some allied health professionals, but not in any depth on reflective practices necessary in radiologic science programs. Mamede and Schmidt (2005) reviewed reflective practice in physicians, reviewing the structure in reflective practice in physician activities. Klemola and Norros (1997, 2001) studied the reflective practices of anesthetists during operative situations. Two qualitative studies reviewed, by Gustafsson and Fagerberg (2004) and Teekman (2000), focused on reflection in practicing nurses. Of interest, Teekman's (2000) study reviewed ten non-routine nursing activities for the presence of reflection, specifically the application of reflection for learning and reflection for critical inquiry. According to Mann, Gordon and MacLeod (2007), this is an important difference that could be extrapolated to allied health science professions. Mann et al. (2007) represent Teekman's work in the context of reflective learning leads to basic understanding of the situation and critical inquiry reflection ". . . as going beyond technical proficiency to considerations of context, and its influences on nursing practice and health (p. 601).

This study also has practical significance for program educators in terms of further understanding and valuing reflective practice in student development. It is presumed that

senior level radiologic science students have developed a mature personal epistemology that allows them to actively reflect in complex problem solving scenarios and negotiate advanced technical applications. Through narrative inquiry methods, specifically semi-structured interview evaluations and critical incident analysis, a qualitative study of this assumed level of reflective practice can be explored. Contributions from this study could positively impact further development of instructional strategies to foster continued and/or heightened student success in a technologically challenging profession and to meet accrediting body expectations.

Further, this qualitative study is needed to present an alternate view of the phenomenon of interest, as the modest literature available provides mainly quantitative information, but very little qualitative exploration. This method provides an opportunity to explore the phenomenon of reflective practice for complex problem solving and contribute significantly to the available literature from the student perspective and his or her recall. Employing semi-structured interviews enables a personal aspect to the process, as it engages the participant in discussions of relationships and a specific setting or event, but attempts not to make assumptions about the setting or phenomenon of interest.

Finally, this study has an impact on the future viability of the radiography profession. In order to stay abreast of technical changes, curricula and credentialing expectations and to produce highly effective students, all radiography programs of any level, will have to embrace and incorporate more reflective practices in the academic process. Through educational experiences that can be made more effective by better understanding how students make meaning from reflective practices, radiography students will form better

reflective skills and be acknowledged for both their technical strength and the capacity for innovative and critically reflective actions.

Definition of Terms

Various terms are used in this research that should be defined and their context in this study clarified. The individual terms are as follows, in alphabetical order.

Allied Health Professions. The Association of Schools of Allied Health Professionals (ASAHP) offers this definition:

Allied Health professionals are involved with the delivery of health or related services pertaining to the identification, evaluation and prevention of diseases and disorders; dietary and nutrition services; rehabilitation and health systems management, among others. Allied health professionals, to name a few, include dental hygienists, diagnostic medical sonographers, dietitians, medical technologists, occupational therapists, physical therapists, radiographers, respiratory therapists, and speech language pathologists. (ASAHP, n.d.)

Clinical experience. Radiologic science students participate in clinical rotations that provide practical experience in patient care and health-related services that occur as part of an educational program. Clinical experiences aid in student development of technical skills and procedural understanding of radiography. For the purposes of this research, clinical or clinical rotations will be synonymous with clinical experience.

Communities of practice. Each community of practice exists with three specific elemental components: a domain of knowledge, a community of people who facilitate the domain's existence and a shared practice or repertoire of resources (Wenger, 1998).

Communities of practice for the rising senior radiologic science student exist in two differing

approaches, the clinical environments they participate in during clinical rotations and the professional community of practice for radiologic technologists.

Critical Thinking. Critical thinking is an evaluation process to determine the meaning and significance of events, observations or arguments (Marzano, Brandt, Hughes, Jones, Presseisen, Rankin, & Suhor, 1988).

Epistemology. Epistemology is the study of knowledge or knowing and has been a strong focus of research by twentieth century scholars including John Dewey, William James and Charles Pierce (Schraw, 2001).

Epistemological Beliefs. The nature of knowledge and knowing is further referred to as epistemological beliefs (Hofer & Pintrich, 1997). According to Kuhn (2001), rudimentary epistemological beliefs begin to develop in childhood and progress well into adolescence. This presents a critical time of development and testing of intellectual skills, including inquiry, analysis, and argument, in tandem with developing intellectual values. The sum of these skills should be vetted in situational tests of judgement that are developed to foster a young adult's individual growth (Kuhn & Weinstock, 2002). In recent research, one construct discussed is how epistemological beliefs range from immature, absolutistic beliefs to the notion of sophisticated beliefs that knowledge is complex and tentative (Ryan, 1984; Schommer, 1990).

PACS. PACS is the abbreviation for electronic picture archiving and communication systems. These systems were developed to provide economical storage, rapid retrieval of images, access to images acquired with multiple modalities, and simultaneous access at multiple medical facilities locations (Taber's Cyclopedic Medical Dictionary, 2009).

Personal Epistemology. Personal epistemology adds another level of detail to basic epistemological beliefs, providing insight into beliefs that individuals have about knowledge (Knight & Mattick, 2006). Of interest is how one organizes knowledge and is certain about its 'truth'. According to King and Kitchener (2002), exploration of these personal epistemologies can help determine how students evaluate new information, seek to resolve conflicting information and make fundamental decisions defined by their personal truth. Anderson (1984) contends that family life and formal education shape one's epistemological beliefs. Schommer-Aikens (1994, 2004) proposes that personal epistemology is further influenced by cultural views, learning beliefs, academic performance and self-regulated learning, with reciprocal interaction possible among the factors.

Radiographer. A person who has successfully completed an accredited education program in radiologic technology who is qualified to complete a process of using x-rays to obtain an image for diagnostic evaluation (ASRT, n.d.). To appropriately link the terminology, the professional titles of radiographer, radiologic technician and radiologic technologist inherently perform the same roles in imaging; the variety of titles have resulted from historical changes in the profession, professional role development and educational expectations to perform specific tasks. For the purposes of this research, the term radiologic technologist will be used.

Senior. A senior is popularly defined as a fourth year undergraduate student in a college or university. Additionally, senior can be defined as relating to, or designating more advanced or older students. For the purposes of this research, rising senior student will be synonymous with students entering their second professional year of the baccalaureate radiologic science program.

Zone of proximal development. Published by Vgotsky in 1978, it is defined as, “the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers” (p. 86).

CHAPTER TWO

Literature Review

The intent of this study was to explore how rising senior radiologic science students reflect in action in order to negotiate complex problems in a clinical setting. This exploration employed a constructivist theoretical framework, seeking to learn from the experiences students' encounter, interaction with others and the environment in which they are situated. To establish the foundation for this research, key areas in scholarly literature and research were reviewed: theories of epistemological development, reflection and reflective practice models, reflective practice in allied health, and communities of practice. Presented next in this chapter is a review of the existing literature and empirical studies associated with this topic.

The exploration of this topic began with literature searches between the years of 1995 and 2010. A review of electronic databases searched for existing research and empirical studies related to reflective practices and complex problem solving skills of radiologic science students. The first research attempt included search strings with the words radiologic science, reflective practice, complex problem solving and evolved to include much more specific terms, like reflection in action, reflection on action, critical thinking, personal epistemology, clinical competency and student development. These search strings were used in a variety of online scholarly databases via the North Carolina State University library hosting site. Table 1 details the databases searched and their descriptions.

Next, specific journal databases, relevant to radiologic science and allied health science were explored, including the American Society of Radiologic Technologists, the

Radiological Society of North America and the Health Physics Society. Finally, library searches of hardcopy resources were conducted, specifically searching for books on relevant topics, to supplement other resources already referenced. Of note, no date range was imposed for books and seminal works in the fields of education, allied health sciences and radiologic science.

Table 1

Electronic Databases used in literature search

Name of Database	Description of Database/Contents
ERIC	Education resources information center
Google Scholar	Internet based resource for articles, conference proceedings, presentations, technical reports, electronic books and book previews, public access
JSORT	Humanities and social science Articles, public access
Medline	Medicine, health and human science resources, public search with preview capability
Proquest	Electronic thesis and dissertations, public access
PubMed	Biomedical literature and life science journals with over 19 million citations, public access
Scirus	Internet based science resources, subscription based
Summons Beta	Scholarly articles, books, e-books, conference proceedings, newspapers, password secured

The culmination of this research yielded no empirical studies or foundational works on how senior radiologic science students reflect in practice to negotiate complex problems. The scholarly literature on undergraduate radiologic science student reflective practice, either

in a classroom or clinical setting, is extremely limited. It is understood there is a certain level of reflection that occurs as students marry their formal knowledge base to clinical practice, however, the details on how and to what level this occurs is not present in the literature. Research of this nature is particularly salient to the problem addressed by this study due to the acknowledged regulatory oversight and potential negative impact of radiation exposure to patients, as identified by federal and state regulatory agencies.

Nonetheless, despite the lack of research that addresses the specifics of this topic, there is a multitude of information available on medical, nursing, anesthesia and generalized allied health students and practitioner development of reflective practices. The information in these studies is applicable and can be extrapolated to the contexts of student technologist maturity in radiologic sciences.

In reviewing the various studies and the applicable literature, students build reflective practice skills and critical thinking abilities as they progress through academic coursework and clinical experiences. Second professional year radiologic science students, following their summer internship, have been socialized to a variety of clinical environments and constructs of clinical expectations in general (Richardson, 1999). Titchen and McGinley (2004) find that the construction of clinical expertise that leads to the ability to reflect in practice in radiologic science students is the blending of self-knowledge, intellectual, emotional and personal maturity with one's evolving technical knowledge base. It is the reality through the experience of clinical practice that solidifies significance and meaning of academic topics, including knowledge, theory, reasoning and technical skills (Higgs, Andresen, & Fish, 2004). Making the analogy of novice to expert as first professional year is to second professional year, Daley (1999), Sim (2006) and Richardson (1999) contend that

novice students may not feel comfortable making meaning of their professional role in clinical practice and rely on both clinical supervisors and methodical patterns of practice as role models. It is through practice and experience that students mature and develop their skill sets, self-confidence and ability to synthesize information in action.

Review of empirical research and scholarly publications promoted the idea of developing meaning via constructivist theory, defined for this purpose as students reflecting on experiences to construct understanding and reflection is dependent on the context in which learning occurs and the promotion of developing reflective student abilities. The constructivist learner uses “an active process in which (he or she)... constructs knowledge in a way that makes personal sense” (Tippins, Tobin, & Hook, 1993, p. 223). Learners always present with pre-existing knowledge, acquired from past experiences; they continue to build new knowledge and construct meaning on this existing knowledge. A constructivist context imposed upon radiologic science education offers students engaging learning opportunities that seek to challenge their personal epistemology and understandings. Although undergraduate students may have a limited experience-based knowledge, building new knowledge on existing knowledge fosters “enhanced self-direction in learning and meta-cognitive development (while it) empowers students with problem-solving, reflecting, and evaluating skills” (Cust, 1995).

Constructivists view students with a pre-existing set of beliefs, values, assumptions and understandings, which exist in the echelons of correct, partially correct and incorrect. However, the student must view learning through these lenses, determine personal understanding and discern what is worthy of becoming knowledge. This meaning is a form of assimilation of information, the linkage that is developed between new information to

existing belief systems in order to formulate applicable import from the learning experience. This dovetails with the views of constructivist learning, where the student is the center of learning and the teacher or clinical supervisor is relegated to a coaching role. Active participation in his or her learning process centers the student for personal epistemological development and deeper levels of information retention.

This study of rising senior radiologic science students adds to the literature by offering an in-depth exploration of how experiences in the clinical environment help develop necessary reflective practice and critical thinking skills for students to function adeptly and safely in patient care settings. To this end, it was important to review literature that addressed the components that shape student reflective practice. Review of the literature is divided into three sections. Section one provides an overview of the literature on epistemological development of students in higher education, moving to specifically address personal and student epistemological development necessary for developing practice epistemologies that are essential to honing reflective practice. In the second section, a review of reflection, models of reflection and reflective practice is presented, to better understand the various components of reflection that students must employ. Section three addresses communities of practice that exist for radiologic science students and how these communities of practice impact student learning and reflective abilities to address ill-defined, complex clinical situations.

Epistemological Development

The epistemology literature was examined with attention to student, personal and practice epistemologies and theories, as well as critical thinking skills and layers of learning that are necessary for development of complete technical competence and reflection. In the

following sections, the development of different epistemologies is addressed via review of historical contexts, models and theories. Critical thinking and layers of learning are described as components of successful tacit knowledge development and epistemological influence. Of ultimate interest is the role of different and developing epistemologies on the application of student reflective practice abilities.

To fully engage the literature and a holistic context of epistemological development, it is appropriate to acknowledge that not all students develop a mature epistemology. College students are assumed to develop a stronger epistemological understanding and perspective with increased education and life experience (Kegan, 1994). However, there is a concern that epistemological development does not manifest to the expected level in some baccalaureate students and acts as an inhibitor to building effective, long-term reflective practice.

Student epistemologies. College education is intended to advance the knowledge base of students who seek to attain a degree as well as a job at the end of the education process. An expectation of higher education is to transition students from a didactic learning expectation into individuals who can function with ill-defined problems or situations using their personal cadre of prior knowledge and skills to craft significance of the information (King, 2000). The notion is to build a skill set that facilitates success in complex, real-world applications.

The information that is taught in the classroom is modified or enhanced by the real-life experiences and life events that students encounter outside the formal walls of academia (Tatum, Calhoun, Brown, & Ayvazian, 2000). As supported in their longitudinal review of post-secondary education reports, Flowers, Osterlind, Pascarella, and Pierson (2001) remark

the majority of these studies illustrated “statistically significant and sometimes sizable indications of growth or change” (p. 565) in student knowledge and cognitive development.

Current undergraduate students exist in a dynamic society of heightened expectations for new graduates. The problems in today’s world are more complex, with heightened expectations for quick success. The idea of information transmission from a teacher or point of authority to the student for memorization and regurgitation is a disservice to the learner. According to Baxter-Magolda (2001), complexities of the 21st century make it imperative for students to experience transformation from “reliance on authority to complex ways of making meaning in which they are able to integrate multiple perspectives and make informed judgments” (p.24). Students need the opportunity to expand their scope of knowledge through reflection, analysis, discourse and synthesis to determine the possible outcomes with the idea that there may not merely be one correct answer.

According to Robert Kegan (1994), a noted scholar on conceptual and interpersonal development, academic programs must hone students’ conceptual and interpersonal development in order for those individuals to meet the dynamic and complex mental demands of modern life. Students will progress from immature individuals to mature participants through the progression of their higher education (Kegan, 1982). It is the concept of globalization, or the ability to contextualize a situation in a larger frame, that students learn to do (Kegan, 1994). The incorporation of life experiences into a holistic teaching approach grounds the information globalization in reality, promoting student’s maturation and enhancement of their academic skills. Kegan supports this concept by stating that students should be able to “. . . identify their inner motivations, hold onto emotional

conflict internally, be psychologically self-reflective, and have a capacity for insight” (Kegan, 1994, p. 27).

Personal epistemological development. At the beginning of undergraduate studies, students present with a focal spectrum of knowledge and their current beliefs on learning, with pre-conceived notions of coursework and how to function as an independent learner (Nelson, Kift, Humphreys, & Harper, 2006). Advancing through college is a time of unprecedented change for student epistemology, developing into instead a personal epistemology that espouses their personal beliefs about knowing or knowledge (Brownlee, Walker, Lennox, Exley, & Pearce, 2009). Most theories of personal epistemology acknowledge development from naive to mature, sophisticated beliefs (Hofer & Pintrich, 1997). Both Perry (1981) and Belenky, Clinchy, Goldberger and Tarule (1986) contend that individuals with more honed epistemological beliefs are more likely to engage in personal reflection and analysis of their understandings and knowledge application. Further, the use of this developed, yet undergraduate level personal epistemology framed in the context of allied health sciences is intended to be translated into practice epistemological development when paired with reflective practice.

Practice epistemology. The notion of practice epistemology evolves from epistemology, or the understood origins, nature, methods and limit of human knowledge, to include the nature of knowledge and generating knowledge in a particular practice (Higgs, Richardson, & Dahlgren, 2004). Embedded innately in the academic growth, development of clinical skill sets and maturation of reflective practices becomes the need to understand and appreciate the diversity and scope of practice epistemologies encountered in clinical settings. As presented by Higgs, Richardson and Dahlgren (2004):

An understanding of their practice epistemology can have a significant impact upon the capacity of professionals to reflect on the ways they recognize and respond to the changing demands of health care. . . . A practical understanding of the multiple epistemological perspectives intrinsic to health . . . care work settings is important to break down the professional boundary barriers of health care which can lead to collaborative advanced thinking and knowledge production . . . much of the success of this mutual understanding is contingent upon education programs and the professional socialization of undergraduate and postgraduate health care students, whether as clinicians, educators or researchers. (p.12)

It is the evolution from a personal epistemology to a student epistemology then culminating in a practice epistemology that defines the levels of maturation that students progress thru as an undergraduate framed specifically in the health sciences. For the purposes of this study, the notion of practice within developing practice epistemologies was rooted in the context of radiologic science clinical practices.

Layers of learning. Understanding how students in higher education internalize knowledge is critical when developing strategies used to improve teaching and student learning. From this researcher's perspective, although understanding the detail of personal epistemological development is essential, the synergistic component necessary to ingest tacit knowledge and synthesize practice information is the internalization of information from surface recall to engrained foundational knowledge. Both the characteristics of the learner and use of specific instructional strategies must be considered in order to achieve optimal student learning, especially for contextual use in clinical applications. In the learning process, students learn by engaging prior knowledge, personal epistemology and values and

abilities, and teaching factors, including teaching methodology, assessment and the learning environment, play powerful roles in instilling information in students (Entwistle & Ramsden, 1983). According to researchers Biggs (1979), Entwistle (1981), Marton and Saljo (1976), the entwinement of learner and teaching characteristics leads to three learning approaches, referred to as surface, strategic and deep.

Surface learning. Many intellectually immature college students have expectations of superficial learning upon starting classes. The instructor acts as the content expert and delivers the information via a classroom conduit to the receiving student in the form of didactic or transmission learning for memorization and regurgitation on assignments and exams. Having only a surface grasp of knowledge via memorization, students are not able to grasp the layers of details and intricate nuances of meaning (Healey, 2006). These students are then ignorant of true knowledge, lack the insight to craft new understandings and connections and often fail to actively engage in the learning process to the expected level.

Strategic learning. Strategic learning is characterized by student activities and interest in the context of the activity, not the nature of activity (Healey, 2006). These individuals have pre-determined the path needed for success and are highly competitive in their pursuit of the end goal. Ultimately, strategic approaches utilize either surface or deep approaches to learning, based on the individual's belief of which approach will culminate in a successful completion (Healey, 2006).

Deep learning. Finally, deep approaches to learning are the lifelong approaches, the foundations that shape a person's skill set for long term knowledge recall and application. Individuals embracing deep learning seek greater understanding of the components, analyze information for depth and blend information to create a 'whole' picture. It is the perspective

of several scholarly researchers (Entwistle, 1981; Marton & Saljo, 1976; Mattick, Dennis, & Bligh, 2004; Snelgrove & Slater, 2003) that deep learning leads to higher levels of academic success in student learning, while surface and strategic learning approaches culminate in minimizing their long-term potential and hopes of coupling knowledge and reflective practice into the development of a reflective practitioner.

It is appropriate to wax philosophical and contend that deep learning translates into a form of reflection and is directly linked to a developed epistemology. Reflection is believed to be an influential factor in the transformation of surface knowledge into deep knowledge and its heightened expectation to positively affect clinical practices (Lockyer, Gondocz, & Thivierge, 2004; Moon, 1999). Moon (1999) specifically embeds reflection in a student's learning process, promoting the transition of knowledge from surface to deep with deep knowledge enabling the integration of knowledge into one's cognitive framework. Lockyer et al. (2004) posit that reflection could be incorporated in learning practices via portfolios and journaling, promotion of personal learning projects and critical incident analysis of events in the clinical settings. It is the use of critical incident analysis that could provide great insight into student's clinical learning scenarios, from the perspective of addressing an ill-structured problem via complex problem solving and reflection.

Marton and Salijo (1976) conducted research studies of students in Sweden, focusing on student approaches to learning. The study explored how groups of college students read an article and perform on content examination. Two outcomes were determined from the research. First, students who sought to understand the content of the article examined the evidence in light of the conclusions, made new meaning from the article and linked the new understanding to personal experience and prior knowledge, achieving a deep layer of

learning. Second, students who read and memorized factual content only and merely highlighted points in the article only achieved a surface layer of learning.

In other studies by Biggs (1979) and Entwistle (1981), the researchers sought to discern deep versus surface student learning approaches of via quantitative means. Exploring several thousand higher education studies, Biggs and Entwistle each categorized the approaches into three categories, 1) utilizing, 2) internalizing and 3) achieving and reproducing meaning and achieving, respectively. Of interest, considering the studies occurred in different countries and independently by different researchers, similarities emerged and are characterized by their different motivators, processes and learning outcomes, summarized in Table 2.

Programs that address critical reasoning and evidence-based medicine have been widely emphasized in the literature (Fraser & Greenhalgh, 2001; Frey, Edwards, Altman, Spahr & Gorman, 2003; Hatala, 1999; Tonelli, 1998). Whereas these programs promote student's capability to critically examine grounds for one's own hypotheses and management of problems, they do not speak to true reflection as a part of this deep learning process (Mamede & Schmidt, 2005). In advanced levels of clinical applications, the student practitioner must use deep layers of learning, as well as critical thinking to amalgamate intuition, reflection, creativity and lateral thinking to design, employ and review professional knowledge (Higgs, Richardson, & Dahlgren, 2004).

Critical thinking. Critical thinking is an evaluation process to determine the meaning and significance of events, observations or arguments (Marzano, Brandt, Hughes, Jones, Presseisen, Rankin, & Suhor, 1988). Scriven and Paul's (1987) definition comprehensively

Table 2

Differences in Motivation, Study Processes and Learning Outcome in Surface, Strategic and Deep Learning Approaches

Learning Approach	Motivation	Process	Outcome
Surface	Completion of Course Extrinsic fear of failure	Rote learning of facts, figures, ideas Focus on discrete task components Limited content interest	Incomplete Understanding Superficial retention
Strategic	To achieve high grades To remain competitive To be successful	Achieve high grades via effective techniques Incomplete and variable understanding	High grades with or without understanding
Deep	Interest in content Vocational relevance Intrinsic, personal understanding	Relates ideas to evidence Inter-course material integration Identify general principles	Deep level of understanding and incorporation

Note. Adapted from “Clinical experience, performance in final exams and learning styles in medical students: Prospective study” by I.C. McManus, B.C. Winder and K.A. Sproston, 1998, *British Medical Journal*, 316, 345-350.

relates to the research question at hand:

Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning or communication, as a guide to belief and action. In its exemplary form, it is based on universal intellectual values that transcend subject matter divisions: clarity,

accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness. It entails proficiency in the examination of those structures or elements of thought implicit in all reasoning leading to conclusions, implications and consequences, objections from alternative viewpoints and frames of reference.

(p. 1)

Halpern (1989) mirrors that definition by espousing the necessity that critical thinking is required in problem solving.

McPeck (1983) offers this similar view, defining critical thinking as co-existing with questioning:

Critical thinking involves a certain skepticism, or suspension of assent towards a given statement, established norm, or mode of doing things. This skepticism might ultimately give way to acceptance, but it does not take truth for granted. Instead, it considers alternative hypotheses and possibilities. (p. 6)

This consideration of alternative hypotheses and possibilities is foundational in reflective practice and the development of practice epistemologies that question and study evidence and circumstances in order to make informed clinical decisions.

Although there are litanies of definitions in the literature for critical thinking, there are fundamental concepts aligning the various definitions including, but not limited to, reflection, alternatives, knowledge, interpretation, and problem solving. Broadest in its approach and application to critical thinking is Watson and Glaser's (1991) Critical Thinking Appraisal (CTA), enumerating five abilities necessary for translation to critical thinking: inference, recognition of assumptions, deduction, interpretation and argument evaluation. According to King (2000), many students identified college as the place that taught them

how to think and provided the introduction to the five aforementioned abilities. Scholarly research by cognitive psychologists and researchers in higher education (Hofer & Pintrich, 1997; Pascarella & Terenzini, 1991; Tsui, 1999) herald this concept in published research that supports positive student growth in critical thinking that indeed occurred during college.

Summary. This section began with a review of the literature on epistemological development in students with pertinent information on how and why developing epistemologies and critical thinking skills impact student learning and growth. An association between students' deep learning approach and successful academic and clinical experiences were discussed, with the recommendation of fostering deep learning habits in students.

According to the research, academic environments need to incorporate strategies to instill and promote deep learning approaches in all student experiences-both formal and informal. The American Society of Radiologic Technologists (2007a, b), which predicates the curricula of academic radiography programs, has expressed a heightened need for critical thinking development in students. With the advanced technology and the potential radiation exposure associated with sophisticated imaging modalities, judicious and competent independent judgment must be honed in students before they enter the practice environment. The following section introduces the context of reflection and reflective practices in developing student skill sets, as a necessary skill to be used in conjunction with critical thinking as components of sound clinical practice.

Reflection and Reflective Practice

As articulated in the previous sections, there is increasing evidence that student decisions and judgments are greatly intertwined with their perspective of a situation, which

evinces their epistemological stance. To continue the discussion, the rhetorical question of “What do I need to do” is how the student approaches his or her role in a situation, gauges the factors involved and reflects in a form of self-evaluation.

Reflection. One of the core functions of reflection is “validating what is known” (Mezirow, 1990a, p.11) and this validation provides the basis for an effective healthcare practice (Young, 2002). According to Dewey (1933), reflecting upon learning experiences is a continuous cycle, vacillating between reflection on experience and the learning or new meaning making that occurs. Boud, Keogh and Walker (1985) illustrate the link between reflection and experience by defining it as a form of response to the learner’s experiences and therefore it is an intentional activity (Boud et al., 1985). Further, Kolb’s (1984) experiential learning model also delineates experience as a key phase of learning, included with reflection, generalizing and planning.

There is extensive research and a range of definitions addressing reflection in the scholarly resources. For this purpose, the researcher focused on the works of Dewey, Boud and Schön to define reflection in the context of reflective activities and how it meshes into professional clinical practice. In Dewey’s (1933) work, he articulates reflection as “active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusion to which it tends” (p. 9). This reference is important as it aligns to premises embedded in critical thinking illustrated in this research. Next, Boud, Keogh and Walker (1985) define reflection as “a generic term for those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to a new understanding and appreciation” (p. 19). Boud et al. importantly describe the affective component of learning as an elemental part of reflection,

since emotions, both positive and negative, can impact learning and reflection. Finally, Schön (1983) is credited with coining “reflective practitioner” as a professional who uses reflection as a learning tool, both of past and present experiences and to frame ill-constructed, complex professional practice problems.

Types and levels of reflection. Akin to the idea of layers of learning, three layers or classifications of reflection exist. Lower level reflection refers to reflection on technical information (van Manen, 1997). Mid-level reflection focuses on validating presuppositions, while high-level reflection addresses reflecting on moral, ethical and political issues (van Manen, 1997). In similar context, research by Mezirow (1991) presents the reflective levels as content reflection (low-level), process reflection (mid-level) and premise reflection (high-level).

Wong, Kember, Chung and Yan (1995) further classify learners as non-reflective, reflective and critically reflective. At the foundational level, non-reflectors describe learning events through content reflection and descriptions with no reflection thinking. Reflectors experience Mezirow’s (1990b) process reflection and critical reflectors change in perspective or epistemological stance in response to premise reflection (Wong et al., 1995).

Models of reflection. The concept of reflection is further illustrated in specific models of reflection, or how various scholars have outlined the actions associated with reflection. Mann, Gordon and MacLeod (2007) present a compilation of models of reflection, based on the works of Schön (1983, 1987), Boud et al. (1985), Mezirow (1991), Dewey (1933), Hatton and Smith (1995), and Moon (1999). These models are divided into two categories based on the learning process: iterative and vertical. The iterative dimension of reflection is based on an experience triggering reflection and produces a new

understanding of a situation that will be used in future decision making (Mann et al., 2007). The vertical dimension incorporates levels of reflection, from surface to deep. Surface reflection is characterized by more description and less analysis and integration of information. Deeper models are more difficult to attain and thus are not reached often. A compilation of these models is found in Table 3, as referenced by Mann, Gordon and MacLeod (2007).

Table 3

Models of reflection and reflective practice as (a) iterative dimension (b) vertical dimension

(a) Iterative dimension	Actions associated with reflection
Schön (1983, 1987)	1. Knowing-in-action, 2. Surprise, 3. Reflection-in-action, 4. Experimentation, 5. Reflection-on-action
Boud, Keogh, Walker (1985)	1. Returning to experience, 2. Attending to feelings, 3. Reevaluation of experience, 4. Outcome/Resolution
(b) Vertical dimensions	Actions associated with reflection
Dewey (1933)	1. Content and process reflection, 2. Premise reflection/critical reflection
Mezirow (1991)	1. Habitual action, 2. Thoughtful action/Understanding, 3. Reflection, 4. Critical reflection
Boud et al. (1985)	1. Association, 2. Integration, 3. Validation 4. Appropriation
Hatton and Smith (1995)	1. Description, 2. Descriptive reflection, 3. Dialogic reflection, 4. Critical reflection
Moon (1999)	1. Noticing, 2. Making sense, 3. Making meaning, 4. Working with meaning, 5. Transformative learning

It is necessary to consider reflective models in the context of clinical situations. Problems encountered in clinical environments are often unpredictable and complex, thus forcing students, as well as practitioners, to reflect in action and on action and draw upon tacit knowledge to derive a solution to a non-standard problem (Sim, 2006). What Schön highlights in his work is that reflection is a means of learning and achieving clinical competency, helping develop the kind of knowledge that informs students on necessary workplace practices.

Reflective practice. Since reflection provides the necessary link between different learning experiences, helping to make sense of learning and experiences, then reflective practice could be defined as the act of engaging in reflection (Ghaye & Lillyman, 2000). In John Dewey's writing, he differentiates reflective action from routine action. In Dewey's 1933 work, *How We Think*, the following definition is given:

Reflective action entails active, persistent and careful consideration of any belief or supposed form of knowledge in light of the grounds that support it and the consequences to which it leads. Routine action is guided primarily by tradition, external authority or circumstance. (p. 9)

John Dewey is recognized with demonstrating the need for individual, self-evaluation.

Aligning with Dewey's theories, reflective practice according to Schön (1985) is the ability to reflect in a professional manner upon your work or focus. It is a ". . . dialogue of thinking and doing through which I become . . . more skilful" (Schön, 1987, p. 31). Dobson (2008) summarizes Schön's work by stating, "to improve, they must not only learn more theory, professionals must also think about the ways they have previously responded to situations, and by engaging theory, develop new ways to respond to similar situations" (p. 3).

Schön (1983) refers to reflective practice in his work as a practitioner's "reflection conversation" with a specific situation (p. 132). In addition, he described it as "the artful inquiry by which [practitioners] sometimes deal with situations of uncertainty, instability and uniqueness" (1983, p. 268). Schön (1983) contended that engaging in reflective practice is often triggered by a situational surprise or extreme uniqueness of the event. For novice student practitioners, it can be inferred that reflective practice is present in all clinical settings, as the situations, events, procedures, environments and technology are all novel and intriguing. Conversely, a seasoned professional would "... respond to the complexity, which confuses the student, in what seems like a simple spontaneous way" (Schön, 1983, p. 130).

Dewey's work on reflective practice is thoughtfully mirrored with the scholarly works of Schön. Where Dewey's work relies on deliberate and retrospective reflection, Schön, as discussed by Kinsella (2009) depicts a "... temporality of various types of reflection and the tacit improvisational possibilities within reflection" (p. 7). Here, reflective practice in Schön's work diverges into two areas, reflection in action and reflection on action.

Reflection in action. Reflection in action specifically, is the type of reflection that occurs while a problem is being studied, in what Schön (1985) calls the 'action-present'. It is a response to a surprise – where the expected outcome is outside of our knowing in-action. At a minimum, the reflective process is conscious, but may not be verbalized or materialized while in progress. Reflection-in-action is about challenging understood assumptions because knowing-in-action forms the basis of assumption (Schön, 1985). It pertains to assessing an encountered problem from a new angle with student's personal knowledge, assumptions and synthesis in use to derive possible solutions. Schön states (1987),

Doing and thinking are complementary. Doing extends thinking in the tests, moves and probes of experimental action, and reflection feeds on doing and its results. Each feeds the other, and each sets boundaries for the other. It is the surprising result of action that triggers reflection, and it is the production of a satisfactory move that brings reflection temporarily to a close. (p. 280)

Schön's (1983) work also depicts the movement of professional practice from the technical rationality theory to reflection in action, explaining in the context of a seasoned professional, how he or she became aware of his or her reactions to complex professional episodes. Referred to as knowing in action, these professionals expressed an inherent 'knowing' via non-rational explanations including, "I just knew. . ." or "It just felt right" (Schön, 1983, p. 54). One can infer that this knowing was an extension of established technical knowledge and experience gained in practice, correlating to intrinsic constructivist aspects of learning.

Reflection in action – practice constants. Within Schön's work is the concept of practice constants. These constants are defined as the attributes that a practitioner brings to the reflection in action process and Schön outlines four of them (1983). The first constant is referred to as language, or the media in which communication is completed during the reflective process. Second are appreciative systems, or the idea of characteristics that define a reflective situation. The third constant is overarching theories, or the high level belief systems or themes that inform the reflective process and help define the reflective descriptions and interpretations. Lastly, the fourth constant is role frames or the definitions of roles and boundaries. Together, these constants influence the reflective practices of the student and practitioner that are first based on personal epistemology, then on the situation and these constants. Table 4 further defines these constants.

Table 4

Schön's (1983) Constants

Language	The use and management of media and languages
Appreciative Systems	Used to frame problem and are adjusted during the problem solving process as needed
Overarching Theories	High level, constant definitions and values that inform a situation
Role Frames	Scope of practice limits, bound by experience and institutional context.

Reflection on action. As a second construct, Schön offers reflection on action as a separate area of reflection- a retrospective type of review. Also referenced in the “stop and think” construct by Hannah Arendt (1971), this reflective action posits the idea of stopping while in the process of acting to assess or construct meaning from a situation (Schön, 1992). This notion warrants meaningful consideration following a situation and asks rhetorically, first, would it have been safe to stop and think and second, would this assessment have made a difference in the actions rendered? The gravity of a clinical situation may not allow for this methodical review, however, this process is engrained with learned clinical skills. Further, reflection on practice actions may not be necessary in routine clinical situations, but may be a quality improvement tool for non-routine, complex problems in order to reason, synthesize and extrapolate data to make an improved, informed decision (Mamede & Schmidt, 2005).

Of clinical relevance and application, the modern practitioner needs to connect different modes of reflection to the development and use of practice knowledge. According to Higgs, Richardson and Dahlgren (2004), meta-cognition is used to critique clinical reasoning and the appropriate “. . . choice, use and soundness of knowledge being applied to

the clinical problem” (p. 11). Peer reflection, as another component, presents an autonomous perspective to identify possible growth areas or emerging ideas that benefit the practitioner. In review of practice, reflection on action offers insight into applied clinical decisions made and possible learning goals that were achieved (Higgs et al., 2004).

Personal reflection. The process of reflective practice, inclusive of reflection in action and reflection on action, are guided by personal codes and influenced by personal epistemologies. Reflective practice cannot occur objectively, but is guided by a ‘code’ of personal conduct and reflection. According to Aukes, Geertsman, Cohen-Schotanus, Zwierstra and Slaets (2007), personal reflection in medical practice education is viewed “ . . . as the exploration and appraisal of one’s own and other’s experiences, thus clarifying and creating meaning, for the benefit of balanced functioning, learning and development” (p. 178).

Reflection, especially personal reflection on experience, is seen as a key factor for acquiring and maintaining balanced professionalism along the continuum of medical education (Irvine, 1999; Simpson et al., 2002). Applied to broader health professions, this reflection is needed for a malleable professional to respond to the patients’ needs or to new circumstances when there are no obvious solutions and there is a need to engrain the new knowledge for future use. This incorporates the new information into practice as well as into life-long personal and professional growth (Aukes et al., 2007).

Practice wisdom. In tandem with reflective practices and layers of learning is the premise of practice wisdom. Referring back to the work of Schön (1991) and the “messy” practices of real-world settings, professional knowledge is integral to making professional judgments in complicated situations where no one answer or ‘ah-ha’ exists (p. 16). Practice

wisdom refers to a person's ability to generate, use and critique a range of different knowledge forms at high skill levels (Higgs, Richardson, & Dahlgren, 2004). It is generated from experience, when cognitive and meta-cognitive processes are married in clinical reasoning, professional judgment and affective processes that culminate in "cultural competence" (Engle, 2001, p. 17). This forms the basis for professional knowledge and skill set application in clinical practice situations.

Reflective Practice in Allied Health

Reflection and reflective practice have been the focus of a wide range of studies, from general education to the increased expectation of medical and allied health students mastering these skills (Argyris & Schön, 1978; Boud, Keogh, & Walker, 1985; Epstein & Hundert, 2002; Moon 1999; Schön 1983, 1987). Models of reflection presented by Schön (1983, 1987), Boud et al. (1985), Mezirow (1991), Dewey (1933), Hatton and Smith (1995), and Moon (1999), form a foundation for application of theory and are summarized in Table 2. The increasingly complex and dynamic expectations of allied health practitioners have conveyed the demand for highly skilled students, forcing educators to incorporate varied instructional strategies in their educational approaches in order to mature reflective practice abilities in students.

Students are expected to demonstrate effective and efficient critical thinking skills in order to synthesize a diverse and large amount of information to ultimately address a gamut of clinical situations. The application of reflective practice in allied health degree programs and professional practice is presented now in formal requirements for practitioners to provide evidence of reflective practice as part of licensing and revalidation processes (Baird, 1996;

Catto, 2005; College of Family Physicians of Canada, 2007; General Medical Council, 2005).

According to the curriculum guide for radiography programs by the American Society of Radiologic Technologists (2007), academic programs must foster opportunities to develop skill sets that facilitate success for imaging professionals throughout their careers. Highly espoused curriculum tenets include self-reflection and critical thinking, which are deemed necessary and formidable staff resources in an occupation that constantly faces rapid, dynamic demands of emerging technological advances and the need to counter worker obsolesces (ASRT, 2007). If future graduates are expected to manipulate, compare and discern sources of information and make decisions based on acquisition of new information, then that future technologist-now an advanced radiography student, must be considered intellectually developed (ASRT, 2007). Intellectual development, otherwise referred to as critical thinking (Glaser, 1985), reflective judgment (King & Kitchener, 1994) and conceptual complexity (Harvey, Hunt, & Schroder, 1961; Miller, 1981), must enable students to frame patient care decisions beyond the context of obvious patient evidence and foster their confidence to judiciously act after intellectually discerning the circumstances and appropriate actions.

Application of reflection. The reflective process begins with the individual contributors, who must apply their knowledge and actions to the larger, more holistic approach of clinical care. Reflection, albeit seemingly an individual art or practice, has merit being employed in a group setting (Higgs, Richardson, & Dahlgren, 2004), as peer collaboration has been alleged to improve student clinical reasoning skills and in essence, their capacity for deep learning (Healey, 2006).

It is the notion that including learners and inviting their contributions demonstrates that reflection can be both a collaborative and an individual experience (Mann, Gordon, & MacLeod, 2007). Take the concept of inter-professional teams:

. . . A group of people from different professional backgrounds who deliver services and coordinate care programs in order to achieve different and often disparate service user needs. Goals are set collaboratively through consensual decision making and result in an individualized care plan which may be delivered by one or two team members. This level of collaborative practice maximizes the value of shared expertise and minimizes the barriers of professional autonomy. (Curran, 2008, p. 3)

This experience with collaborative reflection becomes an important indoctrination tool in the preparation of individual practitioners for participation on inter-professional teams.

Practitioners need to understand what their profession offers to the health care continuum in order to fully cooperate with other professions in an inter-professional team. Further, collaboration and group thinking then incorporates the cognitive approaches and values underlying the decisions of other practitioners on the team that advocate for the best possible patient care (Clark, 2004).

Reflective practitioner. The modern perception of a reflective practitioner is one who reflects on present evidence, determines professional knowledge and practice wisdom and retains practice-generated knowledge (Dahlgren, Richardson, & Kalman, 2004).

Undergraduate academic programs that prepare students for participation in evolving health care environments must bolster a curricula that fosters flexibility, understanding and reflective processes to mold students (Dahlgren et al., 2004). Students must be flexible in their practice to meet the dynamic needs of both practice and contexts of care (Kember, Kam

Yeut Wong, & Yeung, 2001). Thus, the reflective practitioner must develop a constant attentiveness and critical position towards unique situations (Dahlgren, Richardson, & Kalman, 2004). As Clouder (2000) states, reflection is arguably one of the best coping strategies to handle the deluge of demands in health care settings and is not an end in itself but rather a means to an end.

Understanding how students in higher education reflect in practice is crucial to the development of a well-rounded health care practitioner, whether in medicine, nursing or allied health sciences. Mamade and Schmidt (2004, 2005) studied 202 Brazilian physicians, to determine how these practitioners reflected in action to specifically address complex problems in their patient encounters. The conclusions reached by the authors were two-fold: first, the greater the number of years in practice, the less reflective practice the physician engaged in during patient appointments and second, less reflective practice occurred in clinical settings that did not reinforce a scientific foundation to clinical practice (Mamade & Schmidt, 2005).

A study by Pinsky, Monson and Irby (1998) reviewed the reflective practices of clinical instructors in medicine. A survey of 48 clinical instructors focused on how reflection was used to develop professional instructional skills. The researchers identified three phases of instructor reflection: anticipatory reflection, reflection in action and reflection on action. Anticipatory reflection, reportedly used by 86% of the surveyed instructors, relied on past experiences to learn from and then develop teaching plans. Reflection in action focused on maintaining a certain level of flexibility while teaching. Finally, reflection on action was referred to as a careful dissection of an experience. Ultimately, the reflection process was described as an iterative process encompassing observing, reflecting and experimenting.

A related study by Pinsky and Irby (1997) studied the process medical school clinical instructors use to reflect on unsuccessful teaching experiences and how to redirect their efforts towards a positive outcome. Over half of the study participants observed that reflecting on failures was just as, if not more important, than reflecting on successes. The resulting conclusion again supports the use of reflection as a key professional development tool for instructors as well as a professional development tool for students.

In another study of 16 anesthetists, reflective practice was explored in relation to patient care during operating procedures (Klemola & Norris, 1997, 2001). The role of reflective practice was important in understanding how these practitioners reacted to patient information provided to them during a procedure, such as vital signs, procedure changes and responses, and the course of action selected. Two distinct veins of thought were identified by the researchers: the interpretative orientation to care and the reactive orientation to patient care. The interpretative orientation is framed in the context of an unpredictable world and the need to respond appropriately, directing the researchers to claim that reflective practice and critical capabilities are enhanced in this orientation to practice. Conversely, the reactive orientation is believed to hamper reflective development skills in these anesthetists.

In research studies on nurses, reflective practice is prevalent in preparatory clinical rotations as well as daily nursing practice. Using qualitative methods, specifically narrative inquiry, Gustafsson and Fagerberg (2004) wrote that nurses described reflection as an individual activity or mirroring to someone else, in order to exchange ideas to promote better patient care. Citing references to reflection in action and reflection on action, the nurses demonstrated reflection on ethical situations, creative approaches to solving problems and

situations that required courage to address. Additionally, the commentary from the narratives suggests that reflection is possible with practitioner direction and supervision.

A nursing research endeavor by Teekman (2000) studied ten registered nurses in ten non-routine nursing situations, to test their reflective actions in order to derive actions and results. For complex situations and ill-structure problem scenarios, reflection incorporated cognitive activities, self-questioning and situational framing (Teekman, 2000). The researcher's conclusions identified three levels of reflective actions from this study. The first level is referred to as reflective thinking for action, or simply what to do in this moment. The second level is called thinking for evaluation and requires integration of multiple sources of information. Last, the third level is thinking for critical inquiry, or analyzing the situation in order to ask the correct questions to reach the desired outcome.

According to Teekman (2000), reflection for critical inquiry is distinguished from reflective thinking for learning and critical thinking as moving past analysis of a situation beyond technical considerations. For the participants, engaging in critical reflection led to optimal action in a specific situation, but failed to reflect holistically and demonstrate evidence of clinical enquiry in this process.

Critically reflective practice. The idea of becoming a critically reflective student, then practitioner, has two components: academic growth and intellectual development. Academic growth can be attributed to an increase in a student's knowledge base over a variety of topics. Further, in the progression of academic growth in undergraduates, academic growth can be represented through the successful completion of coursework, allowing the student to move up in class and/or class ranking. It is an assumption upon completion of general coursework that students will focus their field of study as a higher

level undergraduate student, specifically in the junior and senior years, to complete degree requirements in a specific venue of study.

Intellectual development is much broader in its application. As explained by Pascarella and Terenzini (1991), intellectual development or cognitive competencies may also be referred to by terms including, but not limited to, critical thinking (Glaser, 1985; Lipman, 1988) reflective judgment (King & Kitchener, 1994), and conceptual complexity (Harvey, Hunt, & Schroder, 1961; Miller, 1981). This development starts with learning how to learn and advancing learning to the next level with a deep repertoire of thought processes that can be universally applied. To be critically reflective then argues that the student must have the ability to move past mere questioning and reframing a situation to ask why, and then judiciously act upon new perspectives that are gleaned.

Transformational learning. In conjunction with critical reflection is the concept of transformational learning (Cranton, 1996). As defined in work by Brookfield (2000) and Mezirow (1990c), transformative learning incorporates dynamic perspectives and the ability to act upon newly formed perspectives. Daley (2000) contends that transformative learning is an integral component of the knowledge construction process, as students and professionals alike often change their knowledge and perspectives via a critical incident that directly impacts their belief and value systems and personal epistemologies. Mezirow (1990b, 1991) maintains that transformational learning is a primary means to encourage critical reflection and can be an essential part of either knowledge building or part of student knowledge outcome.

Nature of reflective thinking. Another facet of reflective practice is the action of reflective thinking. Boenick, Oderwald, de Jonge, van Tilburg, and Smal (2004) reviewed

195 fourth year medical students for reflection on ethical dilemmas. Each student offered his or her response to four vignettes, with outcomes indicating that female students, students with prior health care experience and knowledge, and students heading for general medical practice careers scored highest on the vignettes. In review of the outcomes, the conclusions indicated that reflective thinking responses were framed by a person's level of reflective thinking, prior knowledge and experience and general predisposition towards the act of reflection.

Using four constructs espoused by Jack Mezirow: habitual action, understanding, reflection, and critical reflection, David Kember and associates (2000) developed a 16-question tool to assess reflective thinking in undergraduate and graduate students in the fields of nursing, occupational therapy, physiotherapy and radiography. The outcomes demonstrated a clear lack of habitual action and critical reflection. Statistically relevant findings indicated significant differences between undergraduate and graduate student reflective thinking on all four constructs, specifically identifying graduate students as potentially utilizing deeper levels of reflection. Of note, this is the only quantitative research identified that specifically includes radiography students within the study's target audience.

Studying nursing students and their supervisors, Hallett (1997) interviewed 26 participants for their views of reflective practice in community based work environments. Outcomes of the 12 student interviews and 14 supervisor interviews indicated that student reflective thinking skills matured with increasing practice experience.

Various qualitative studies in scholarly literature reviewed written works of students to explore and assess reflective thinking. Williams and Wessel (2000) reviewed weekly journal entries of 48 physical therapy students for reflective thinking. Using five levels to

gauge the analytic nature of reflection in journal activities, as previously identified by Williams, Sundelin, Foster-Seargeant and Norman (2000), the outcomes demonstrated that all students (100%) practiced describing learning and analyzing learning; 96% verified learning; 66% gained a new understanding from learning; 25% indicated a future behavior after engaging in reflective thinking.

Wong, Kember, Chang and Yan (1995) used the works of Jack Mezirow (1991) and Boud, Keogh and Walker (1985) to analyze nursing student essays for reflective learning effectiveness. Of the 45 entries reviewed, six students were categorized from their essay as non-reflective, meaning they were descriptive and non-analytic in approach; 34 students were categorized as reflective or the essays were written by individuals who described and related to experiences; and five were categorized as critical reflectors who validated personal assumptions and experienced epistemological change.

Interested in the use of personal portfolios to track reflection, Pearson and Heywood (2004) completed an attitude study of 110 general practice registrars in the United Kingdom. For clarity, a general practice registrar is synonymous to a general practice residency in the United States. Out of 92 responses, 65% reported using a personal portfolio and 42% reported using the portfolio for reflective learning. To further describe the use of the portfolio, Pearson and Heywood (2004) organized the general practice registrars into three categories: reflectors who used the portfolios constructively for reflective thinking; recorders who merely recorded journaling entries for required assignments and non-recorders who did not use the portfolios at all. Overall, the conclusions indicated that those who viewed the use of portfolios as constructive and useful were inherently reflective thinkers from the onset.

Larrson, Lundberg and Hillergard (2008) reviewed radiologic technologists' use of knowledge in image production work with picture archiving and communication systems (PACS). Fifteen Swedish radiologic technologists were studied via semi-structured interviews and observation, only to determine that radiologic technologists use of PACS systems for image acquisition was a static, route process that lacked reflection. The conclusions of the study addressed the need for radiologic technologists to be flexible, critical and reflective in practice, using 'good judgment' in all work efforts.

Finally, a longitudinal study by Niemi (1997) explored the reflective thinking of 110 medical students in their pre-clinical years, using content analysis on their learning logs and identity status interviews. The outcome of the content analysis helped group the students into four levels of reflection. The first level is referred to as committed reflection, indicating experiences and observations in a health care setting are analytically considered by the student. The second level, emotional exploration, is characterized by self-identification of emotional expressions, embarrassment and self-consciousness. Third, objective reporting is defined as an explorative review of events, facts and objective scenarios. Lastly, the fourth level is avoidant reporting, where reflective reporting is scant, avoidant or diffuse and non-committal. The outcomes of this study helped determine if students had effective reflection skills in clinical settings and how their reflective practice impacted their learning and performance in patient care environments.

Assessment of reflective practice. According to the literature, reflective practice has been measured in predominantly quantitative research approaches. David Kember and associates (2000) developed a four scale, 16 question instrument and tested 303 health science students to measure reflective thinking, based on the work of Jack Mezirow. The

four scales measured were habitual action, understanding, reflection and critical reflection. The outcome of the research demonstrated distinct differences between each of the four scales between undergraduate and graduate students.

In another study by Leung and Kember (2003), they studied the relationship between deep learning and reflection as well as surface learning to non-reflective forms of thinking. 402 health science students completed two questionnaires, the Revised Study Process Questionnaire by Biggs, Kember and Leung (2001) and the Reflection Questionnaire by Kember et al. (2000). The outcomes showed surface approaches to learning were linked to habitual action and deeper levels of learning were linked to understanding, reflection and critical reflection.

Using a semi-structured interview format, Boenick, Oderwald, de Jonge, van Tilburg, and Smal (2004) assessed reflection in Dutch fourth year medical students, prior to beginning their clinical rotations. Using four case vignettes, the researchers identified acceptable consistency across measurements and correlation across vignettes was moderate.

Mamede and Schmidt (2004) developed an 87-question instrument to explore the nature of reflection in medical practice and identified a multi-dimensional, five factor model of reflective practice. The outcomes from this research identified elements of reflection that provide a foundation for additional study of the structure of reflective practice and the link between physician reflective practice, degree of expertise achieved and maintained throughout professional career.

Finally, Wong, Kember, Chung and Yan (1995) conducted a content analysis qualitative research study attempting to derive coding schemes for reflective journals. Using Boud, Keogh and Walker's (1985) six stages of increasing depth of reflection, which

includes attention to feelings, association, integration, relationship-seeking, validation, appropriation, and outcome, and Mezirow's (1991) categories of non-reflectors, reflectors, and critical reflectors, the researchers concluded that journals could be used to gauge the existence or lack of reflective thinking in students.

Summary. Of the literature identified on reflection, reflective practice and the related topics depicted for this summary, the majority represents quantitative research approaches on this subject. The gap in the literature identifies a need for more qualitative exploration of this topic, especially in allied health science professions. One particular researcher, David Kember, is linked to the vast majority of the very limited empirical research that includes student focus, reflective practice and radiography as an area of research interest.

Communities of Practice

The purpose of this study was to explore how senior radiologic science students reflect in practice. A fundamental tenant of this research is to describe the communities of practice that students engage in and learn from, both academically and socially. A community of practice involves groups of individuals who have a shared expertise or interest (Lave & Wenger, 1991; Wenger, 1998). This common ground is furthered by the idea that these collective groups work together on a regular basis, share a concern or passion and seek to mitigate the situation or learn to perform an action or function better (Wenger, McDermott & Snyder, 2002). These communities of practice can be developed in organizations, government entities, education, social sectors, associations and other groups that have a common need of knowing and learning (Wenger, 1998).

Communities of practice exist in a variety of environments and are described by a variety of characteristics, including size, state of existence, locale, and demographic

constitution (Wenger, McDermott & Snyder, 2002). Additionally, they can be spontaneously formed as an extension and separation of a workplace or formally planned and fostered by an organization (Wenger, McDermott & Snyder, 2002). Regardless of the make-up, each community of practice exists with three specific elemental components: a domain of knowledge, a community of people who facilitate the domain's existence and a shared practice or repertoire of resources (Wenger, 1998). Fundamentally, communities of practice influence perspectives of knowing and learning to support efforts of developing learning systems in a variety of arenas and levels of scale (Wenger, 1998).

It is important to discern how communities of practice are defined for radiologic science participants in this research study. Communities of practice for the rising senior radiologic science student exist in two differing contexts, the clinical environments he or she participate in during clinical rotations and the professional community of practice for radiologic technologists. Each clinical environment offers a unique community of practice, with different individuals who influence and shape the cultural norms and expectations. Students experience these different contexts by rotating through varying institutions, fostering different opportunities for development of both soft, inter-personal communication skills and hard, technical skills.

The profession of radiologic technology is an autonomous and vast community of practice. As a profession, it is defined by specific norms, codes of conduct and expectations of practice, as well as regulatory requirements due to the nature of x-ray imaging. On a macro level, the community of practice of the profession governs the scope of work for radiologic technologists, offers a standardized structure for functioning professionals and sustains the professionalism and expected integrity of these individuals in health care arenas.

Reflecting with communities of practice. A community of practice is a group that forms because of shared expertise and interest, has a desire to learn from the collective knowledge and historical contexts of the individuals, values individuals as members of the community of practice and provides an excellent opportunity for a developing student to learn and hone reflection skills. Radiologic science students function as part of an autonomous, technically rooted group of professionals, who share a well-defined scope of practice, repertoire of skills and comprise an integral component of a health care team. To build off learning opportunities presented in communities of practice, students must extend their individual reflection and bask in potential insights from a larger community of practice. Group reflection then acts as aggregation of individual skills and offers a social and political dimension to mere reflection (Bolton, 2001; Ghaye & Ghaye, 1998; Jarvis, 1987).

Collaborative reflection can be vital to maturing students. These senior radiologic science students learn from muddy or ill-structured complex problems in clinical settings, with the aid of group participation, sharing and guidance. Having the opportunities to group think, or peer evaluate a process, has the added advantage of expressing individual ideas to peer critique in a safe and positive learning environment. According to Wenger (1998), learning gives rise to communities of practice and is a source of social structure. If the effort is to develop radiologic science students into reflective student practitioners, who are cognizant of competent practices, patient care and effective technical application, then the opportunity to participate in situated learning opportunities in communities of practice will deepen their knowledge and heighten their skills (Fenwick, 2003).

Tara Fenwick (2003) addresses knowledge creation through situated cognition in a similar framework to Wenger's theory of social learning. Situated cognition shares a

commonality with constructionism and argues that knowledge is created via people's social interactions (Fenwick, 2003). Further, constructionism is similar to constructivism if defined through the lens of Crotty (2003) as developing new understandings through social interaction. This is a key link as constructivism plays an influential theoretical role in this intended research.

Reflection carried out in communities of practice is touted as a key to unlocking professionals' practice understanding and advancing the radiologic science profession (Wesley & Buysse, 2001). When undertaken in a mutually supportive environment, reflection can provide students "with the courage and intellectual capacity to turn insight into improved action" (Ghaye & Lillyman, 2000, p. 96). Considering the protocol driven work and rigor within radiologic sciences, reflection within their community of practice can serve as an essential method of learning, both formally and informally. Per the requirements of Radiography curricula set forth by the American Society of Radiologic Technologists (2007b), the demonstration of required clinical competencies personifies the collective effort of a community of practice, in which the student radiologic technologist has worked with other practitioners to successfully build and link reflective practice with tacit and technical knowledge.

Summary. This study explores the reflective practices of rising senior radiologic science students in clinical settings, to understand how they form skills to address ill-defined, complex clinical problems while successfully mitigating unnecessary exposure to patients during examinations. Since a large portion of radiologic science student learning occurs in the clinical environment, also known as a community of practice per research and definitions espoused by Wenger, Lave and others, understanding the machinations within communities

of practice can provide opportunities to enhance the development of reflective skills in students is essential.

Engaging in the fundamental components of clinical practice introduces student practitioners to a myriad of social learning interactions. Before each examination, patient interaction is necessary to verify personal information and attain patient history that is clinically pertinent to the exam or treatment. Student practitioners experience a variety of communities of practice through the various clinical rotations and contract learning assignments. The diversity of each one is an attribute of learning, as clinical skills are learned through practice and significantly add to the scope of knowledge and perspectives that students access in future scenarios.

It is naïve to consider that all meaning made and knowledge gained in communities of practice is positive and useful for students. Communities of practice are comprised of individuals with shared interests, ideas, goals and objectives on some level, however, the intention or agenda of each individual is unknown. Quips including, ‘that’s the way it’s always been done’ limit the learning experience of the student if the student is uncomfortable in challenging the status quo. Organizational change can be impeded by communities of practice who are reluctant to accept change. From this researcher’s critical perspective, participation in social learning from communities of practice, as well as day-to-day clinical activities, is in the best interest of student practitioners who must discern what information is useful and will be internalized as knowledge.

Chapter Summary

The literature reviewed in this chapter is intended to give insight into epistemological development and critical thinking, reflective practices and communities of practice and their

inter-relational existence. In order for radiologic science students to effectively reflect in practice to negotiate complex problems, these individuals must mesh the aforementioned topics into their foundational knowledge and pull from this base in order to aggregate, analyze and synthesize information in a dynamic clinical environment.

The scholarly literature depicts that much of the best clinical learning takes place during reflection and conversation among inquisitive people, prompted by events, situations and people encountered in daily work (Gunderman, Nyce, & Steele, 2002). Successful reflective practice is an art of asking good questions, which involves seeing connections and drawing distinctions that other people, for whatever reason, fail to consider. Reflective practice requires asking not “What do we know?” but “What don’t we know?” and “How can we go about finding out?” (Gunderman, Nyce, & Steele, 2002). However, some individuals inherently reflect better than others.

Instilling reflective skills in all students through education, clinical experience and communities of practice will bolster their usefulness and adaptability in future professional settings. Educators and supervisors must foster student development toward reflective and critical learners, who approach their training with a skeptical eye and are rewarded for asking good questions and acting competently. In a work environment that is adrenaline charged and haunted by rapid advancements in imaging technology, non-reflective practitioners who cannot synthesize and react to changing needs of the environment will face swift obsolescence. Replacing these individuals with a savvy generation of professionals who are reflexive and malleable to health care’s dynamic needs will quickly occur. It is imperative to foster and grow reflective practice, information synthesis and critical thinking in this profession. The application of these reflective skills in mitigating complex clinical problems

will be further explored with the intended research activities. A compilation of the research studies related to the literature discussed in this chapter is included in Appendix F.

CHAPTER THREE

Methodology

The purpose of this qualitative study was to explore how senior radiologic science students reflect in practice and negotiate complex problem solving in clinical settings. The theoretical undergirding for this investigation was rooted in the literature, using a narrative qualitative approach. The research questions that guided this study include:

1. How do rising senior radiologic students learn to reflect in practice in order to solve complex problems?
2. What application do rising senior radiologic science students make of reflective practice in clinical settings?
3. How do senior radiologic science students learn to negotiate knowledge from classroom and clinical instruction to make informed clinical decisions?

This chapter details how the research endeavor was constructed and implemented to achieve its intended purpose. To describe the entire research process, this chapter addresses the overall study design, the site selection and sample selection of the population of interest, approaches to data collection, data analysis, validity and reliability considerations, research assumptions and bias and a project summary.

Overview of Research Design

It is important to define qualitative research, as it differs greatly from quantitative research. Preissle (2006) states the term qualitative is wholly deficient in its labeling of this research stream, but says “the label has worked . . . it is vague, broad and inclusive enough to cover the variety of research practices that scholars have been developing” (p. 690).

Merriam’s (2009) compilation of various qualitative research definitions offers a broad

synopsis, “Qualitative researchers are interested in understanding the meaning people have constructed, that is, how people make sense of their world and the experiences they have in the world” (p. 13). Since the purpose of this research was to explore reflective practice in senior radiologic science students, this definition embodies inherent characteristics of qualitative research. The foundation for this study was narrative inquiry—a component of a qualitative approach to research.

Characteristics of qualitative research differ among researchers; however, three key areas seem to overlap within various scholarly resources. Merriam (2009) summarizes these topical characteristics as 1) the focus on meaning and understanding; 2) the role of the researcher as the primary mechanism for data collection and subsequent analysis; and 3) the inductive nature of the research process.

The first characteristic frames the nature of qualitative research as an exploratory and inquisitive form of research. It promotes exploration of unique situations, contexts and interactions that define a phenomenon of interest (Patton, 1985). The information garnered is situated in the participants’ perspective, while the researcher functions as data collector and does not seek to explain or interpret the experience (Creswell, 1998). For this research study, exploring how radiologic science students reflect in practice to critically think and solve complex problems or situations was pursued via analysis of past significant events from the perspective of the student. Ultimately, the goal was to derive deeper understanding of reflective practices and personal meaning making via the narratives and experiential details gathered from participants (Merriam, 2009).

The second characteristic of qualitative research is the role of the researcher in data collection and analysis. Since the qualitative research process is exploratory and

incorporates naturalistic inquiry (Patton, 2002), the researcher as the data collection instrument can proactively respond and adapt as the interview proceeds. Merriam (2009) characterizes qualitative research design as flexible, evolving and emergent, even tolerant of dynamic study conditions during the course of action. Research process familiarity allows for flexibility in inquiry, thus the researcher redirects non-responsive lines of questioning in search for other information with rich possibilities. The additional information gathered from these narrative exercises provides a fount of details, insights and participant reflections not otherwise gleaned, assuming the researcher can adapt to the changing dynamics.

Since the researcher is the primary data collector, a wide range of resources may be used to gather information. The primary data sources for this research were semi-structured interviews and critical incident narratives, gathered at mutually convenient locations for the researcher and the participants. The secondary data sources used for this project included historical documents, regulatory guides, programmatic documents and research field notes recorded during research.

The third characteristic of qualitative research is the utilization of inductive processes. Inductive processes are defined as the gathering of data to construct “. . . concepts, hypotheses or theories” (Merriam, 2009, p. 15) when there is a clearly lacking theory to adequately explain a specific phenomenon of interest. Conversely, deductive processes seek to test existing hypotheses and are often employed in quantitative research endeavors. The intent in this research was to gather rich, descriptive details from interviews, documents and observations and construct high-level themes related to reflective practice and critical thinking of radiologic science students.

Through the use of interviews, critical incidents, field notes and observations, the fourth characteristic of qualitative research is addressed- the use of rich descriptions to convey the data's message about the topic of interest instead of numeric data as employed in quantitative inquiry. Insights drawn from these rich descriptions can be supported and supplemented by participant profiles, expanded participant quotes, and personal stories that highlight important nuances of their perspective (Merriam, 2009).

As a qualitative approach, narrative inquiry offers a wide and varied range of applications. Narrative inquiry provides a conduit for information gathering through forms of storytelling. This qualitative form of research uses stories, life events and personal perspectives to understand experiences lived and recounted by individuals. According to Clandinin and Connelly (1994), "Experience . . . is the stories people live. People live stories and in the telling of them reaffirm them, modify them, and create new ones" (p. 415). Thus, the use of narrative inquiry allows for degrees of freedom in the data collection process. Prompting questions start a dialogue and open new avenues of information gathering when the participant delights in sharing their lived events that are then used as research data.

Since narrative inquiry is situated in qualitative research, it is an appropriate approach used to explore a broad topic when searching for themes on how, why and for what purpose. This qualitative research will employ narrative inquiry in the form of semi-structured interviews that focus on recounting a past event, specifically a critical incident. In situating the review of a critical incident in the semi-structured interview process, the participant's story is drawn out with guiding questions and the participant often freely participates as it is relatively easy to entice someone to tell a story about themselves (Saven-Baden & Van Niekerk, 2007).

The use of narrative interviews elicits narrative data, in the form of the participant's story. According to Polkinghorne (1995), narratives “. . . combine a succession of incidents into a unified episode” (p. 7). Participant's stories contain some form of action that is shaped by a plot line as the story progresses and culminates with an element of change; therefore narrative inquiry is an appropriate approach for this study.

Sample Selection and Site Selection

Selecting a specific sample and site to best study the specific phenomenon of interest is important to this research as qualitative research is much more focused and intimate. In order to hone this qualitative study, selection of a small, relevant participant sample and one site to perform the research is essential (Patton, 1990).

Within the design stage of this research, the sample group of interest was determined as a small and focused population. This group was intentionally selected, based on the presumed “useful manifestations about the phenomenon of interest” (Patton, 2002, p. 40). It is the search for valuable details that provide positive insight into the phenomenon of interest, thus the point of study may exist on a micro level, such as individuals or individual events, or resides in the meso and macro levels as well, such as communities, cultures or organizational events.

Randomly selecting radiologic science students would not yield a sample that would best fit the proposed research. According to Maxwell (2005), small scale qualitative studies do not present many situations in which random sampling would be useful. Hence, the sample selected for this study was purposeful and was supported by Patton's (1990) observation, "the logic and power of purposeful sampling lies in selecting information-rich cases for study in depth. Information-rich cases are those from which one can learn a great

deal about issues of central importance to the purpose of research; thus the term purposeful sampling" (p. 169).

Study participants were offered an incentive to participate in this study. All participants who completed the in-person interview received a \$25 gift card to Target retail chain stores as a token of appreciation for their time. Although the incentive was optional, all student participants accepted the offering.

A purposive sample was used to select the participants for this research. The target sample of interest was small in size ($n \leq 10$), as the baccalaureate program solicited for participation maintained a small class enrollment size. All senior, or rising second professional year students ($n=10$), were interviewed for this research. The unique curriculum and clinical experiences of this program identified it as the baccalaureate program of interest for this qualitative study. Specifically, this radiologic science program curriculum completes all radiographic positioning instructional classes in the first professional year, preparing the students for intensive clinical participation by the culmination of the year. The clinical experience is heightened by an intensive 8-week summer internship program between first and second professional year, that move students from a defined, structured and highly supervised clinical environment, to the role of a self-directed student with the expected level of independence under appropriate supervision (UNC-Ch, n.d.). This ability to fully engage in a variety clinical imaging situations, with a focus on advanced application and evaluation of radiographic practices in the clinical setting, provided a foundation for this study.

Further, rising senior radiologic science students were specifically selected for exploration of reflective practices and negotiating complex problems in clinical settings and the derived research questions. The decision to use rising senior radiologic science students

is two-fold. First, it is assumed that these students have a matured personal epistemology that guides their decision making process. Second, these students have extensive clinical experience as rising seniors and possess a cache of significant events to reflect upon. Since this research employed homogeneous sampling, recruiting efforts were not biased by gender, race, class, or creed, but targeted the entire population of rising senior students in the baccalaureate program.

Data Collection

For this study, the research activities engaged human subjects and required the review and approval of the North Carolina State University Institutional Review Board (IRB). The IRB approval to complete the proposed research is attached in Appendix A, with the participant consent form (reference Appendix B). Once approved, research began with various data collection methods, including primary data sources of 1) in-person, semi-structured interviews (reference Appendix C); and 2) critical incident narratives from participants. Secondary sources of data included 1) participant observations during the interview process (reference Appendix D); 2) researcher field notes associated with observations; and 3) document review and analysis.

Although this study employed purposive sampling, an official letter requesting participation in the study was provided to the radiologic science program director, as well as to each intended participant (reference Appendix E). This letter explained the context of the research, the purpose of the research and the potential implications the research could have on radiologic science academic programs and clinical experiences.

Primary data collection by means of personal interactions was a dynamic effort in which the researcher was cognizant of changing conditions and impacting forces on the

participant (Riessman, 2008). The researcher's intention was to relive specific events vicariously through the participant in order to gather illuminating details, while simultaneously promoting mutual respect, openness, and receptiveness in non-judging and non-condescending ways (Riessman, 2008). Further, the researcher was privy to both verbal and non-verbal information in face-to-face interviews. It was the prerogative of the researcher to analyze all words and contexts presented by the participants in order to process information swiftly and offer pointed queues necessary to attain information. When presented with limited information or stalled conversation, the research proactively sought new lines of dialogue to evoke greater participation, in addition to scripted questions and guiding pointers (Merriam, 2009).

For this research, interviews and observations worked concurrently. As primary sources of data collection, these fieldwork tools were used to directly engage the target audience in the research and glean personal perspective and context. Interviews offered the researcher a semi-formal process to connect with the participant and elicit information. Observations served as a supplementation of emerging information, a method to substantiate findings from document analysis and interviews (Merriam, 2009).

Interviews. The primary data collection method for this research was semi-structured interviews that included critical incident analysis. Ten interviews were conducted and recorded via dual digital recorders for verbatim transcription. Each interview was pre-scheduled for a date, time and location mutually agreed upon by both parties. These interactions occurred in naturalistic settings that put the participants at ease during the process.

At the onset of each interview, the participant was given an overview of the intended research, the Consent to Participate form for signature and an opportunity to ask questions about the research or the interview process (reference Appendix D). The intention was to complete each interview in no more than one and one half- hours, with each participant interview occurring once. However, considering the interview questions were open-ended, in order to elicit as much depth and breadth in detailed narratives as possible, several interviews lasted longer than the expected time commitment.

The use of an interview guide, developed from a formal literature review on the topic, kept the interviews focused and flexible (Merriam, 2009). Semi-structured interviews were “more suitable for obtaining in-depth information where the interviewer does not want to be restricted by a prescribed question order but would like the advantage of having asked the same questions of all respondents” (Sommer & Sommer, 1997, p. 109). Employing the same, open-ended questions related to a pointed critical incident example in the participant’s clinical practices allowed the participants an opportunity to tell their stories, from basic details to expression of learning contexts on a broader scale. The researcher is then granted the chance to streamline the information collected for analysis. Interview questions were tested in mock interviews in a pilot study comprised of program graduates unrelated to this research.

Using this type of research design allowed for the possibility that while the intent was to use predetermined questions, the order and exact wording of the questions was subject to change (Merriam, 2009). The end objective was to collect the student’s unique recall of an event during the conversation, no matter the sequence of events that surfaced. The culminating answers ultimately evolved from non-premeditated student experiences and

associations and fostered the assumption is that an increased awareness of the dynamics involved in formulating individual perceptions of complex problem solving could be key in shaping or reshaping reflective practices taught in classroom and clinical settings.

Since the intended interview strategy was to complete one-time participant interviews, it was imperative to capture significant detail and descriptions of the phenomenon of interest by relying on scientific methods of technical reasoning and data analysis to deduce what additional information was needed during the interviews. The essential outcome was to capture the essence of the participant narrative through expansion on information gaps in the recall process and elicitation of substantive information.

Critical incidents. In order to explore senior radiologic student reflective practices in clinical settings, this research employed critical incident theory in the data collection and analysis process. Reviewing a significant event that occurred in a clinical setting was used to determine the impact of reflective practice, critical thinking skills and complex problem solving on the students actions and the associated outcomes.

John Flanagan was one of the first individuals to contextualize critical incident technique (CIT), from his work as a military psychologist in World War II (Butterfield, Burgon, Amundson, & Maglio, 2005). Although it is rooted in industrial and organizational psychology, its applicability to a myriad of research avenues makes it a very resourceful tool as a component of narrative inquiry.

According to Flanagan (1954), the critical incident technique of data collection is not governed by a strict set of rules, but is adaptable as a flexible principle set for any situation. The focus of a critical incident study ranges from detailing “effective and ineffective ways of doing something, to looking at helping and hindering factors, collecting functional or

behavioral descriptions of events or problems, examining successes and failures, or determining characteristics that are critical to important aspects of an activity or event” (Butterfield et al., 2005, p. 476). The focal use of critical incident technique in this research was to determine the objective of a specific activity and what the participant gained by experiencing the activity.

The essence of critical incident technique aligns well with the stated characteristics of qualitative research, according to Creswell (1998):

Specifically, CIT research takes place in a natural setting; the researcher is the key instrument of data collection; data are collected as words through interviewing, participant observation, and/or qualitative open-ended questions; data analysis is done inductively; and the focus is on participants’ perspectives. (p.16)

According to Flanagan (1954), there are five steps inherent to the critical incident technique. First, the researcher must have a general understanding of the activity of interest. Next, careful planning and considerations must be made in order to appropriately collect data, as the third step is the actual data collection. The fourth and fifth steps entail data analysis, interpretation and reporting of results. These major steps are used synergistically with modern qualitative research approaches to bolster the overall soundness of the data produced (Butterfield et al., 2005).

The evolution of critical incident technique from its inception in the 1950’s has broadened its original intended use. No longer solely a task analysis tool, it is widely viewed as an investigative and exploratory tool for qualitative research, in areas including education and medicine (Butterfield et al., 2005; Keatinge, 2002). One of its modern uses is to have participants recount an incident of personal importance, growth or development, and then

explore the impacting factors on that experience and precipitated outcomes (Dworkin, 1988; Wodlinger, 1990). Another approach is the use of critical incident technique to attain personal beliefs, opinions or projections that formed from an incident, instead of detailing the incident directly (Cheek, O'Brien, Ballantyne, & Pincombe, 1997). This dovetails with the use of critical incident technique to explain feelings, actions and reasons participants respond as they do to an event (Ellinger & Bostrom, 2002; Kanyangale & MacLachlan, 1995). Lastly, the approach of most interest to this research was detailed by Morley (2003), building the focus of critical incident technique on what a person did, why they did it, the outcome, and the most satisfying aspect of the event in its entirety. Fundamentally, critical incident analysis became a reflection on action for the participant.

To explore radiologic science student reflective practice skills invoked to negotiate complex problems in clinical settings, one of the open-ended questions in the semi-structured interview focused on review of a critical incident. Critical incident technique, as depicted by Flanagan (1954), has been used to refine primary data collection instruments as well as shape the significant event review into a secondary source of useful data. The intent of reviewing significant events that occurred in clinical settings was to determine the impact of reflective practice, critical thinking and complex problem solving on the students actions and the resulting outcome. The reflection on this event was meant to evoke thoughtful understanding of his or her actions and the associated resulting outcomes.

Participant observations. According to Creswell (1998), observation, as a component of narrative inquiry, is a very important factor in comprehensive research. To determine what should be observed, the researcher should examine the study's theoretical framework, the research problem and the research questions (Merriam, 2009). To supplement

the information garnered in interviews, participant observation could have occurred in two different ways for the purposes of this research. First, observations during the interview process offered non-verbal cues about both the participant and the information he or she presented in the interview. Second, observations in the academic and clinical settings that student's reference in critical incident reviews would have supplemented the narrative data collection. Participant observations during the interview process were recorded in the researcher's field notes; however, direct observation in academic or clinical settings was not feasible for this study.

Since critically reflective practice skills in clinical settings may be considered ill-defined phenomena, the inclusion of observation in the data collection process was salient to this research. Participants were informed via the IRB Consent to Participant form that researcher observations would be recorded during the interview process and served to support participant narratives and comments. Observation field notes included information on body language, verbal and non-verbal cues, emotion and expressive details that enhanced or distinguished information. To maintain research rigor during this study, field notes were extremely detailed, factual and as free as possible of subjective information and researcher suggestion and bias (Bogdan & Biklen, 2007).

Researcher field notes. The use of a fieldwork journal allowed tracking of personal notes, theories, points of clarification and other pertinent information that impacted the data collection and analysis process. As a form of data collection, the fieldwork entries became another means of qualitative research as the information collected guided data analysis, independent epiphanies and lent credence and validity to other sources of data (Merriam, 2009).

As a form of observation, the journaling process offered a means for researcher reflection in and on action. The recorded data was composed of quotations, descriptions, antagonistic thoughts and observer comments that were anecdotal at the time of collection, but were immensely helpful in reconstructing the individual interview environments for data analysis.

The development of a personal field work journal began with researching this phenomenon of interest. Since the applicable scope of a field journal is very broad, its uses included brainstorming, concept mapping and research planning from the infancy of this project. This journal was maintained in an electronic format for its essential portability and use in every component of this research process, as the process and data was evolving and dynamic. However, the researcher did not actively type during participant interviews in efforts to not detract from the interview process nor deter the participant's full engagement.

In keeping with the research design framework of this study, the use of field notes mirrored the constructs inherent in constructivism. Since the journal entries were a means of reflecting upon information to make new meaning and internalize the new knowledge for application in specific contexts, this process for the researcher was a forming experience that influenced personal epistemological perspectives. Further, it assisted in honing the researcher's critical thinking skills, as an individual who categorized new information, applied his or her personal knowledge and belief systems to the identification of themes in the data collected. Ultimately, journaling in this context mimicked critical incident interview components in which student participants were asked to engage.

Document review. The final component of data collection for this qualitative research was document review, which may also be termed as document analysis in the

qualitative literature. In order to identify gaps in the literature and determine a research topic, comprehensive literature reviews were integral in this process (Merriam, 2009). Fieldwork and data collection were founded on educated guesses, hunches, research intuition, and then connected to information presented in the literature in various regards (Creswell, 1998).

According to Patton (1990, 2002), document analysis informs the research context. It provided the means of gathering insight into educational and professional practices of the radiologic science profession, including history, activities and beliefs of the program that is serving as the context of this study (Patton, 1990). Documents, publications and websites reviewed included peer-reviewed articles in scholarly journals; radiologic science program curriculum guides and professional licensure requirements promulgated by governing bodies and professional societies. All items reviewed for this research provided context and information on the demands placed on students and offered a foundation for interview questions and face-to-face dialogue.

Document review information was recorded in the researcher field notes and used to supplement or substantiate information in the research process. When pertinent, findings from early document analysis was shared and discussed with study participants during the interview process in order to test and validate early assumptions and findings. Additionally, supplemental document review was necessary to follow-up on information provided in participant interviews in order to corroborate and further explore the interview information.

Data Analysis Strategies

In order to analyze data, the information collected must be richly detailed, precise and accurate of the participant's story. Each participant case can then be compared to other

cases through inductive analysis, or immersion into the data for identification of patterns, themes or details that illustrate interrelationships or outcomes. The intent was not an attempt to mold the findings to an existing theory necessarily (Patton, 2002). The larger picture is not a mere sum of the parts, but a constant comparative method that builds substance and credence to this complex system of parts. According to Patton (2002), when representing the data in analysis, a “researcher’s focus becomes balance— understanding and depicting the world authentically in all its complexity while being self-analytical, politically aware, and reflexive in consciousness” (p. 41).

The data analysis and coding portion of this project began at the conclusion of the interviews. All data collected, whether from interviews, observations or researcher field notes, was systematically reviewed and coded for analysis (Clandinin & Connelly, 1990). Cognizant of the researcher role of primary research instrument, it was incumbent upon the researcher to review the data in its entirety, then compartmentalize, reflect and compare findings to draw out the hidden meanings and themes. An extensive code book was developed and used to narrow the code categories, although initial coding schema was evident during data collection (Bloomberg & Volpe, 2008). This information was used in conjunction with document and literature review findings to facilitate comprehensive coding for this project. The final coding outcomes were framed in the context of reflective practice to answer the research questions.

Comprehensive data analysis consisted of multiple stages, from transcription of the interviews to comparing themes from this research to published literature to discern new meanings. The first stage included transcription of the participant interviews and intense reading for content clarity and understanding. The interviews were transcribed verbatim to

represent the participant's exact words. A completed copy of each transcript was delivered to the student participant for member checking of the data to bolster validity and reliability. Member checks, also referred to as respondent validation, were necessary to validate the information collected and allow for clarification of participant meaning (Maxwell, 2005).

The second phase of the analysis process included increasing familiarity with the various sources of data associated with this research. These sources included interview transcripts, document analysis, observation records and researcher field notes. A strong working knowledge of the information base was essential to start correlating the data to the pre-determined research questions that guided the study.

The third phase included broad category, open coding of the data sources with manual coding of the data sources. The fundamental activity was to aggregate data into categorical themes until no ideas are left independent and no new themes emerged from the data sources. Inherent to the researcher was the expectation of certain themes and patterns to exist in the data, since the data collection tools were written with a certain amount of researcher bias and personal influence. However, monitoring for this bias and influence was intently addressed via field notes, to minimize the impact on the authentic themes located in the data, not inferred in the data.

The fourth and final phase of the data analysis was to compare the final themes elicited from the data to the literary foundation used to develop the research topic of interest, specifically how senior radiologic science students reflect in clinical settings to solve complex problems. It is this phase that significant findings were identified, which is elemental in answering the initial research questions (Patton, 2002). Understanding the reflective practices of senior radiologic science students via their significant event

experiences emerged and associated findings addressed the research questions and impact of the study's findings.

Ensuring Validity and Reliability

According to Firestone (1987), a “. . . qualitative study provides the reader with a depiction in enough detail to show that the author's conclusion ‘makes sense’” (p. 19). According to Lincoln and Guba (1985) as well as Connelly and Clandinin (1990, 1994), expectations of research rigor are described by dependability, credibility, transferability, authenticity, external and internal validity and objectivity. Threats to validity and reliability were considered from the conceptual development of this project to the final analysis and interpretation of the data (Merriam, 2009; Patton, 1990).

Since narrative inquiry focuses on a participant's recall of an event, which is subjective and at best, authentic in the eyes of the participant, the inability to verify the authenticity is a challenge to managing validity issues. Having all participants focus on the same questions and topics minimized validity issues (Sharoff, 2008). According to Flanagan (1954), even subtle changes in the wording of questions can create a change in the response. Thus, critical incident technique was used to refine the primary data collection instrument and became a secondary source of useful data (Flanagan, 1954).

Rigorous safeguards are instituted early in the process to enhance the reliability of the data collected and translated by means of data analysis. From the onset of the process, “systematic and self-conscious research design, data collection, interpretation and communication” were fundamental to ensuring rigor (Mays & Pope, 1995, p. 110). The final outcome should “produce a plausible and coherent explanation of the phenomenon under scrutiny” (Mays & Pope, 1995, p. 11). The researcher exhausted all means to ensure the

research methods and data were used in an infallible manner and are reproducible by another researcher (Mays & Pope, 1995).

Various methods exist to test the rigor of validity and reliability of data in qualitative research, including, but are not limited to, member checks, triangulation, bracketing and repetitive meetings with participants (Creswell, 1998; Merriam, 2009; Patton, 1990). This research employed the use of member checks and triangulation of data sources to bolster validity and reliability of the research.

Investigator Bias and Assumptions

When this topic became the focus of research, a strong concern of researcher bias surfaced. The researcher, like the participants in this study, is a radiologic science program graduate and has participated in many of the same clinical rotations. There was a strong desire to define the link between the radiologic science technical background and the opportunities that adult education present in order to determine the true gap in the literature on rising senior student reflective practices. Not only were there positive implications for the development of instructional strategies that will bolster the development of this skill set, the applications of this teaching extends far beyond this profession and into health professions that pull from the same academic and technical knowledge base as radiologic science.

Since the researcher has previous experience as a radiologic science student and technologist, a predetermined perspective on clinical expectations and inherent reflective practice with critical thinking skills that students must possess and master, was present. However, these prior experiences and beliefs did not bias the research process nor impact researcher objectivity. The intention was to conduct the interview process as objectively as possible, to minimize influence on the participant to answer questions in the same frame as

the researcher's expectations and to guard probing questions in order to minimize injecting perspective instead of collecting participant information.

In the research design stage, purposeful sampling was selected to include a specific population, with characteristics that would align with the research goals. Interviewing student participants who matriculated through an academic program which has a curriculum the researcher understood and a resonating paradigm allowed the researcher to grasp the common language and shared professional norms with the students in an unspoken capacity. In addition, other identified research variables were controlled in order to limit any impact on the data analysis possibilities. The researcher's relationship to the context of the study permitted better understanding of the interview details and reduced excess time needed to digest and extrapolate information.

Study Limitations

The advantages of this study were numerous. The narrative inquiry approach, via semi-structured interviews, granted insight into student experiences and presented perspectives that the researcher had not considered when developing the research project. Additionally, it provides a qualitative research endeavor that addressed a gap in the literature on radiologic science students.

A number of limitations were present as well. The number of radiologic science baccalaureate programs is limited when compared to the number of associate degree programs in the United States. In addition, travel and research costs limited the participant populations available for this study since these programs are geographically dispersed.

The program of interest, which was considered a purposeful sample, often invites approximately 12 to 15 students each academic year. The representative population of

interest has a specific first professional year curriculum that is individual to this particular baccalaureate radiologic science program. Thus, the interviewed population had a subjective perspective in regards to events and information shared that must be accounted for and may not represent the overall trends of all programs. Specifically, when extrapolating the data ascertained in this research, the comparison groups would need to be as similar as possible with regards to level of clinical competency and academic seniority.

Chapter Summary

This chapter addressed the qualitative methodology and research design components of this study. Explanation of purposeful sampling approaches was presented. Data collection and review procedures were addressed in order to adequately interview the population of interest and ensure validity and reliability of the data. Additionally, sample data collection and consent tools were discussed.

CHAPTER FOUR

Profiles and Critical Incidents for the study participants

To explore the reflective practices of rising senior radiologic science students, the researcher interviewed and observed 10 current program participants. Participant interviews were conducted during the summer of 2010. Follow up discussions with students and clarification communications with program professors were completed by the fall of 2010.

Interviews were conducted at locations of the participant's selection to facilitate ease of meeting in a timely fashion and geographical convenience for the student. Each in-person interview lasted between one and one and a half hours, with subsequent communications conducted via phone or brief, in-person encounters, for an approximate total of 18 contact hours with research participants.

According to the pre-established criteria, all research participants were rising seniors, otherwise known as second-professional year, in a baccalaureate radiologic science program and had successfully completed their summer internship. All students rotated through at least three independent clinical sites and completed all foundational coursework in patient positioning by the end of their first professional year, or junior year, in the program.

When prompted to discuss what path led each student to study radiologic science, seven students identified a desire to pursue a profession in a medical related field, with one student specifically identifying radiologic science as the pre-determined path of study. Three students sought entry into the program as a second degree option and a change in career path. Of these three individuals, two had previous science related degrees and careers, one did not and chose health professions after a life-altering experience.

Participant Overviews

Radiologic science cohorts are usually small in number, to allow focused instruction and to facilitate placing all students in clinical locations. The rising senior population interviewed for this research was no exception, with 10 rising senior students. Of these 10 students, six were Caucasian, three were African-American and one was Asian-American. Their collective ages ranged from 21 to 33, with a mix of seven traditional age undergraduate students and three non-traditional students. Four of the 10 students had prior degrees from other institutions, either associate or bachelor degrees in non-radiologic science degree programs. Participant demographics are outlined in Table 5.

In studying 10 rising senior radiologic science students, demographic questions on involvement in professional societies were included, of which, two indicated their student participation in various medical societies. Six indicated plans to pursue graduate level education in the future, two students were undecided and four stated they would move directly into the workplace as practicing technologists, with no indication of furthering their education. Student grade point averages (GPAs) ranged from 2.90 to 3.87 on a 4.00 scale. Finally, six students reported plans to pursue careers outside of radiography, including medicine, public health and anesthesiology. Participant overview information is included in Table 6.

Each student participant was uniquely different and presented an interesting perspective for this research. In this section, a brief student profile is presented, in alphabetical order by pseudonym. Study participants were asked to share a critical incident that was self-identified as having a significant impact on their student clinical experiences.

Table 5

Participant Demographics

Pseudonym	Age	Race/ Ethnicity	Gender	Marital Status	Prior Degree
Ann	30	Caucasian	Female	Married	Baccalaureate
Carly	21	African-American	Female	Single	None
Georgia	21	African-American	Female	Single	None
John	33	Caucasian	Male	Single	Baccalaureate
Kate	21	Caucasian	Female	Single	None
Lynn	21	African-American	Female	Single	None
Nancy	30	Caucasian	Female	Married	Baccalaureate
Sarah	21	Caucasian	Female	Single	None
Susan	23	Caucasian	Female	Single	Associate
Thomas	21	Asian-American	Male	Single	None

Of interest while interviewing the participants on a critical incident, nearly all participants expressed difficulty determining a single meaningful event, but recounted a variety of brief introductions to a gamut of stories with declarative statements akin to Carly’s, “I feel like I’ve had so many.” Each student was challenged to tell his or her story, rich in detail and

Table 6

Participant Overview

Pseudonym	GPA	Professional Society Participation	Considering Graduate Education	Career Aspirations
Ann	3.89	No	No	Radiography
Carly	3.20	No	Yes	Medicine
Georgia	3.00	No	Yes	Medicine
John	3.30	Yes	Undecided	Radiography
Kate	3.67	No	Yes	Public Health
Lynn	3.10	No	Yes	Anesthesiology
Nancy	3.80	No	Undecided	Radiography
Sarah	3.20	Yes	No	Medicine
Susan	2.80	No	No	Radiography
Thomas	3.27	No	No	Radiation Therapy

descriptive language so that his or her personal interpretation could be felt by the listener. To focus the answers, probing questions were used to guide the storytelling and to dig deeper in order to capture the essence of the activity.

The critical incident portion of the semi-structured interview was, by far, the most intriguing portion of this research endeavor. Although each student had numerous stories and took a moment's pause to select the 'right' one, the process of how the participant's stories built, from timid introductions through crescendos of details, was phenomenal to watch. For this target population, their age-group specifically, asking each student to tell their tale coaxed out the most vividly detailed, thickly rich sagas of adventure.

According to Flanagan (1954), there are five steps inherent to the critical incident technique. First, the researcher must have a general understanding of the activity of interest. Next, careful planning and considerations must be made in order to appropriately collect data, as the third step is the actual data collection. The fourth and fifth steps entail data analysis, interpretation and reporting of results. These major steps are used synergistically with modern qualitative research approaches to bolster the overall soundness of the data produced (Butterfield et al., 2005).

Although Flanagan's (1954) five steps of critical incident analysis promotes the comparison of critical incidents to previously published data, no literature was discovered on critical incident analysis associated with narrative inquiry of radiologic science students. Therefore, the narratives were analyzed solely in the context of answering research question three of this study. This chapter reviews the critical incidents described by each student. To maintain authenticity of the student's event recall, exact wording was maintained in the quotes. Table 7 summarizes the participants' critical incidents.

Table 7

Summary of Critical Incidents by Study Participants

Pseudonym	Synopsis of Study Participant Critical Incidents
Ann	Learning to handle emotional patient-centered situations that infringe on her personal comfort zone in clinical environments, specifically trauma patients
Carly	Gaining understanding on how to correctly position for an extremity exam with the assistance of a staff technologist
Georgia	Working with a staff technologist to complete a non-routine imaging examination
John	Being inadvertently drawn into a staff dispute and having to confront staff conflict in the clinical environment
Kate	Learning to act and reflect independently while performing examinations when staff technologists were too busy to oversee the procedure
Lynn	Reacting quickly to an unresponsive patient, preventing patient injury
Nancy	Being held accountable to unfair performance expectations due to actions of other students that were beyond her control and knowledge
Sarah	Standing up for herself and explaining the actions of a technologist when an examination's resulting radiographs were substandard
Susan	Observing a confrontation between a technologist and a supervisor over substandard radiographs
Thomas	Working with a disgruntled patient to successfully complete the radiographs

Ann. Ann is a young woman, with a quiet and confident air. She is a former Biology major, returning to school for a chance at a second career path, while juggling the rigors of child rearing, marriage and a household. Committed to her studies, she espouses a strong moral

compass and personal direction. It is obvious she is committed to conveying this direction to her children.

A pensive person through most of the interviews, Ann would occasionally flare with a staccato of strong conversation. She is as conscious and thoughtful about her answers as the decisions she makes in life. Ann's positive tone and articulate nature make her a natural for a patient-care oriented career, as her critical incident example and interview stories were brimming with empathy and compassion. Ann experienced a clinical moment that tested her personal, emotional limits. Working in the Emergency Department, Ann was unable to complete a patient radiograph as the nature of the event was too personal; she was able to quietly excuse herself and discuss it later with a technologist for perspective. Ann gazed into the park and sadly recounted the details:

I think I have an instance but it doesn't reflect very well on me because I wasn't able to follow through. . . But I was in [a hospital] and we had gotten called to a trauma. And trauma is not for me . . . And so any time the trauma call would come, I was hoping I would be busy doing something else. But, so it came, it was like a Level 1 trauma call and we went over there and . . . He had a sort of service...job title . . . And this patient was not actively serving at the time of the incident . . . And we were waiting outside and the patient was coding and they would get a heart rate and then he would code again. And I'm standing out there and really having a hard time. Like it was...it was too challenging for me...to be watching that. And so I actually was not able to complete the exam and it turns out that he died before the chest x-ray was needed anyway. But I had to leave and I really struggled with that – not being able to

kind of complete that exam. . . and I think I've matured a lot since that incident . . . So now, kind of, I wish I could go back and see what I could do.

Ann implies that working with empathetic technologists offers counter perspectives on situations like this one, allowing her to glean more understanding and experience with coping. Through reflection, she gained a new personal outlook and reconciled epistemological concerns to be better able to handle clinical situations that infringe on her personal comfort zone.

When reflecting on her participation in the radiologic science program, Ann appears invigorated by its challenges and undaunted by being a non-traditional student. Very confidently and calmly with unwavering eyes, Ann offers pointed, cautious advice from her experiences in the program to others who decide to follow this same academic path:

Be prepared before you go. Know what kind of exams you might see that week. Ask a student who's already been there. . . . Also [do] not go in and say, you know, "well I learned it this way" and you know, "this is the way I learned it." You know. "Why are you doing it that way?"

With a worldly context in mind, Ann amended her thought, urging students to maximize their experiences while in the program and added:

I would just say . . . you will see and hear and do things that you never thought that you could do. You will see things that are just fascinating. You will meet people who are very inspiring and fascinating. And you'll be challenged in ways that you never knew. You will be challenged.

When prompted to discuss what defines a good technologist and any associated expectations in her own words, Ann offers a heartfelt description that resonates with her personal beliefs,

clinical experiences to date and her own expectations. With thoughtfulness and a distant, but intent stare, she shares what draws her to ‘good’ technologists, “The care that I take with patients - not talking about patients after they leave . . . just someone that has my ideals as far as patient care and work.”

During the interview, held on July 27, 2010 and conducted outside in a family-friendly park, Ann appeared calm and collected in her demeanor and answered the questions with sincerity and little levity. Ann is a caring individual, as evinced in her answers that indicate her desire to work in areas of radiography that allow for extended patient contact. She is energized when she can get to know the patient, to go beyond the minimum of clinical statistics, and truly know their story and better understand their situation.

Carly. A vivacious and gregarious 21-year old, Carly is an active Certified Nursing Assistant and is anxious to be an integral part of patient care. After experiencing health care from the perspectives of nursing and radiology, she is dedicated to the notion of becoming, at a minimum, a Physician Assistant and advance beyond to whatever additional careers await, in order to contribute her utmost to the medical profession.

While managing multiple part-time jobs, Carly does not lack for adventurous academic stories and clinical experience examples, while bubbling at the notion of rallying her classmates for a cause or event. She conveys a focused mindset about the role of students in clinical settings; her expectations for others are rigorous and demanding in order to create an effective and enjoyable work environment for all.

Carly’s critical incident narrative recalled the positive benefit of interactions with staff technologists for assistance with non-routine examinations. Carly described her interaction with a technologist when making the same mistake repeatedly and how that

interaction impacted her future practice abilities, not to mention her self-confidence just knowing she was prepared. Smirking while telling the story, she recalled:

So there was this one lady, she was like overweight and I kept messing up the lateral knee. . . The way I learn is when the tech asks me questions and challenges me.

Yeah, it's going to make me look dumb 'cause I don't know what I'm talking about right now and I don't know what I'm doing but I bet you that I'll learn something and that I'll remember it. Because a lot of times, a lot of people don't want to see you constantly make the same mistake over and over again.

Carly's story tells how she values and receives the instruction and advice of clinical professionals. She believes that staff investment in a student's learning process is equally invaluable to hard, technical skills and soft, people skills.

Reflective of her clinical experiences to date, Carly is keenly aware of the individuality of both patients and patient care environments and is quick to articulate the dynamic demands pushing students to embrace all types of clinical experiences. Carly is candid and unabashed as she advises, "Show initiative and take part in as many procedures as you can. Because once you get off in the real world, it's just you by yourself." When directed to discuss what makes a good technologist, she quickly answers without pausing, "One who is compassionate and who can relate with their patients."

The interview occurred on July 27, 2010 at a Panera Bread location, on Carly's day off from work. During the interview, Carly was quick to answer all questions without hesitation. Her answers were full of youthful, contagious enthusiasm, as she spoke highly of her patient interactions and the desire to work with people in general. Carly's body language

exuded a genuine, almost Pollyanna personality and her comments were always positive or constructive.

Georgia. Very chic, fashionable and willowy thin, Georgia has a calming spirit and shy personality when first encountered. Underneath the shy façade, she is a vibrant 21-year-old African-American female who is attacking the demands of school and work with youthful resolve. Georgia began her undergraduate studies at another four-year university and relishes her new experiences after transferring to this school, specifically, the opportunities in the radiologic science program that provided the impetus for her to become a well-rounded person, both academically and personally.

Describing herself as a hands-on learner, Georgia's shy personality matched her approach to clinical experiences – a strong willingness to learn, but hesitant in her initial actions for fear of making mistakes. When discussing her critical incident in the context of the positive impact that staff interactions and assistance have on student development, Georgia described her staff interaction as a collaborative effort on a non-routine examination. Her comfort with asking for assistance and knowing the support is available if needed promotes her confidence to attempt even the most challenging situation as a team:

I went to get the patient. She was in a wheelchair and went and got her in the room . . . and we had to get her on top of the table for her hip pictures. She hasn't moved. Like she hasn't been moving or mobile so that was the difficulty. So she was afraid to get on top of the table because she had one good and one bad and she was afraid that she was going to fall. And so, at [this facility] they want you to . . . if you can do something without moving the patient, then do it. . . . And we only moved her on to the table for her hip and get her back off, you know, as quickly as possible. . .

seeing different ways of how to get a good AP and a good lateral with what the patient could do is always a good thing.

When asked if she would have done anything differently, Georgia hooted and explained that the patient actually had more range of motion than expected once on the imaging table, which made radiographing other anatomy much easier.

Georgia practices self-affirmation and holds steadfast with her advice to other students, “Be aggressive because your impression – that is the impression that will carry on.” Further, she speaks highly of her need to “try it” and experience the process and mistakes, as the transition from book learning to practical application does not have cliff notes or a probability of radiographing a model patient as presented in textbooks.

Georgia’s empathy towards others is keenly evident when she was asked to define a good technologist and the expectations she holds for this person. She centered her answer on patient care demands of a technologist and nervously but quietly added:

Definitely working with the patient and taking care of the patient and not just doing what’s supposed to be done. You know. Do what’s supposed to be done but do it at the patient’s, you know, what they can or can’t do because you can’t force them. If they’re in pain or if they are...you know, you can’t force anyone to do anything or make them uncomfortable. So . . . a good tech will always put the patient’s abilities, their feelings, their emotions, their um, you know, their physical capabilities first.

Georgia was interviewed on August 3, 2010 at a Panera Bread location in a brief window of time before her part-time shift at a retail store. Georgia is a quiet person, but willingly answered all questions during the interview, either with straightforward answers or with a probing counter question. Her answers reflect her experience level as a traditional

undergraduate student with limited real-world experience; her examples and answers were sincere, albeit brief and in some ways, naive.

John. Exuding a self-assured air, John arrived at the interview offering casual greetings, a handshake and a sincere smile. A non-traditional student at 33-years-old, with slightly graying temples and a compact athletic build, John is on his day off and is balancing the demands of homeownership projects before school resumes. Having held professional jobs in research arenas, John participated in the interviews with an attentive and engrossed air, enhancing the conversation with seasoned answers and polite banter.

John is quick to articulate his career goals as long term, investing in his radiography education and the various imaging modalities in which one's career can expand. His position as a returning student is truly grounded by a need to start a new career and earn a living-a concern permeating the interview and conveyed with angst over the current job market. The available health care employment opportunities or lack thereof, were of great concern. When asked about his involvement in professional societies for growth and networking opportunities, John beamed. Just the idea of co-mingling once again with experienced professionals is an important complement to his current role as radiologic science student.

Broaching the topic of a significant clinical event, John offered a critical incident grounded in inter-personal communication conflicts. His adaptation to different clinical environments introduced him to a communication situation beyond his control, yet, he found himself unwittingly embroiled. John characterized his routine in the clinical setting by working with and learning from technologists that he liked, meaning he admired their nature and clinical habits. "Usually I just kind of find a tech that I work well with, and kind of stick with them." While working in a new environment with unfamiliar staff, John recalled:

. . . there was an . . . inter-department conflict that [the technologists] tried to draw me into. And when I told them I would rather not, they kind of turned on me instead. It was kind of difficult because I felt like I was taking the high road in choosing to stay out of the department drama. So I don't know if there was really anything I could have done differently. Well I did actually have to have a conversation with one of my instructors. Only because it had escalated to that level. I was going to be the big person and just kind of look the other way and pretend it didn't happen.

When asked if he felt this situation impacted his clinical experience, unabashedly he answered yes and added, “. . . it was the first time I've actually experienced on that level.” Having limited facility options for clinical rotations, radiologic science students have to navigate such socio-political waters of intra-institutional conflicts as well to succeed as a student.

Petitioning advice for future students, based on his program experiences to date, John waxes philosophical and considers the gamut of demands that clinical rotations have for students. Speaking from his own lessons learned from both clinical experiences and real work experience in medical offices, he candidly warns that the program is “challenging [and] very hectic.” And in order to successfully embrace all opportunities and challenges, John carefully adds, “. . . just plan ahead.”

Transitioning the topic with John to defining a good technologist in his own words garnered the sincere and respectful answers reminiscent of his personality and demeanor. Offering a patient care perspective of empathy and perspective, John casually remarked:

I think, first of all, you have to be very knowledgeable and very much a people person. If you don't like working with people, it's really not the job to go into, at all.

You have to be very patient because a lot of people are sick; they're crabby, not necessarily because of what you're having to do or what you've said or done, but just in general because they don't feel well. You just have to be really patient with them. His incorporation of empathy in his clinical practice was essential to developmental success in practice.

The interview was conducted with John on August 5, 2010 at a Barnes and Noble Bookstore, on one of the few remaining days of summer break. Proud of completing several home improvement projects before returning to classes, John found a unique outlet for his energies outside of class. His savvy answers, as he drinks a cup of coffee, were untailored and relaxed. This inner confidence delineated the difference between his experience and maturity level when compared to other classmates.

Kate. Kate is a 21-year-old Caucasian female. A very well-expressed person, Kate appears as a confident and focused young woman, who naturally refers to life experiences that shaped her academic stepping stones. Previously on the track to pursue radiation therapy as an advanced modality, a recent summer outreach mission to Honduras has changed her life's direction; now her need to pursue social action via public health is paramount in her goals.

Explaining that a family illness increased her familiarity with x-rays, Kate clinically outlines her dynamic goals, while the expressive tones of her voice explain how life events miraculously molded her path. Possessing a Spartan academic diligence, planning and structure are important tools Kate employs for both school and life. Because of this strict regimen and discipline she is able to incorporate other meaningful components into her schedule, such as dancing and outreach activities. From her lessons learned in the radiologic

science program, Kate spins her advice succinctly and speaks from experience. “Well, what I *have* told [future] students . . . is just expect to be tired. But it can – you have to make it fun but it can be fun.”

When asked to discuss a critical incident that impacted her clinical practice development, Kate noticeably bristled as she decided to discuss a patient-related event. Although she maintains personal high expectations in clinical practice, she believes others should have reasonable expectations for student learning as well. Kate described her situation, framed in the context of learning to reflect independently as she was semi-autonomous in the clinical environment on several occasions. “Many times there has not been a person available to help . . . Especially towards the end. They would just kind of leave you in the room with the patient. And a lot of times it’s fine, but sometimes you have a question and you have to leave the patient in the room and go ask them.” As Kate’s story affirms, the machinations of developing a reflective process are often grounded in the reality of the clinical environment-fast paced examinations and stretched resources.

Kate, however, offered a formidable set of expectations when asked to define a good technologist. Clearly, her expectations are candid and realistic, which is consistent with her life expectations, as she professes, “I think, first of all, they have to have a good attitude towards their job. Because if you don’t like the job, then there’s no point in being there. They have to be able to think critically; think about the situation. Not just kind of go about their business, but to constantly um, think about what’s happening and how they should react to it.”

Kate was interviewed on August 6, 2010 at a Panera Bread location. She chose the date and time of our meeting based on her scheduled short weekend excursion, on the cusp of

returning to school and resuming classes. Thus the interview was succinct, but fruitful. She spoke in general terms about her program and classmates, but was specific and brutally honest about the time demands of the clinical rotations. A well-rounded life of academics and extra-curricular pursuits were the constellations by which she navigated; she answered all questions within the context of a connection to her larger life map and personal goals.

Lynn. From her petite frame, to her coiffed hairstyle and unexpected tattoo, Lynn is a refreshing 21-year-old African American female. As a rising senior, Lynn is excited at the idea of becoming an integral component of the health care network and enthusiastically recalls how a job-shadowing opportunity during her freshman year drove her application to the radiologic science program.

Lynn knew in high school her dream college. Her interest in medicine began around the same time when she accompanied a mentally-challenged family member to doctor appointments for batteries of tests-many of which were x-rays. Once in the program, Lynn was able to articulate her confidence and clinical experience into advice for future radiologic science students who are unsure of the path ahead. Lynn casually offers:

Don't be nervous. [The professors have] already taught you a lot. There's still a lot to learn but just go in there and...don't be overconfident but be like comfortable because they teach you all the stuff for a reason . . . don't be afraid to ask questions. Especially it's like your first week. [The technologists] don't expect you to know everything.

The authenticity of her words is truly reflected in her critical incident event as well. Lynn recounted a very positive experience with staff that promoted moments of student growth centered on patient care scenarios.

Lynn's story on her quick reaction that prevented a patient from falling is markedly detailed, as if the event just occurred:

It was an outpatient and he – it was a guy, an older type guy. And he seemed okay when I went and got him from the room and then . . . I got ready to take his PA chest and I told him to take a deep breath in. But, I didn't like see his body move. Usually your body moves. So I was like "sir can you hear me?" and he wasn't responding so I went there to check and like – I don't know – his eyes were kind of around in the back of his head. So like I got a chair real quick so luckily he didn't fall or hit the ground. But like it scared me, and so I went and got somebody really quickly. But, like all the techs were like "you acted like really fast and prompt like you were. . . at least he didn't hit the ground and hurt himself even worse. But, he came to after a little bit and then um, we went on with the x-ray.

In the teaching moment immediately following the event, the staff technologist assisting with the procedure took the time to reiterate patient care standards for this type of event, with Lynn absorbing the details. "[A technologist] said a lot of times when people take a deep breath in, they close their eyes and then . . . and something just happens to them where they're like – they black out a little bit." The technologist's observation of Lynn's quick thinking and response was also a simple kudos for her efforts and the incidental bit of trivia became invaluable to a novice who is grappling for handy information.

Reflecting on these experiences, coupled with her strong desire to work with people, Lynn understands and expects medical professionals to be reciprocating entities-willing to help and willing to accept help in a myriad of situations. This expectation is pervasive in her definition of a good technologist and the expectations she holds for technologists that she

would hope to work with, expecting “someone that’s compassionate. Knowledgeable. Friendly. Not afraid to help someone. Not afraid to ask a question for themselves. And does a good job.”

The interview was scheduled for August 10, 2010 at her on-campus dormitory. Lynn answered all of the academic-related interview questions with a visible nervousness and fidgety outward appearance, but beamed with cheery emotion when she discussed her patient care interactions. In general, she spoke positively about her classmates and recalled scenarios from both high school and college when she could not say ‘no’ to helping others with studying and coursework.

Nancy. Nancy is a 30-year-old Caucasian female with an athletic build, whose ‘old eyes’ speak volumes about her life experiences. Possessing a previous degree in business administration, the death of her brother drastically changed her life’s goals and led her to pursue a career in health care.

A highly successful student who conveys a confident and driven personality, Nancy speaks eloquently about the difference between her original undergraduate experience and the current program. Candidly reflecting on feeling lost and lacking direction in her first undergraduate institution, her life experiences and personal goals have matured her and are now clearly defined and reflected in her plan. Although Nancy displayed numerous leadership characteristics and personal initiative for completing her goals, she feels disconnected from the radiologic science program, as she is not willing to be fully engaged in all the components of the program outside the classroom. It is clear that Nancy seeks successful equilibrium in all of her pursuits-school, work and family.

Nancy is a candid person whose willingness to help others is evident. Her critical incident narrative exhibits these characteristics, as well as a level of frugality characteristic of Nancy—she expects to use her time wisely and productively, thereby harnessing learning in all possible environments. During a summer clinical stint, Nancy was drawn into a controversial situation associated with actions of a colleague student, merely because she was a student in the same program. The negative event impacted her learning journey, but culminated in heightened self-awareness and a new level of epistemic reasoning within her soft skills:

I had a situation occur but I was kind of an outsider in this. I became part of the situation because I was at the clinical site. The other student was... basically an effect of her actions and I got drawn into it because I was also wearing UNC scrubs . . . So, I guess I was approached and told that I was not doing enough exams and not, you know, stepping up and doing everything that I could . . . I had this perception of where I was – who I was as a student and what I'd put into clinic and my competency level. And it was completely wiped out from one day . . . The challenge was to regain the... respect . . . And it put in perspective of how easy it is, whether you do it directly yourself or somebody else does it for you, how easy it is to ruin your reputation in a work environment.

In order to grow beyond this situation, Nancy engaged program faculty for advice on the issue, but felt the ramifications would be beyond her control if she did not address the situation. With realization of the situation, she adds:

I directly confronted the technologists involved and I said like “this is how I perceive myself in this environment. Can you tell me what your perspective is and then we'll

try to figure out where the discrepancy is?" You know. We talked it out and came to conclusions and um, after speaking to [a professor] about it, it basically came down to they have this unreal expectation of students being able to walk in there and have twenty-five years of experience in one year.

Addressing the communication conflict, although unwanted, helped Nancy learn a new approach to socio-cultural conflicts that are present in various clinical environments.

With regard to sage advice interwoven with realism, Nancy is not shy with her words of wisdom for future students, as she feels stronger and undaunted by her learning experience this time:

Talk to [fellow students] before you go anywhere . . . don't read what's on the [professors] syllabus. I consider myself to be halfway intelligent . . . [syllabi] are ridiculous . . . I mean you can ask [professors] questions left and right and still you... it doesn't make sense until you've already done it and you've already messed something up.

When looking to the future, Nancy has as defined a persona of a good technologist as she does her own path in life. Without a doubt, her previous experiences help her enunciate her expectations clearly, stating:

Communication skills. I would expect everyone to be able to – I know that's a ridiculous expectation - but to be able to interact in an adult manner and communicate and you know, delegate work properly and . . .work positively in a team environment because no matter what, you're always going to be working with someone.

Nancy was interviewed on August 11, 2010 at a local Whole Foods Coffee Bar. She selected to meet after sleeping during the day, but before dinner and her late night shift at

work began, as she works nights at an emergency veterinary clinic. Nancy conveys a hard-working personality as she answered all questions with little hesitation and appropriate levels of details, reflective of her maturity. A sense of ease permeated the interview and was carried over to her discussions of patient interactions in clinical settings. Nancy demonstrates empathy for patients and co-workers, as well as a delineated expectation of others to act professionally and pull their weight at work.

Sarah. Characterizing herself as very independent and stubborn, Sarah is a 21-year-old attractive and fashionably clad female. From the onset of the interview, she exudes confidence and is an articulate individual whose smile is heartfelt.

Sarah portrayed herself as a very hands-on learner who admits to getting frustrated on occasion and shutting down. Her experiences in the radiologic science program have been rewarding from both technical perspectives and learning to navigate the social structures and expectations inherent to any clinical setting. Her outgoing personality makes her a natural people-person, with a demeanor that genuinely conveys her desire to help other students, technologists and patients.

Sarah's critical incident event resonated with a negative tone, as the unforeseen event led to circumstances that culminated in a moment of staff-student conflict. Sarah was forced to handle a difficult situation involving a technologist. The situation's outcome did not rectify itself and Sarah's minimal comfort level from the beginning of the situation climaxed with a clarifying, heated situation with the radiologist as she recalled:

I was in the ER and they had me basically pretty independent. But this patient – they wanted me to go in and do a hand on this patient . . . [who was] completely paralyzed, just on his right hand. So I went in and got one of the techs from the workroom and

said, ‘...if you guys could at least be in here ‘cause I know these aren’t going to be beautiful images.’ So, one of the techs came in not so happy about it and um, helped me with it . . . [The technologist] said, ‘I want to do two [images] on one [cassette]’. So basically [the technologist] ended up just kind of taking over and putting my marker on [the images].

When poor quality images were sent to the Radiology, Sarah was forced to explain her side of the situation:

. . . I found out what had happened . . . So I walked over to the reading room. I said, ‘[Radiologist], I heard you’re upset about this patient. I just wanted to let you know that...’ you know, and I told [the radiologist] what happened. [The radiologist] . . . was still pretty hot. But um, I wasn’t about to just let [the radiologist] think that I was ignorant, not knowing what I was doing.

The context of Sarah’s situation forced her to use epistemic reasoning on positioning, imaging principles, patient care and especially, interpersonal communication. When prompted to discuss the takeaway message of the situation, Sarah empathetically exclaimed, “So if anything, I learned that you should do – go with your gut . . . I probably could have done that better and it would have had a better outcome if I had just done it myself and trusted myself. But you know.”

Sarah offered an extension of her friendliness and confidence with gracious advice from her own experiences, operating under the premise that clinical experiences occur in a shared environment that requires everyone’s assistance and awareness. She offered wise words: “From the clinical side, I would say be really observant. I would say to pay attention to your surroundings. Pay attention to how patients are treated. What you can do better.”

In the progression of the interview, Sarah offered a detailed depiction of a good technologist and her personal expectations associated with such a depiction. With great thought and confidence, she voiced the following:

I would say the technologist is someone who is pretty open, willing to work as a team. . . . Independent but not stubborn. To ask for help when needed. [To] accept help from others or accept criticism from others.

Sarah added as an afterthought; a good technologist also needs to have time management skills, physical endurance in order to complete all the dynamic demands of the workday, understanding of lifting techniques and equipment, as well as possessing a sound knowledge of exposure techniques. Her answer was not concise, but full of all possibilities in its staggered presentation.

The interview with Sarah occurred on August 13, 2010 at a Panera Bread location in a local shopping mall. A really warm person to speak with, Sarah answered all questions with zeal and authenticity that is unmatched by the other participants. From experience in her clinical rotations, she freely acknowledges how she has learned from her mistakes, knowing intuitively to trust her instincts and to stand up for herself in situations beyond her control. A very self-confident person, Sarah's interview offered great insight into the details of student roles in clinical settings, from an objective, steadfast and positive perspective.

Susan. A 23-year-old, Caucasian female, Susan is a very animated and talkative young woman. From the beginning of the interview, her stories are full of rich detail and fluent descriptions, further articulated with constant hand gestures and engaging body language. Upon completion of an Associates of Arts degree, Susan matriculated into the

program with the idea of becoming an ultrasonographer in an obstetrics and gynecology clinic.

Susan exudes a keen sense of observation and perception in both classroom and clinical locations and casually notes power dynamics and competitiveness among the students in her program. She is quick to add a constructive perspective to her observations, looking for insight from her program experiences. Susan offered a critical incident scenario that embodied her sense of observation versus action when appropriate to student learning in clinical environments.

Susan relived an event observing a staff technologist complete an exam that was in direct conflict to the way she learned to perform the exam. However, as a student, she felt no grounds to intervene and merely observed a tense situation between the technologist and the supervisor:

Most my week that I was [at this facility], I saw nothing but chest and abdomen . . . And you know, kind of as a student, I felt – I've been doing this for a while now. I felt comfortable doing chests and abdomens, no problem. . . Well, this particular technologist kind of shooed me out of the way a little bit and took charge. He does pretty much everything but I'm standing back and I'm noticing that he hasn't worried about centering and he hasn't worried about collimating . . . I wouldn't have sent [the x-ray to the Radiologist]. I would have repeated it. And so the director was there and actually she kind of thought along the same lines as me. And she looks . . . on the screen and she said, 'You're not going to send that, are you?' and he said, 'What's wrong with it?' And you know, at this point I'm just kind of standing back.

She opined that one of the best ways to learn or assert your point is to observe other professions in their work environment.

Susan is a fount of information on the progressiveness of her academic program, mentioning the use of iPhone technology to track clinical competencies. Susan promotes teamwork and shared community support among students and offers this advice to new students, “. . . Don’t feel bad if you don’t understand a term or . . .you feel a little lost in the beginning because it’s very much up to your class to kind of come together. Everybody teaches everybody. So you kind of just follow the flow.” Openly embracing the program faculty and the challenges of the clinical experiences, Susan is enthusiastic about the possibilities of extending her practice skills and applying to a Radiology Assistant program for graduate studies.

Susan was interviewed on August 13, 2010 at a local shopping mall. The meeting was sandwiched between her morning errands and a professional appointment, but was carried out with an abundance of conversation. Susan openly discussed student/student and student/professor dynamics, which are of continued concern as she progresses into her senior year where inferred inter-student competition will remain strong. Spinning off Susan’s dialogue on inter-personal communication, the researcher segued and prompted her to define a good technologist. She did not seem interested in the question and referred to a previous answer, merely reiterating the need to be “self-aware” and “go the extra mile.” Susan was, by far, the most talkative participant answering most questions with a wealth of additional, juicy detail.

Thomas. Thomas is a 21-year-old Asian-American male, who is smartly attired and exhibits a cool, quiet demeanor. Although he seemed to be casually distracted during the

interview, he successfully addressed the questions while simultaneously focusing on unidentified objects outside a window. Once comfortable, he retold stories from his summer travels to domestic metropolitan locations and how he is looking forward to starting back to school in the coming weeks.

Thomas' slow and deliberate responses were very insightful and full of thoughtful detail. When retelling a critical incident patient care example during our interview, he breaks his controlled character and earnestly laughs about an Emergency Room patient 'firing' him—just because the patient was not having a good day! Humor helped Thomas deal with a curmudgeon of a patient who gave him his first professional introduction to being fired from a job. With great animation, Thomas spins the tale:

[The technologist and I] were trying to get the patient off of the stretcher onto the table. Um, he was very old and grumpy, from the first moment he stepped in the door, uh, rolled into the door I guess. Extremely grumpy, hated everyone in the room, hated the fact that he was down there in Radiology.

He continued to explain the x-ray set up process and the patient's concern over his patient care skills:

. . . since I was the one moving the stretcher, he yelled at me and he actually fired me and so I stopped and looked at the technologist like 'shall I stop?' She's like 'no, keep going' so I was like 'okay.' So I then apologized to the man. He still said I[am] fired, I'm going to be a horrible technologist and all that other stuff. . . I tried to shield him. He complained I threw it on him too rough or it[is] too heavy or something, so he yelled at me for that too. . . . But in this case, he was in a bad mood for the whole exam.

Maturely, Thomas relied on the technologist for solidarity in his actions, despite the vexing patient's efforts to inflame the process. In the end, teamwork, and levity, made this a positive teaching moment. Ultimately, Thomas' stories confirm the levels of learning that occur in the social, work and patient contexts that students must live to negotiate in development of mature practice epistemology.

Thomas further beamed when reminiscing about his leadership role in a small, student medical organization at the university and how that role, plus his participation in the radiologic science program have shaped him as a person and a student. Characteristic of Thomas is the advice he offered future students, punctuated with his usual calm, but youthful exuberance, urging a strong, positive first step:

I would say "jump in" and position the patient from when the first requisition comes off and every single one after that. To go ahead and jump on it. Do everything from start to finish, including requisition, getting the patient positioning done, getting them dressed, putting them on the table. Even setting the technique.

Now familiar with his expectations of student clinical involvement, when asked how he would define what characterizes a good technologist, he mused and answered with, "I would say a caring one, who cares about the patient not so much as getting the exam done but really one who thinks about what's best for the patient."

Thomas was interviewed on August 17, 2010 at the same Panera Bread location as several previous interviews. Thomas answered all questions candidly and with a quiet, focused demeanor. Thomas offered answers that blossomed with obvious personal drive towards improvement and growth in his abilities. Although openly stating he was unsure of some of his answers, he did not diminish the weight of the information he chose to share.

Chapter Summary

This chapter presented the study participants, their critical incidents, sage advice for new students and definitions of a technologist. From the interviews, students remarked on both positive and negative situations that impacted their soft skills more so than their hard, technical skills. In order for an incident to be “critical”, it must leave little doubt concerning its effect or impact on the participant, according to Flanagan (1954). From the critical incident experiences students discussed, it is evident that these events sculpted the wise and forthright tales each offered. Chapter Five discusses the study data and its relationship to the research questions of this study.

CHAPTER FIVE

Findings

This qualitative study embodies the experiences of ten senior radiologic sciences students at one southeastern baccalaureate institution. The purpose of this study was to explore how rising senior radiologic science students reflect in clinical environments in order to solve complex problems and make informed decisions. Using the gap in the literature on reflective practices of rising senior baccalaureate radiologic science as the impetus for this study, the following research questions were investigated:

1. How do rising senior radiologic science students learn to reflect in practice?
2. What application do rising senior radiologic science students make of reflective practice in clinical settings?
3. How do rising senior radiologic science students learn to negotiate knowledge from classroom and clinical instruction to make informed clinical decisions?

Chapter Five is organized into two areas to thoroughly discuss the findings of the research: medical imaging baccalaureate program elements and the findings of this study. To better understand the academic context of these students, the findings section begins with a brief overview of pertinent curriculum components of the baccalaureate program that directly impact this research. Next, the research findings are presented based on the research activities and data collected.

Using a constant comparative method for data analysis (Glaser & Strauss, 1967) along with Alexander's (1990) Nine Identifiers of Saliency, the narrative text was interpreted. Next, the researcher fragmented and reconstructed the primary source of interview data collected from the eight female and two male participants, using their stories to identify

themes across the data set. Ultimately, all data sources amassed during this research process, including participant and researcher observations, field notes, document analysis (curriculum guides and accreditation guidelines), and researcher logs, were used to fully determine how participants reflect in clinical environments to tackle a gamut of clinical issues. Table 8 gives an overview of the findings for each question, with explanation and support for the themes from the narrative text described in detail following the table.

Program Overview

A baccalaureate degree in radiologic science is designed to move a student beyond the level of a practicing radiologic technologist to a plane of greater understanding, synthesis and managerial capabilities. Each four-year degree program has curriculum and clinical requirements, as well as clinical competency stipulations that are designed to demonstrate an achieved level of knowledge retention and application. However, every degree program has latitude to determine their approach to implementing the required learning elements.

The baccalaureate radiologic science program studied in this research has two unique curriculum features of note: all radiography positioning courses are completed in the first professional year and rising senior students participate in an intensive summer internship between first and second professional year. The positioning courses serve to complement and bolster the clinical experience in the various medical imaging rotations facilitated in the first professional year of the program.

Senior radiologic science students identified the rigor and fast-paced expectations that the clinical rotations present. With each two-week clinical rotation during the first professional year, students were presented with various clinical sites and different imaging modalities, both fundamental modalities and advanced imaging modalities. The summer

Table 8

Data display / Summary of findings

RQ1: Learning reflective practice

- a. Engaging patients
 - i. Applying embedded knowledge
 - ii. Employing evidence
- b. Interacting with communities of practice
 - i. Interacting with staff technologists
 - ii. Interacting with professors
 - iii. Interacting with other students in the clinical environment
- c. Logical reasoning
 - i. Correlating information

RQ II: Processes rising senior students use to reflect in clinical practice

- a. Learning through simultaneously engaging and reflecting
 - i. Valuing performance
 - ii. Mentoring in clinical environments
- b. Applying maturing practice epistemology
 - i. Mapping and integrating experiences
 - ii. Critically reflecting to hone epistemology

RQ III. Learning to negotiate knowledge from classroom and clinical instruction to make informed clinical decisions

- a. Engaging decision enabling resources
 - i. Consulting formal resources
 - ii. Utilizing clinical staff as resources
 - b. Assimilating information from classroom to clinical
 - i. Acknowledging learning styles
 - ii. Inhibiting information assimilation
 - iii. Engraining information through clinical experiences
 - c. Impacting informed clinical decisions via clinical experience
 - i. Varying clinical rotations to bolster learning
 - ii. Linking consistencies between clinical rotations
 - iii. Dissenting clinical rotations
 - f. Navigating uncertainty and complexity
 - i. Reconciling book/classroom and application/clinical information
 - ii. Critically reflective practitioner
-

internship served to solidify basic imaging skills and meet program requirements for hours of clinical experience. Further, it is intended to move students from a defined, structured and highly supervised clinical environment, to the role of a self-directed, student radiologic technologist with appropriate supervision (UNC-Ch, n.d.).

Through extensive document analysis, it is clear that the import of this unique curriculum structure enables students to have a complete and accessible working knowledge of positioning, patient care and imaging specifics to use for the entirety of their second professional year. From field notes gathered during interview interactions with participants, it is feasible to determine that this affords an opportunity for expanded application of clinical skills and chances to explore advanced imaging modalities otherwise not available to students in other curriculums.

Learning Reflective Practice

The first research question addressed the components and processes that rising senior radiologic science students use. Since the participant interview process was semi-structured, discussion of developing a reflective process revealed three contexts that the students correlate to reflection. Associated with these three contexts- solving patient care problems, solving imaging problems and solving inter-personal and communication problems, three themes emerged from the data that discern the student's developing reflective process, 1) engaging patients, 2) interacting with communities of practice and 3) logical reasoning.

Engaging Patients. Students enter the clinical environment armed with fundamental knowledge of radiography in areas of patient care, positioning skills and imaging physics. Interacting with diverse patient populations offers a realistic view of textbook information not otherwise illustrated in the classroom. Patient interactions, as depicted in this study,

included patient communication skills, basic patient care and contact during radiographic procedures. Students were expected to refer to their existing epistemology while interacting with patients and extrapolate it into the context of a given imaging situation, in order to complete the examination. Subthemes of benefits of interacting with patients emerged as use of embedded knowledge and use of evidence.

Basic patient interaction was novel to seven out of ten first professional year students entering clinical rotations. Students like Georgia, a 21-year-old student, had limited patient/health care interaction prior to starting the radiologic science program. She spoke highly of clinical time and how important it is to developing students, “. . . you don’t feel comfortable until you’ve been in there, you know, working with patients. So I definitely value have the opportunity to work with patients and then becoming comfortable.”

Applying embedded knowledge. Students often remarked in the interviews on lessons learned in courses that provide the fundamental information used to make clinical decisions. When preparing for clinical rotations, Thomas, a 21-year-old student, as well as Susan, a 23-year-old radiography student, referred to imaging texts taken to the clinical facility for reference: “I’ve ordered the Pocket Merrill’s, and I bring that with me just in case I need to review um, like a radiograph...that’s not very common. I have to look it up.” Kate, a 21-year-old student, creatively compiled her own flashcards for review during clinical rotations: “So I’d make flash cards and stuff and I’d drill myself ...and I would take those to clinics . . . so that would help. Like if I would know that a foot’s coming out, I would pull out my foot thing and brush up on it and go do it.”

Ann, who is 30-years-old, argued the best reference was practical knowledge, musing that she relied on book smarts to guide her clinical decisions:

I try to have that foundation from the book and I do review books before I go, and classroom materials. But honestly, like every chest x-ray, even though it's a basic like exam, every chest x-ray is done differently it seems. Even though you think you're centering the same, you know, it's all done differently. You really have to have a good practical/clinical understanding of how to do it too.

Concurring with Ann is Kate, who enunciated: “. . . Like a book, you know, can tell you stuff but not specifics.” This sentiment is a common thread among majority of the students, who also found hesitation with book learning and recognition of the clinical activity applications.

In student narratives on their approach to routine radiographic procedures, the narrative information unconsciously linked deep, classroom knowledge to clinical application. Although patients are an obvious component in the learning process, when students recounted the basic preparatory steps in conducting radiographs, the patient transitioned to be the main focus of the stories. The level of detail articulated in the stories was dependent on the student and correlated to the comfort level the student had in their overall clinical experiences to date.

Take Georgia, a 21-year-old student, for example. Her most recent clinical experience was a high-volume outpatient clinic that focused on orthopedics. Georgia elucidated radiographing a knee, “You get your requisition, you get all your cassettes and scan ‘em all in. Set up for AP, bilateral standing, lateral/side, angle as needed, and um, then you do the tunnel view and the Merchant’s.” Innately, Georgia has completed so many knee radiographs that the process is distilled down to key check points. Realizing that Georgia is a shy, but

methodical student, she supplemented her original story on the inherently applied portions of radiography when prompted:

Well, patient on the table first. Then I'll line up my tubes and my Bucky and then position the patient where I want, depending on the area of interest . . . Center the knee to the light because I wouldn't move my tube anymore. And then, um, shield.

The recall was riddled with implied details, as the level of intricacy associated with imaging is not conveyed in her story. After heightened repetition of exams, the minute details become rote and the machinations repetitive, which is of key concern to stiling development of reflective practice.

Another student, Lynn, who is 21-years-old, gave a different perspective on how she prepared for an x-ray. Her narrative illustrated how patient context provides crucial cues that helped students retrieve stored information. Lynn appeared to reference an intangible checklist of items while preparing for and then, performing a chest radiograph:

. . . First thing I'll look at is...the age, just because you need to know what size IR [image receptor] to use . . . and see their reason for getting an exam. . . . I usually wait until I get [the patient] in the room to ask them like their date of birth and stuff like that . . . I usually already like put my plate in the Bucky or whatever before the patient's finished so it makes it quick and easy 'cause chests aren't really that long. So when I get 'em in there, tell them what to do – I position them . . . I tell them to take a deep breath in, hold it. And uh, then we'll take [the lateral] one . . . and done, then let them go.

Novice radiologic technologists find having Lynn's aforementioned information very important as a pre-developed, now inherent, working checklist to innately know what step precedes the next.

Thomas gave a much deeper recounting. His personal drive to perform better was obvious when he later explained how he challenged himself by self-timing the duration of each exam and how he sought improvement through personal continuous quality improvement exercises. His example was very clinical: retrieve and read the requisition; initially and methodically prepare the exam room to include positioning the overhead tube, aligning the bucky, installing and marking the plate and pre-collimate; call the patient, verify patient information and provide instructions on proper attire for the exam. In recalling a flexion-extension lumbar spine exam, he keenly identified novel patient imaging "tricks of the trade" that students do not comfortably adopt as practice at this early a stage of clinical practice. When performing a lateral radiograph, he explained:

Tell [the patient] to look to their left, turn their body to the left . . . I'll bring out an IV pole to get their arms out of the way. . . It kind of straightens out the back too. . .

After they do that, set technique, take the exposure – tell them to take in a deep breath and then take the exposure. . . And then I would tell them to um, either bend down as if they're touching their toes or to bend backwards as much as they safely can. . . to finish the series.

Thomas' experience exemplified the need to take foundational knowledge to a higher level, using practical ideas to expand upon embedded knowledge for sensible application. Not all students articulated their use of embedded knowledge as an integral component of clinical; however, its presence was clearly identified in narratives.

Employing evidence. Clinical patient interactions are an important proving ground for students building reflective skills, as evinced in student interviews. Logically assessing evidence presented from patients, patient history and supporting documentation was a step that helped convert surface understanding to deep learning for several students.

Use of evidence was expressed as concepts including the student's seeking more information, use of personal common sense and the ability to discern pertinent information from non-verbal or non-written cues. As implied by student narratives, patient interaction in radiography is not simply about performing an x-ray; it is understanding patient history, visually assessing the patient for not only his or her ability to complete the exam, but also how to properly select imaging factors for the exam and to finally, counseling the patient in the appropriate context when concerns or questions arise.

As applicable in the context of the student narratives, any student centered activity that focused on the student's ability or need to seek additional information or clarification before or during an exam was considered in appropriate use of evidence. Lynn illustrated how she learned to rely on evidence, as well as her instincts, when working with patients:

It was an outpatient and . . . an older type guy. And he seemed okay when I went and got him . . . and I asked him was he feeling okay, had he had any like falls or anything in the past couple of months. And he's like "no." He's coherent and everything. So I got ready to take his PA chest and I told him to take a deep breath in. But, I didn't like see his body move. So I was like "sir can you hear me?" and he wasn't responding so I went there to check and . . . his eyes were kind of around in the back of his head. So like I got a chair real quick so luckily he didn't fall or hit the ground.

After working in the Emergency Department, Ann's lessons learned changed the way she assessed patients, saying her practices have changed most in ". . . how [I] adapt to different patients as far as . . . being able to read body language from a patient . . . and scope out the situation to know what decisions to make as far as positioning and safety and things like that." Ann learned this lesson from an unpreventable event with a patient who collapsed, solidifying the neither unexpected nor predictable portion of human interactions.

It was not surprising to find that evidence seeking behavior was prominent in most student narratives, some more explicit than others and showed marked differentiation between those students who seemed to possess a surface versus deep level of learning. Sarah noted that detailed patient history before an examination would have been of interest in her situation of a patient collapsing during a procedure, a situation that required a Code Team to assist the patient. Student experiences demarcated the difference between information not provided or unexamined and scrutinized evidence when working with dynamic patients.

Interacting with communities of practice. Communities of practice were highly pervasive throughout the student narratives and were referred to as highly influential on learning. As framed by this study's participants, communities of practice referred to personnel, specifically other radiologic science students, staff technologists, clinical mentors/professors, and patient care teams that exist in various clinical environments in which these students engage. Students were asked to describe how non-patient interactions and communications shaped their developing skills and perspectives in clinical locations. Students identified effective interpersonal communication as key to heightened understanding and application of skills. Having these relationships promoted a comfortable learning environment and lessened anxiety about taking new risks and safely tackling the

unknown. Further, these interactions stimulated heightened information processing and understanding through questioning and allowing for guidance, as well as offering feedback to confirm strengths and target growth opportunities of weaknesses. Interacting within communities of practice was broken down into encounters that facilitated learning via technologists, professors/clinical mentors and other students.

Interactions with staff technologists. As students travel the path of academic enrichment, building relationships between the students and staff technologists is essential to student growth and success. The guideposts in the student descriptions imply that technologists serve to promote confidence, assuage fears and encourage interest in learning the profession. Students make the most of working with staff to increase their practice confidence through proactive participation in examinations and procedures. Open communication facilitated relationships between clinical staff and students and in instances where communications were stilted, various means were taken to re-open those channels. All ten students referenced the relationships with staff technologists as an integral component of learning, both positive and negative.

Observation is not framed as a passive act, but rather an act of reflection or contemplation to work through scenarios and determine the role of the student versus the role of the observed technologist. Sarah, a 21-year-old student, approached a new clinical rotation by overtly studying the staff technologist and cataloguing useful information. She wanted to be a sponge and absorb all the intangibles that the professors, books and lab practicals cannot give. At the start of a clinical rotation, she began by “. . . learning techs, learning how they [do] things, learning where they put things . . . their arrangement . . . or how they position, [their] technique and then... when it came to Wednesday, I was ready to go . . . Every tech

does things differently and I took... Instead of getting frustrated with it, I took it as an opportunity to kind of see what I liked and what I didn't like."

John, a 33-year-old student, is an easy-going although highly articulate individual; he discussed how his observation of technologists in his early clinical experiences helped clarify workplace dynamics as well as technical and procedural expectations. However, John's experiences started with fairly autonomous, active participation his first day of clinical. "The first day I walked in, they handed me a requisition and they said, "here, go do it." It was my very first day at it. I'd never done an x-ray." John's personality easily adapted to these unexpected challenges and he prevailed successfully.

Kate asserts that observing and polite engagement of staff technologists is essential to student success. "... [technologists] should know everything that they need to know and everything I need to know. And so they kind of like should just be a well of information all right there in one thing." Kate's demeanor capitalizes on staff/student interaction for her continued development of clinical competence.

Ann stated her learning directly correlated to the interpersonal relationships with staff technologists and explained that positive role models empower her to learn and participate more:

I think mainly my perception of rotations I like the best has to do with the technologies I like the most. And I don't know if I could see myself doing the same thing all day long because it's very repetitive. But the technologists I'm working with are so good that I can see myself working in that kind of environment. I'm very much affected by people that I'm working around and there are certain rotations I know I will never work in, just based on the technologists that were there.

Ann further adds that communication is two-way between students and technologists. “I think if you go in seeking knowledge from them, they are much more receptive to you and treat you a whole lot better.” She announces, “...you want to go in and say, ‘I want to learn a new way of doing this. Tell me how you do it.’ You know. ‘I like the way you do that.’”

When scrutinizing both sides of interpersonal relationships and the impact on student learning, Carly, a 21-year-old student, found her inquisitiveness capped by time constraints associated with patient load or staff technologists disinterest in explaining in-depth material. Carly’s air when recalling this narrative was disconcerted by the lack of technologists sharing her same level of enthusiasm in sleuthing:

I feel like because I’m more curious, I ask questions beyond the scope of radiology standpoint. And because I’m interested in going into Medicine, I’ll ask more about patient’s disease process; “what are we going to do now that we see something like a pneumonia or something in the patient? What are we going to do from here on?”

And a lot of techs are like “I don’t know.” Like “we’re here to get ‘em in, get ‘em out.” I’m like “okay, well...”

In Carly’s case, she is undeterred by the lack of enthusiasm primarily due to her character. This same determination and steadfast resolve is not applicable to all students in the study.

Staff technologists who appear intimidating, distant or frustrated by student interactions can impede deep learning and the reflection processes in students. Four of the ten students gave pointed examples of how staff technologist interactions actually inhibited or slowed their learning. When asked to describe causality factors that hindered her learning in clinical rotations, Nancy, a 30-year old student, cleanly stated that, “being in a clinical setting where there are technologists that are not willing to work with you.” Her utmost

concern was, “they absolutely ignore your presence.” When prompted for further details, she adds, “I think . . . I’m the type of person that I need to know. I need to figure out all the . . . different equipment, different computers, different protocols. I just need to ask to make sure that everything fits with what I’m doing.”

After dissecting the situation and seeking guidance from professors, Nancy reports the crux of her particular situation started with detailed circumstances surrounding staff technologists operating with, “unreal expectation of students being able to walk in there and have twenty-five years of experience in one year.” After pausing to control her thoughts, Nancy continued:

Just because I ask you “what four views you want for foot?” doesn’t mean I don’t know how to do a foot x-ray. It means I want to know what your doctor wants. . . . I want to know what exactly your protocols are— it’s not a reflection of whether or not I’m confident enough to do the exam.

The pivotal point for her was to clearly delineate to the staff technologist that she did not lack book knowledge, but lacked practice procedure clarity.

Susan recalls catty, unnecessary comments from a staff technologist after she completed a chest x-ray at the end of her first professional year in the program. She narrated:

I did a chest x-ray. [The technologist] was like “oh, you did that.” And she was like “oh, I didn’t think they taught y’all how to collimate.” Just derogatory, unnecessary comments . . . It’s just very frustrating for us because it feels like we shouldn’t even . . . be wearing those green scrubs that day.

The data clearly demonstrates the influence of power and interest on students in this community of practice. Five students gave pointed examples of learning in inflamed social

contexts. Sarah candidly discussed the variety of clinical environments and how some are not hospitable to students: “It’s like it’s a family or a very miserable place with a lot of enemies. You’re just kind of thrown in the middle.”

Georgia takes a different outlook to minimization of negativity towards student involvement in hostile work environments. Pausing to focus her thoughts, Georgia announced:

Be aggressive because your impression – that is the impression that will carry on. Like even if you are a nice person, the techs don’t look at you as being a nice person. They look at you, “are you a hard working student or a lazy student?” And so if you’re being aggressive and engaged and even if you don’t know what you’re doing; you know, go in the room and ask questions because that’s what they want to see. If they don’t see that, then they’re thinking that you know, you don’t want to be there and so they’re not going to help you and so it’s going to be an X on your shirt for the rest of the time.

Her sense of realism is shared by other students as well, all seeking to develop synergistic and productive relationships with technologists, for both competencies and developing professionalism in practice.

Interacting with professors. Although select professors are present in the clinical environments, all program faculty play a role in the developing student practice epistemology and reflective abilities. It is essential that students have clear lines of communication with clinical faculty for added assistance in understanding procedures and expanding their scope of practice. Ann distinctly valued the faculty and the role they play in her success, “The type of relationship we have with our faculty . . . [is] so open and . . . I relate to them.” Sarah, in

addition to John, reiterated similar feelings, as she valued the professors most out of the program resources. Sarah declared, “I feel as though I’m pretty open with them. If I’m having trouble, I’ll just go and say, ‘What is going on? Help me get through this. What am I doing wrong?’ because sometimes you get so caught up in it.”

In reviewing critical incident information garnered during interviews, students reference consulting professors on more issues relating to interpersonal communications and clinical relationships than on technical skills. John distinctly recalled an internal conflict with staff, that, as a student, he refrained from participating in:

There was a[n] . . . inner department conflict that [the staff] tried to draw me into. And when I told them I would rather not, [the staff] kind of turned on me instead. . . It was kind of difficult because I felt like I was taking the high road in choosing to stay out of the department drama. So I don’t know if there was really anything I could have done differently. . . Well I did actually have to have a conversation with one of my instructors. Only because it had escalated to that level. I was going to be the big person and just kind of look the other way and pretend it didn’t happen. Um, just you know, I didn’t want to get anybody in trouble. I didn’t want to, you know, rock the boat or anything like that. . . They kind of went to that level so I had to spill the entire beans and then their supervisor got involved and that person’s supervisor got involved and it was kind of crazy.

The more nebulous circumstances that student confronted often required professor disarmament more readily than say, having the ability to consult textbooks or literature for hard skill development.

Interacting with other students in the clinical environment. In select clinical settings where students interacted with peers, it was perceived to have a positive influence on developing reflective practice. Sarah recalled how she and another unnamed student initiated role playing to better understand new procedures. “We were fairly new and in a high workflow environment at the [clinic]. And so there was some downtime. I think it was our lunch, so we both went into an exam room and role-played. We went through different things and that helped me. I think it helped her too.”

Four students did not portray peer-interaction in clinical settings as helpful. Instead, Nancy characterized her experience as troubled when she was indirectly judged by the actions of another student. With a disheartened air, she recalled:

I was in Diagnostic that week. I had done Fluoro the previous week. And then when I moved to Diagnostic, um, [another student]...was doing Fluoro . . . [that student] made it clear to them that [they] hated Fluoro so at that point, every single technologist in the building . . . was not okay with both of us. So, I guess I was approached and told that I was not doing enough exams and not, you know, stepping up and doing everything that I could. In the previous week I was running a Fluoro Room by myself the whole entire Friday, so I... had this perception of where I was – who I was as a student and what I’d put into clinic and my competency level. And it was completely wiped out from one day. I was like “what happened?” you know?

The drastic change in technologist’s support of Nancy was a direct result of another student’s action and imparted a new and unexpected level of self-doubt in her. Flustered during the retelling of the story, she continues:

So at that point, you know, I really had to stop and think like “what...what’s changed about me in one week?” The challenge was to regain . . . I don’t know if it’s respect or, yeah, their opinion of me. . . . And it put in perspective of how easy it is, whether you do it directly yourself or somebody else does it for you, how easy it is to ruin your reputation . . . in a work environment. . . . And how hard it is to get it back.

Similar to Nancy, Lynn feels she has learned a lot about social dynamics, power and relationships among students after experiencing the wide variety of clinical environments. With calm resolve, she states, “I hope I’m like a person that when people talk about you they say good things about you. They don’t gossip in a bad way. . . Like, someone who always does their job; knows what they’re doing. So...and not the other way around.”

Although two other students experienced similar circumstances in the clinical environment, no one articulated the personal impact as clearly as Nancy and Lynn. The reality of practicing in a variety of work environments helped globalize the student’s perspective and their ability to be effective, reflective practitioners by honing soft skills like teamwork and communication.

Logical reasoning. The third theme that emerged under this research question was the need for students to develop logical reasoning abilities while working and reflecting in clinical rotations. Students cannot merely draw from one body of knowledge to address complex problems; they must pull from theoretical, procedural and practice knowledge (Schön, 1983, 1987). The act of reflecting includes viewing all components, analyzing them and making informed decisions or actions. Reasoning through the empirical evidence and the available options is fundamental in radiography. Learning to logically reason, much like reflecting, takes time to make linkages between data points and transform that information

into deep levels of learning. Finally, active engagement, learning by doing, is explored via two sub-categories: student experiences and a constructivist approach to learning.

Nine of the ten students stated they learned more while actively involved in clinical education and could live the experiences by participating in them. Accompanying the active participation portion, students posed interactive questions to staff that improved their understanding of specific situations in a context or environment rife with the unfamiliar.

Thomas explained how he addressed reflection through active engagement with a patient examination that was unfamiliar to him. His idea was to test his comfort zone, apply all the working knowledge he had, as well as logical reasoning, in an attempt to complete the task:

Many, many times I've done this . . . if I kind of knew what I was doing or if I probably didn't know what I was doing, I would set it up and position the patient the way I think it's done or should be done. . . . And then before I expose them, I would go ahead and get a technologist and ask . . . if the setup is okay, if it's correct and all that. And sometimes someone does correct me and sometimes they'll be like 'well, that's ah...it could be done that way, but let's see how this turns out.'

Thomas' experience demonstrates authenticity in learning and the ability to learn from one's mistakes as they occur.

Carly's mantra was to try everything, "Show initiative and take part in as many procedures as you can. Because once you get off in the real world, it's just you by yourself." Georgia is honest about how active participation helped her embed knowledge for use in clinical practice, "Trying it. Definitely trying it, 'cause um, to be honest, in the class, I didn't really learn any of the positioning until I actually had to do it." In concurrence, Kate

summarized her active learning as the “see one, do one” technique and relishes in getting involved quickly.

Several students discussed being pushed out of their zone of perceived capabilities quickly to try different exams. According to Vgotsky (1978), this is referred to as zone of proximal development (ZPD), with the definition of, “the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers” (p. 86). Thomas described how a difficult patient made him push past his comfort zone to develop a new level of confidence and independence in his clinical reflective practice:

This was... a patient that came in around 1:00 p.m. or something. So that was a very difficult patient. . . . He was hooked up on oxygen . . . so I tried to move the stretcher out of the way a little bit just so that we could get to the um – the Bucky. The oxygen tubing had been a little short and it actually got caught on something and then it tugged on his nose piece and his ears a little bit. And since I was the one moving the stretcher, he yelled at me and he actually fired me and so I stopped and looked at the technologist like “shall I stop?” She’s like “no, keep going” so I was like “okay.” So I then apologized to the man. He still said I’m fired, I’m going to be a horrible technologist and all that other stuff.

During the retelling of this event, Thomas had to stop and laugh out loud at the surreal events of the day. After shaking his head and with a good attitude about the whole scene, he continues:

So I got the stretcher out of the way...I tried to shield him. He complained I threw it on him too rough or it's too heavy or something, so he yelled at me for that too. He continued to bash me about how I'm never going to find a job. So yeah, that was horrible . . . After that, I just brushed it off and laughed it all off.

This student's learning was augmented on many levels, since he proactively sought new learning opportunities on his rotation, undauntedly prevailed with this exam and actually experienced a 'one of a kind' lesson.

While interviewing the students, obvious epiphanies were noted during the discussions. Students, during recall of specific events, developed new meaning in reaction to their lived experiences rather than learning rote meanings from others. Lynn, a reserved young woman, explained how a certain level of autonomy in clinical environments promotes this type of constructivist learning in students. Her experiences with varying patient body types helped map concepts from books to application, in order to reflect and solve complex imaging problems:

If [the patient is] really thin, I know to decrease like the mAs or the kVp, just because there's less tissue to go through. If they're really big, you have to increase it, depending on how heavy they are. And usually, people in a wheelchair, that calls for you to increase it too because just because of the metal that's all around. Especially like for the PA because you can only do the PA with like an AP...an AP grid. So, yeah I mean...The class has kind of taught me how to prepare. . . Particularly with [positioning] class, positioning and procedures. And then once you get in [clinical], a lot of times you can't really go by the textbook and so I've gotten a lot of hints from the techs themselves, and tips from them for what they use. A lot of times I'll use

theirs...techniques instead of what's in the book 'cause you can't always go by the textbook.

Lynn's experience is heightened by her practical understanding of patient imaging and her willingness to reason through imaging specifics to effectively complete an exam. These skills are expected to mature over the course of varying clinical rotations as required by radiologic science curriculums, where students are exposed to unfamiliar procedures and forces to reconcile all possible information to make informed decisions.

Correlating information. At the end of the interview segment for research question one, each student was asked to complete a metaphor with the opening prompt, "Figuring out this problem is like what . . .?" The intent of this question was to challenge students to put their reflective practice experiences into lay examples that non-medical people could relate to, in order to illustrate how the use of reflective practice, active learning and reasoning all resonate in radiologic science education as well as some of the simplest of life's tasks. These illustrative metaphors demonstrate how students have prior experience with certain tasks or events and the ability to reflect on the outcome-positive or negative. The examples from the students were wonderfully creative and a joy to watch each answer evolve from very pensive students. This section ends with these quotes, as they segue nicely to the next concept of the processes students use to reflect in practice. All ten students provided their individual perspective in this information assimilation exercise.

For Ann, figuring out how to approach a technologist about the appropriate use of sterile technique is like many of life's moral dilemmas. Frustratingly recalling events, she explains: ". . . this is a dilemma of what I need to do . . . who I should tell . . . trying to make a decision about what right or wrong is like, it's hard."

Carly chose to relate her radiography learning to authentic learning through her personal experience. As she recalls the specific event, she chided herself and laughed while retelling it. “Figuring out how to move the tube and move the Bucky is like . . . learning never to put aluminum foil in the microwave. Okay. It’s sad but it’s happened to me. But...and I bet you, I’ve never stuck aluminum foil in the microwave ever again.”

Offering answers with distinct brevity, Georgia associated solving radiography procedural problems with experience. She explains, “So, definitely experience helped me to learn how to do each procedure.”

With an expression of confident wisdom, John waxed philosophical with his story. After much contemplation, he announces, “. . . figuring out how to do an x-ray and getting the proper anatomy on a film in the way that it should be oriented would be like knowing what’s in a shoebox and knowing that it’s in there and what it looks like but not necessarily being able to see it.”

Kate was not quick to provide an answer, but instead took a few moments to muster a prophetic answer. Articulating her example with little hesitation and a huge smile, Kate said: “. . . memorizing technical factors is like . . . memorizing a multiplication table.”

Lynn offered a cogent and familiar life experience. She wistfully recalled, “Figuring out chest x-rays is like riding a bike. Because once you figure it out, you’re good to go.”

Expressing frustration with the activity, Nancy equated her understanding of x-ray physics to higher level learning, when the epiphany of understanding occurs during a time when it is least needed or applicable. She nervously laughs and says, “Figuring out x-rays.... It’d be like building a machine and not being able to plug it in anywhere.”

Markers on x-rays are road signs for a radiologist, according to Sarah. She speaks from a hard lesson learned while in clinical and knows to follow all the rules, saying “. . . learning how to mark an x-ray is like learning how to drive on the right side of the road.”

Applying time management skills in order to be a successful student was a necessity to overcoming habitual procrastination for Susan. She equates conquering procrastination to climbing a big hill, “when you’re a procrastinator like I am . . . everything seems like a big hill you’ve got to get up to, so you try to avoid approaching it until you have to.”

Instructing patients on how to position body parts for x-rays takes practice, but according to Thomas, some examples are more direct than others, Demonstrating while he talks, Thomas announces firmly, “Taking a lateral wrist radiograph is like asking the patient to do a karate chop.”

From the perspective of the students, clinical rotations provide the essential proving ground to try what is illustrated in textbooks and classrooms and to add to their developing skill sets the “tricks of the trade” as espoused by professional radiologic technologists and clinical staff that have working wisdom and institutional knowledge. Having a logical understanding of the textbook information allows each student to use their experiences and practice wisdom, as represented by the metaphors, to link this content specific knowledge with engrained personal tools, in order to achieve good clinical application of their developing skill sets.

Processes Rising Senior Students Use to Reflect in Clinical Practice

The next set of findings relates to research question two and the processes senior radiologic science students use to reflect in clinical practice. This section explores accounts of critical incidents to better gauge student problem solving processes in clinical settings.

The critical incident examples include patient care situations, technical/positioning situations as well as communication/interpersonal situations. From the interview data collected, two main themes emerged that provide insight into the processes students use to reflect in clinical practice, 1) learning through simultaneously engaging and reflecting and 2) maturing epistemological development.

Learning through simultaneously engaging and reflecting. Active learning engrosses students in the actual processes and analyzing what is involved at each step. In this research, students who were actively engaged described behaviors that are true to active reflection and integration of information. This section contains descriptions of factors present in various clinical practice environments that impact how students reason and reflect in practice to solve complex problems. The clinical practice environment is defined by student descriptions as the clinical setting context and its inherent characteristics, which include staff interactions, communication, clinical competencies and clinical mentoring.

Eight of the ten students routinely asked questions of the staff technologists, which was a necessary step to improving their understanding of what they were supposed to do in procedures-information not discernable in textbooks for the practical nuances. These question and answer activities filled information voids and made links between old and new learning, thereby strengthening their knowledge and shaping personal epistemological beliefs into practice epistemology and application. These interactive moments deepened student understanding and heightened their motivation to learn and seek more from the clinical environment.

Valuing performance. The atmosphere and size of the clinical environment has an impact on the student's opportunities to perform versus merely observing procedures. After

completion of the first professional year, students seem to have an expanded, sound repertoire of clinical competencies and procedural understanding, as well as a comfort zone for participating in a cadre of exams. Carly openly relied on communication with clinical staff as a component of her reflective processes and to grow as an imaging student, “. . . what I’ve learned in every single thing that I’ve done on the job, if I don’t know it, go ahead and ask because it’s just a waste of time to keep doing what you’re doing.” She continues her thought by describing the value, and frustration, of participating in varying clinical settings that present new information and challenges.

Unlike Carly’s stance on learning by asking questions, Ann relied on her explicit knowledge of textbook information as the first process in reflection before an exam. Prior to performing an abdomen x-ray, she must reason through the various procedural steps, the deviations that may exist and the abilities of the patient to participate. Ann delineates her thoughts in a methodical manner:

There [are] different positions you would want to use to show different pathologies. You want upright positioning for free air or do decubitus to assist for free air for tests. You’d also need to compensate on your technique. If you think there [is] a lot of fluid, you may need to up the technique or you might need to alter breathing instructions as well.

Combining Carly and Ann’s approaches, Georgia meshes book information and her personal core of information as the first process in reflection as she explains,

From experience, patient to patient, if I have a baseline I can . . . go back to that baseline and say, “okay, that’s what you do for the average patient and this is what you would do for a bigger patient or a smaller person”.

Lynn builds on Georgia's perspective and created a fail-safe mental list of items that she may need to reason through in order to complete examinations:

. . . if they're really thin, I know to decrease like the mAs or the kVp, just because there's less tissue to go through. If they're really big, you have to increase it, depending on how heavy they are. And usually, people in a wheelchair, that calls for you to increase it too because just because of the metal that's all around.

When asked where she learned the basic skills for this type of reflection, Lynn unwaveringly credits her foundational radiologic science classes first, and then transitions to working with staff technologists to hone her reflective processes through observation of their actions. Staff observations allowed for quiet absorption of otherwise unwritten examples, “. . . and then once you get in [clinical], a lot of times you can't really go by the textbook and so I've gotten a lot of hints from the techs themselves.”

Assessing the challenge of imaging a casted extremity, John pulled from classroom learning and a situation that could not be fully illustrated by an instructor and a book. He muses about process factors he must consider in practice:

I would say that they're in a cast so I had to kind of double-check to make sure that my positioning was good even though I couldn't necessarily see the anatomy.

Probably have to go up a little on the technique because of the cast.

John clearly demonstrated his use of reflective practice in the invaluable context of clinical learning, where he deliberated as well as aggregated information from different experiences to solve the intricate dilemma.

Six other students referred to examples of how explicit knowledge is the primary personal resource in clinical practice, with one participant referencing the radiography

registry examination categories that everyone has to know and pass before becoming credentialed to practice. Even with the knowledge that reference books provide as necessary building blocks, the students demonstrated the deep value of different approaches that clinical experience affords.

Nearly every student scenario referenced the role of staff technologists and mentors, more than professors, as “guides”, “helpers”, “hint-givers” and “goaders” of learning in their clinical settings. In asking students how they would approach a sample examination or procedure, the answers were methodical when the example procedure was highly repetitive, such as a two-view chest, one-view abdomen or three-view knee. However, further probing prompted Georgia to discuss what questions she asks herself when stuck on a problem that was not routine, “Well, first I’ll be like ‘could I angle to get this view? Could...how much further can I move the patient without hurting them?’ ” When prompted further on supporting factors that solidified understanding of practical methodologies, all students had at one least one reference to a mentor, professor or technologist who helped facilitate an exam.

Mentoring in clinical environments. Once in a clinical setting, it is expected that experienced students will perform procedures, attempting at first independent of a technologist, then with guiding assistance or prompts necessary to complete it. Ann clearly identified the role of clinical staff as a different teacher who facilitated practical learning and the realism of reasoning through complex situations:

. . . we went over some variations in class like a patient that’s not able to stand; how you could do it in a chair because you really want to do it upright if possible. But pretty much every other variation, I learned in the clinic setting, having techs who

were watching the first few times. How to do a wheelchair chest. How to do a stretcher chest. How to get children to sit and have their parents, you know, hold their arms. Things like that. We didn't really learn those things in class.

Technologists who have vested interest in mentoring students will incorporate them in all aspects of different exams, knowing that a cadre of experiences will serve to fully develop their practice epistemology.

Kate was very forward about how the role of a technologist mentor impacts her reflective practice development in clinical environments, declaring “a good technologist mentor cares about the student’s learning and shares any knowledge that they have . . . like if they know that the student needs that knowledge, they give it to them in a timely manner, not just like all at once.” However, she ruminates then adds that it takes time to build personal confidence and a connection with technologists that engages in detailed conversation, instead of just watching their performance. “[Clinical] made me realize I need to ask questions because before, I would do [the exams] and the images wouldn’t be all that perfect. But I would kind of nonchalantly ask how they do it but I wouldn’t like specifically ask ‘how do you do this?’ ”

Similar to Kate’s scenario, John likens the role of a technologist supervisor to that of a wise mentor as well, posturing, “You know, and being a student, you can kind of always rely on the tech a little bit and ask them ‘where would they start?’ ‘What would they feel for?’ You know, if you’re... doing a KUB, you just kind of have to hope you feel a pelvis in there somewhere.” He candidly discussed his fledgling clinical moments and relished understanding what a technologist does after years of practice.

Carly mentions a situation where the staff technologist walked through the reflective steps necessary to correct a lateral knee radiograph. The assistance not only solidified the academic connection to the clinical application, but instilled a tremendous amount of confidence in her that she was still excited about:

I kept messing up the lateral knee and so one of the techs came in and she was like ‘. . . what is that that you see posterior to the. . .’. Well, it was the medial adductor tubercle. And so she’s like ‘okay now look at it and tell me how I need to rotate it.’ And I was like ‘uh, honestly I don’t know.’ She was like ‘because you can’t see in it.’ . . . she was like ‘well, you need to rotate it away from the board’ . . . and then I got it right on the dot. So now every time I do my knees, I know whether I need to rotate it toward or away from the board. And then I know how to make it perfectly lateral by straightening up the patella and make sure their legs are straight, because before then I would just put the knee up there. I was like ‘okay, we’re done.’ But my knees looked okay but they were never perfect.

Having her confidence bolstered was an invaluable component of Carly’s experience with a mentor and clearly demonstrated the positive impact that technologists have on student skill development.

The clinical mentor’s role is not always directly related to patient care or imaging issues, but to building student confidence. Lynn sought feedback from her clinical mentors for affirmation of her reflective skills, a necessary step for her to develop clinical confidence. “So I usually ask before because I think about that – and I don’t want to miss anything else. So even if it sounds redundant or makes me sound like I don’t know what I’m doing, I’d rather ask than get in trouble.” Similarly, after attempting to complete a truly challenging

exam, Nancy decided not to compromise a disabled patient's safety and candidly shrugged, "So I need some help thinking outside the box."

Susan presented a different perspective on clinical mentors that shaped her reflective practice via a negative experience with technologists who acted complacent. For a developing student, exposure to negative situations can shape their reflective practices in a positive direction, through the use of a teachable moment. After participating in two different clinical settings, Susan reflected on her view on the professionalism of staff technologists:

There are so many techs, I have learned . . . they [are] just there. It's not like they care about what they're really supposed to be doing. It's they've been doing it so long that it's just like 'oh well nobody says anything to me so I'll just let it go.' So you know, I kind of see this and first off I think 'okay, obviously I'm not going to say anything because I'm a student. . .'

Students are at a disservice for maturation of soft skills when forced into compromising situations that condone mediocrity instead of correctness and self-exerted professionalism.

Applying maturing practice epistemology. Progression from first professional year to second professional year in a radiologic science program represents a huge step in a student's developing epistemological beliefs and epistemic reasoning abilities. Further, it is a crucial period of development and testing of their intellectual skills of inquiry, analysis, and argument, in tandem with developing intellectual values.

Mapping and integrating experiences. Clinical situations offer a proving ground with situational tests of judgement that foster their individual growth. Building on the range of epistemological beliefs, from immature, absolutistic beliefs to the notion of sophisticated

beliefs that knowledge is multifarious and tentative, a developing student can mirror different epistemologies with their experiences and clinical anecdotes.

When asked to reiterate the steps involved in a radiographic procedure, each student selected a procedure and methodically walked through the sequence of events that occurred. The level of detail and scope in their stories directly correlated to the level and/or direction of their epistemological beliefs at the time of this research. Georgia exhibited an absolute epistemology, citing the routine, sequential steps to a knee radiograph: “You get your requisition, you get all your cassettes and scan ‘em all in. Set up for AP, bilateral standing, lateral/side, angle as needed, and um, then you do the tunnel view and the Merchant’s.” When challenged with hypothetical, non-routine changes to her patient’s situation, her answers never waiver from textbook correctness. It is important to note that the brevity of her answer did not impact the interpretation or context of the data once the story was distilled and thematically coded.

Ann, who is a non-traditional student with non-medical practical experience, enthusiastically offered more detail and insight into her scenario. As she told the story, her hand gestures ‘ticked’ off each step:

Bring the patient in. Check patient ID/date of birth. If they’re an in-patient, check armband. If it’s a person over the age of, I’d say, 10 or 11, ask about pregnancy. Have the patient remove any objects like artifacts – necklaces, earrings, a bra. If the patient has on a shirt that’s got any kind of print that would show up, they would have to remove that and put on a gown. Then you have the patient face the board. Put a shield behind them and then you line up the Bucky 72”, make sure the Bucky’s lined up with the tube. Make sure you put the cassette in there. [laughing] I would have to

remember that in the very beginning. I mean... and then you just make the exposure after the breathing instructions.

Of note, when prompted about non-routine possibilities to her exam, she readily offers an example of a patient who verbalized the ability to stand unattended for a chest x-ray, but instinctively, she disagreed just in time to turn and catch him falling.

Thomas reiterated in astonishing detail, the steps involved in flexion/extension lumbar spine radiographs. From setting up the room to initiating small talk in order to slyly validate the patient history and the appropriateness of the exam, Thomas included practical tricks and epistemic reasoning to aid in imaging. “Then I’ll get the lateral. Tell them to look to their left, turn their body to the left . . . I’ll bring out an IV pole to get their arms out of the way . . . It kind of straightens out the back too.” His example, even with the level of verbalized detail, still conveyed an increased awareness of his highly articulate thought process and attentiveness to complex and dynamic knowledge. Thomas demonstrated his ability to differentiate and integrate information for a more holistic epistemological approach.

Carly unknowingly personified her developing practice epistemology-one truly in the realm of a mature epistemology and worthy of being framed as practice epistemology, by narrating the links between classroom and the evaluative nature of clinical. She reflects:

Okay. So this program helps you to use the information that you have learned in the classroom as a basis and then you create and twist it in your sort of own way to deal with everyday patients. So every day, you are adjusting what you have learned to fit a different patient population. It’s never going to be the same.

Citing a supportive example of how evaluative practice epistemology allows students to creatively manipulate the environment, not the patient, to address non-routine exams,

Thomas extols:

This girl had been in a car accident and they were looking at a possible fracture of her ankle. So she came in, we had to help her up onto the table and she couldn't really move her ankle so, my classmate had...my classmate and the technologist devised a way to angle the plate as well as the tube and everything so that it will still be in line and she took the image . . . it was [the student's] idea to go ahead and do it that way as opposed to trying to force it into the conventional way we're used to doing.

Critically reflecting to hone epistemology. In clinical rotations, students are often confronted by situations that challenge their mental model of thinking and perceiving information as knowledge. These challenges and opportunities to learn through dissonance may help confirm existing understanding when applied to patient care scenarios. One student's experience while working in a large hospital setting challenged the proper way she had learned to complete an exam. The explanation of the event exemplifies the student's deep learning since it challenged her to critically assess the situation and compare to her internalized knowledge:

So there's just a whole little checklist you have to be aware of depending on – each patient's different. Ability to critique and criticize, And so this tech comes in and we're supposed to be getting a routine chest x-ray and have the patient step up to the board . . . he does pretty much everything but I'm standing back and I'm noticing that he hasn't worried about centering and he hasn't worried about collimating and those are two big things that we learned in school to do. And so he takes the first exposure

and the patient, he's exposed not only the patient's chest, but probably three-quarters of her abdomen. So we call it a 'chabdomen' 'cause it's chest/abdomen (Susan).

Pulling from Susan's experience, contradictory information can also challenge students to seek deeper meaning and understanding in efforts to resolve conflict with learned information and the present clinical experience. As implied by student narratives, reconciling these two sources of data results in deeper understanding and intense thought.

Lynn conscientiously reconciled issues with imaging techniques from different technologists. To a novice student, manual technique factors can be quite daunting and having a confident understanding of these is a challenge. When someone challenges the comfort zone, then a maturation process begins as the student considers more aspects to the situation. According to Lynn and Susan both, this culminates in a new mental model for the student to use in the future. Lynn explained clearly:

Every technique is different. I'll learn one way to do something and then at another rotation, they're like "no, I learned it this way." . . . I mean it's helpful to know, but then when you get something stuck in your head and then you try to do it and they try to teach another one. And then you go back and it's like "What did you do here? I don't really remember." . . . But I mean it's good to know different stuff but I guess you just have to make your own as you go.

Like Lynn, Susan faced a situation of reconciliation between her engrained knowledge and the working expectations of a staff technologist during a routine pelvis x-ray. Extending beyond the technical factors, Susan was compelled to include complementing factors like patient exposure and computerized image manipulation when justifying her work

in a competency examination. She opined that technologists do not take into account this same holistic approach to imaging, instead favoring shortcuts and artificial supports:

I don't think a lot of 'em do [critical reflection]. I think they look at the wrong things. They focus on brightness instead of, you know, of the quality – you know, whether the mAs is right; the S number . . . They want to make sure that . . . after the radiograph is taken, they look at it in terms of 'what do I think looks good?' and that's where [our professors] really tell us like 'don't mess it up' [by digitally manipulating the radiograph]. You know, "don't mess with it because that will affect how the radiologist is able to mess with it." . . . So I've found a lot of techs, they look at all these different things that don't necessarily matter. . . And I think a lot of them are *not* critically reflective . . . for instance, I . . . was at [a hospital] and I took a pelvis and the S number was perfect, the density was good, the brightness. I mean, it was all good. The only thing that was a little off was the centering. But in the exam, every bit of anatomy that was required for that exam is a pelvis. . . And if the anatomy is there but the centering is off, I would consider that fine enough to send to PACS without exposing the patient a second time.

Of the examples discussed in this research, it is both implied and verbally affirmed that the students benefited from these challenges and added new depth to their clinical reasoning.

Learning to Negotiate Knowledge from Classroom and Clinical Instruction to Make Informed Clinical Decisions

In exploring research question three, data was ascertained from the student participants on how they learn to negotiate classroom knowledge and clinical instruction to make informed decisions in the clinical environment. The themes that emerged from the data

related to decision enabling resources and students' handling of uncertainty and complexity of a clinical situation.

Engaging decision enabling resources. Resource decisions as described by the participants as choices related to who or what a student included in his or her decision making process and to what extent and when to access the resources. In efforts to support and manage the decision making process, students make selections of the best processes to use when immersed in a patient situation that engaged their decision making skills.

Consulting formal resources. It was not surprising to find these students utilized a wide-range of formal information resources in courses in order to prepare for clinical rotations. These resources included textbooks, flashcards, pocket guide books, journals, course handouts or PowerPoint presentations and staff technologists or clinical instructors. Most used these resources as a stepping stone to expanding and supporting their knowledge base in the radiologic sciences. Dependence on these resources helped shape decisions derived from engrained information and contoured by the individualized embedded situation.

Kate never entered a clinical rotation without her personalized exposure factors information worksheet. With confidence, she explained, "I've tried to put together a little chart of, like manual factors but it's very small." This small, but powerful chart acted as both a resource and a source of confidence in clinical rotations to Kate.

Unlike Kate's homemade resource guide, Lynn relied on more substantive information with the use specific textbooks to aid her clinical development:

I usually take my radiological imaging book because it's good. It has the pictures as well as like techniques that you can use. It's really good about telling you what to do

and it's easier for me 'cause I can actually see the picture and see like how to position . . . If I don't take anything else, it's always the book I take with me.

Use of the book with Lynn and extrapolation of book and experience into a technique chart by Kate are pragmatic means to bolster practice confidence.

When prompted about on-hand resources for quick reference, both Susan and Thomas depend on a modified version of a textbook. Susan nodded in affirmation and confirmed, "I take Merrill's. I've got Pocket Merrill's. . . [It is useful for those] random exams that you have to do that you can't really recall because you don't do them often." In concurrence, Thomas noted the same, "I've ordered the Pocket Merrill's, and I bring that with me just in case I need to review um, like a radiograph that I've . . . that's not very common. I have to look it up." John added that Pocket Merrill reference book is a relatively new resource and very handy in its portability.

Not all students feel the necessity of having a reference textbook for guidance during clinical rotations. Sarah confidently prepared for a new rotation prior to starting and was sure to bring class work or reading material to clinical, to make the best use of any breaks or downtime. She explained:

I take resources for me to study when we're down time . . . I've looked at my Power Points a couple of times, you know, before clinic. And if I was going to [a clinic] for the first time, I would definitely read up on my stuff but I didn't tote those around with me.

Sarah hastened to note that preparation for new clinical rotations was necessary but may be difficult if the clinical procedures are unfamiliar, thus students lack authenticity in learning to connect the book information to clinical practice prior to starting the rotation.

Similar to Sarah's preparatory measures, Kate used creative flash cards to review pertinent information on positioning and procedures prior to starting a clinical rotation, "So I'd make flash cards and stuff and I'd drill myself. But, I really...and I would take those to clinics at the time so that would help. Like if I would know that a foot's coming out, I would pull out my foot thing, you know, and brush up on it and go do it."

Utilizing clinical staff as resources. The role of the clinical staff was characterized as invaluable to supporting and extending learning. This expansion of learning achieved an enhanced level of information that is beyond what the student can achieve independently. The clinical staff was supportive of the learner's needs in the clinical environment, as those needs dynamically emerge during procedures or activities. As students pointed out, the role of the clinical staff varied greatly, from technical resource to clinical reasoning guide or thought provoker to trigger clinical reasoning and reflection. When discussing these roles with the participants, most found the staff technologists and clinical instructors to be invaluable extensions of textbooks and classroom learning, often being the most sought after resources to understand application of basic concepts in practice.

According to Carly, the course textbooks were merely an informational starting block and did not offer practical knowledge or realities of clinical challenges. "The book . . . it gives this ideal patient with the perfect body type. They're not going to be that way. And so I have to rely on the tricks that the techs tell me. Like 'this is how you're going to get it every single time.'" Kate agrees and readily picked a staff technologist over a textbook or technical resource. "I'd go to a tech. Because they would be right there first of all and they have experience. Like a book, you know, can tell you stuff but not specifics."

From John's experience, he felt clinical instructors were very accessible and willing to assist with student roadblocks. "If you have a question, you can always go to [academic instructors], no matter whether it's in the classroom or their office and it makes a really good learning environment, I think." Thomas' perspective extends the realm of clinical staff to include experienced students as well. "Best way of doing it would be to ask a classmate or ask a technologist. Ask anyone who's been doing it for a while and how they would do it and if they were in my situation."

Coupled with the use of available resources, Georgia and Nancy interweave the use of their personal experience or active learning, in negotiating information into practical application. Nancy reiterated her experience when a professor was unavailable and her success took self-directed learning and facility staff assistance:

I would say personal experience and the technologists [helped me learn]. I've found...in my personal experience, we had one of our teachers – [the professor] was [unavailable] so the person who stood in for us was not necessarily the best substitution so what we had to learn from was the books. And I found it very challenging to pick up a book and try to learn a technical skill from a book.

Like Nancy, Georgia finds immersive learning best suits her learning style. Working in a clinical environment with staff technologists facilitated the link between classroom and clinical application, "I learned it from experience. Definitely trying it, 'cause um, to be honest, in the class, I didn't really learn any of the positioning until I actually had to do it. So, definitely experience helped me to learn how to do each procedure."

Assimilating information from classroom to clinical. To better understand how radiologic science students learn in the classroom, this research question explored their

academic strengths and weaknesses. Student's understanding of the academics correlates directly to their comfort with, application of or need to better understand and relate the information in clinical settings.

When exploring the strongest, weakest and most favored academic area of each student, Carly is quick to voice all three in one long story-like statement:

I would say patient care is my strongest and then physics is my weakest . . . because it's all about determining the technique for your patient and sometimes that can really be hard to grasp. And right now, we really don't get a strong emphasis of the technique in the classroom; therefore, we're learning on our own once we get to clinicals . . . My favorite part of the program was actually . . . pathophysiology and learning how to read the x-rays. . . . We did the actual physiology in the fall and we did the pathophysiology and learning the x-rays and stuff in the spring semester. That was my worst class but I loved it. It's something...it like brought light on what I want to do, which is diagnosing patients.

Resonating with Carly's experience of academic challenges, Susan felt very firm about her academic skills and weaknesses. Unlike Carly, however, her forte was not pathophysiology, as she enlightens:

[My] strongest academic skill would probably be anatomy. I'm really good with anatomy. . . .you know, the parts of the body; bones in the body. Disease – like pathophysiology is probably my hardest thing. Physics was okay. So as far as classes go, the anatomy aspect and when we were working with the cadaver and stuff like that, I did very well on that aspect. But like pathophysiology where you're

learning about, you know, interstitial lung disease and stuff like that, kind of wasn't my strong...point.

With the need to have a working knowledge of pathophysiology for clinical understanding and reasoning, Kate has a healthy respect for course content and realistic application. "My least favorite class at the time... was pathophysiology, but now I appreciate it. I like positioning class because it was most practically applied."

Ann offered insight into another class, imaging physics, and found the class offered a healthy challenge for her academic appetite. "As far as physics . . . I'm still not as comfortable with understanding equipment. I'm more comfortable understanding x-ray production. Things that you can't see, I think I'm understanding a little better than like generators and things that you can see." John extends Ann's thought of seeking deeper learning and readily offered, "I guess I'm good at gathering information and interpreting it." As evinced in his other answers, his analytical nature is prevalent in all his academic endeavors as well.

Acknowledging learning styles. Moving into the clinical settings, students individually identify the best way to learn in each environment. Student learning perspectives provided crucial cues for how best to use their knowledge in clinical contexts.

Classifying herself as a practical experience learner, not a textbook learner, Lynn struggled with having to convince herself of the idea and that it was acceptable, as she recalled this story. When prompted to explain how she learns, Lynn mused:

I'd say more practical experience. I tried to go by the book like probably the first month or so that I was in clinicals but then I realized that most of the people didn't go by books. I mean, a lot of times the only reason they actually went into a book and

looked at things were like for weird things they didn't have. Like a lot of school work, that may have come out that they hadn't done it and they had to do it so they had to go to the book.

John's stance harmonizes with Lynn. A supportive learning environment maximizes his learning potential in its practical, yet most methodical sense. According to John,

I'd say I guess I'm more analytical in thinking. I kind of have to . . . visualize and learn how something works and then apply it. I think I probably learn better in the classroom from hearing someone explain something rather than just reading it and trying to regurgitate it. I guess I'm not . . . what you'd typically call a textbook learner.

Opposite of John is Nancy, who is a practical learner. She described a personal struggle to retain classroom information with practical knowledge for immediate recall and use. With animated frustration, Nancy explained:

I think it's personal. And an example of that would be when we went to [take exams] on positioning, it was like the end of spring semester and kind of overloaded a little bit and I just – like “I can't get this stuff to stay in my brain.” Like “I can't do it.” I'm talking [to a professor] and I'm like “I don't know why I can't . . .” I said, “there's flash cards, flash cards, flash cards, nothing.” [The professor] said, “Nancy, you're not that kind of learner. You ask questions and you have to think through . . . that's why pathophysiology is so good for you.” I'm like “you're right!”

Nancy's recall of the event even demonstrated her need to reason through her learning style before attempting to understand the shortcomings of her supposed retention of information.

Ann, Kate and Georgia emphasized their need for practical learning opportunities, via lab exercises and “see one, do one” opportunities in clinical. Sarah also declared she learns best from extension of the lab learning paradigm and postured,

[My learning style is] practical. Definitely hands-on. I like hearing things. I can... read a lecture all day but I can sit in class with nothing and retain better. . . . When I was in lab, I was always like trying to get my hands on everything and trying to do it. So that way, if I saw it and it was something that I did . . . [the professor] would let me do things wrong to see why – you know, to see the outcome. Okay, “this is wrong but fix it.”

She unequivocally identified the value in laboratory exercises prior to real-time application.

Susan’s stance agrees with Sarah on learning style and she purports:

. . . Instead of reading about it prior, I’d rather just jump right in and someone show me hands-on how to do something. . . . Like I would much rather go in the lab and work on how to position for each one, other than reading it in the textbook. . . . So I take from the textbook in a way that I can transform the textbook information into my own little story or a little quip or a word or something. But some trigger that I remember.

Nine of the ten students identified the benefit of practical information application to support didactic learning; yet, no student stated that one learning style would work independent of another. This synergistic blend of learning styles offers complimentary solidification of information for deeper levels of learning that foster mature practice epistemologies.

Thomas was the outlier and explained his multiple learning styles, “[Imaging physics] just doesn’t make sense to me. It’s...to me it’s just a whole bunch of dry facts that I have to

remember. Hmm. When it comes to the positioning, I would say practical. But when it comes to pathology, ‘cause we don’t really see it that much, I would say book; so a little bit of both.” He was quick to point out that different learning approaches are needed in different parts of this academic journey and each would best serve him when needed for his growth and comprehension.

Inhibiting information assimilation. Though the range of clinical experiences varied, the intensity and speed of the practice presents another level of challenge to the student’s ability to recall and apply knowledge appropriately. Prior to establishing a strong working knowledge of clinical cases, several students expressed reliance on textbook guidance and how it was limited to the use of model cases. It is the practical nature of clinical learning that teaches what cannot be learned in the book.

According to Ann, she must first rely on formal resources and learn to scrutinize evidence to make informed clinical decisions: “The book just tells you the ideal patient and the fact, you know, the image and patient is of like this really skinny person with a Speedo on that you can obviously see every bone in their body.” Carly’s experience solidifies the idea that patients are not perfect and students are faced with a myriad of unknowns, including, but not limited to stability, pathology, and drug interactions when imaging them. “Patients are not always going to be textbook patients” as Carly aptly summarized.

Having sound working relationships with staff technologists is essential to learning. This synergistic relationship is elemental to student success with competencies and with building a practice epistemology that allows for sound reasoning and decision making. Roadblocks to this process included derogatory relationships among staff and students, where students felt inhibited or a lack of support. Nancy keenly believed that social relationships

and power issues are a huge impediment to students, “Being in a clinical setting where there are technologists that are not willing to work with you. Yeah. They absolutely ignore your presence.”

In accord with Nancy, Sarah vehemently expressed similar concerns about “derogatory comments from clinical staff . . .” and clearly stated:

It’s just very frustrating for us because it feels . . . awful to be wearing those green scrubs that day. [Clinical] IMPACTS future practice decisions, it makes me never want to go into diagnostic, which is sad because I enjoy the critical thinking of the ER and the OR and getting “okay, you have a patient that can’t do this. Get this image.”

And that, I thrive on . . .

Engraining information through clinical experiences. Student participation in different clinical communities of practice served to strengthen both their hard, technical skills and soft, inter-personal skills. By varying the clinical environments, students were introduced to a wider spectrum of technology options, patient populations, and staffing cultures. The culminating idea was to introduce this expansive nature of medical imaging, enmesh the student to stimulate reflexivity and deepen clinical reflection to advance students in formulating informed clinical decisions.

When asked what students glean or benefit the most from clinical experiences, the answers were widely varied, from the experience of the institution, to the challenge of new protocols, patients and staff and to finally, challenging their bounds of practice and autonomy while in the clinic. Ann is aware of the different patient populations and the challenges each population brings to a radiologic technologist. She explained how different patients require different skill sets:

[You have to] adapt to different patients as far as, um, their mobility, seriousness of conditions. Being able to read body language from a patient. Being able to tell if they're going to stand if I stand them up for that chest x-ray or if they're going to fall. You know. Just being able to scope out the situation to know what decisions to make as far as positioning and safety and things like that.

Ann summarized her perspective that one of the best ways to challenge student learning is to introduce different procedural parameters regularly, to move superficial understanding to deep meaning and remove any chance of complacency.

John was mesmerized by the fluctuation in imaging protocol between facilities. With differing expectations between facilities, and even site physicians, John said students have to possess a strong working knowledge and proactive mindset to thrive in these situations. He explained:

I've learned that the protocols can be very different from one place to another. What you learn as maybe being incorrect in one place may be correct somewhere else, depending on what they're looking for. Just say for example, like for positioning you may only position this far, you know, a smaller area at one place but in another area they want basically what would be considered a – you know, a knee, a tib/fib and an ankle somewhere else...when really all you're getting is a knee.

John clearly delineated that staff adapt to these specializations and specific procedures within facilities and become highly proficient with the process. This gives students the opportunity to witness finely honed skill sets in action and identify areas of personal growth and interest.

Whereas John identified positive learning benefits from different clinical institutions, both Kate and Lynn noticed the contrary dynamics of staff in different institutions. Feeling

comfortable within the clinical communities of practice was important to fostering student confidence. Lynn, with her heart on her sleeve, candidly addressed her maturation process within the bounds of different clinical rotations. She mused:

I think what I learned the most is about the people that I've actually worked with. I guess I was a little naïve maybe, before the program started because I felt like everybody should be nice to us because we're the students so they should all want to teach us. And so there's a couple of places where that's not so much true. I guess it just made me tougher. . . . I've learned like who to work with and who not to work with and how to act around other people. . . . I can't really be who I want to be, I guess, because I'm afraid of what they'll say.

Lynn's personality made clinical rotations harder. Since the rotations were short in duration, she did not have a chance to connect with the staff and build strong working relationships. Instead, the modest comfort level was more necessary to achieve her short term goals.

Kate had a slightly different approach, noting the recurring variation and short length of clinical rotations was a challenge to her mindset and need for comfortable learning. "I've learned how to adjust to different personalities and different areas and different types of exams so that was big for me . . . I learned that I need consistency in my life, that I did not have this whole past year." The introduction to a new learning environment in the radiologic science program challenged Kate to wrangle with how to learn and retain knowledge in environments where she lacked complete control of the situation.

Impacting informed clinical decisions via clinical experiences. As an extension of this research on the value of clinical experiences to making informed clinical decisions, nine students distinctly identified positive aspects of the overall clinical experiences that define a

part of who they will aspire to be as practicing technologists. Ann's stories of patient events were shaped by her warm and nurturing personality, which she believes will be an asset with patient care practices that require time for examinations and offer the opportunity for extensive patient interactions. Beaming, she announced, "I love fluoro. I love fluoro and I love GI procedures, mainly 'cause you're spending a lot of time with patients. I don't like getting 'em in, getting 'em out kind of thing." Nancy agrees and also longs for more direct patient and doctor interaction in clinical settings.

Several students enjoyed rotations with fast-paced, high excitement opportunities. Susan embraced the controlled chaos of the emergency department. Beaming with excitement, she explained, "I would have to say so far, my favorite rotation was the [ER] . . . And you know . . . I am very much a trauma girl. I love to see stuff like that." Analogous to Susan, Carly liked the challenging, yet exciting opportunities that the emergency department presents, from gunshot wounds to delivering babies. She reflected, "Right now, my favorite would probably have to be either the ED or outpatient clinics. The ED because you never know what you're going to see." She then added a mixed perspective on fast-paced locations, ". . . and then outpatient clinics, it's because patients can walk most of the time and so it's like get 'em in, get 'em out. You still have that nice bond and you can talk to them most of the time . . . [and then] a lot of times patients come in on stretchers, comatose, going crazy."

Four students commented that the most beneficial portion of rotating clinical locations was gaining perspective on areas of interest for advanced studies. Kate liked orthopedics and the operating room rotations, but absolutely detested pediatrics. Similarly, Sarah had the opportunity to shadow technologists in vascular imaging before entering the radiologic science program and identified a definite clinical interest. Further, she enjoyed the

“neat studies” the operating room rotation provided and “. . . loved the blend against the normal” the experiences provided.

Parallel to Sarah’s experience, Lynn’s participation in the operating room was an emancipation event for her. She recalled triumphantly:

. . . I really enjoyed the [OR]. Because I think that one helped me more so that I’m not so scared of like blood and everything like I may have thought I was. Like I can see stuff on TV and it doesn’t really bother me. But once you get in a situation, things might be different . . . And so the second day in [OR] I saw a guy getting brain surgery and then one guy getting a tumor taken out from like the back of his eye or something. But it was so cool and I didn’t think of like the blood and everything else . . . It just really opened my eyes and made me realize I’m not as scared as I thought I might have been.

Her awe of procedures and overcoming perceived personal obstacles actually heightened her interest in multi-disciplinary approaches to patient care and strengthened her resolve and perseverance in unfamiliar circumstances. Likewise, Thomas saw the rigors of clinical practice as a push to excel and sharpen performance. “I have a love/hate relationship with [this] clinical rotation . . . Where it’s extremely fast paced . . . they want everything perfect. [The technologists are] extremely harsh on you . . . it brings out the best in you, I would say.” Both Lynn and Thomas experienced moments of personal success when pushed beyond their comfort zone. These learning moments created new levels of confidence and entrenched information needed for future practice.

Varying clinical rotations to bolster learning. Per student stories, different clinical settings have different value-add potentials and present new challenges. As depicted in their

narratives, different rotations included operating room, emergency department, gastro-intestinal, portables, orthopedics, pediatrics, urology and diagnostic radiology.

Most students suggested the benefit of varying clinical rotations was negating the possibility of being complacent. Students, as well as staff, must remain fluid, proactive and flexible. Georgia credited her increased versatility to rotational clinical experiences and expressed her thoughts with an appreciative tone,

I've learned how to adjust in different situations. Just because you know, not going to the same place all the time, you get comfortable. And so being able to go different places, you have to learn how to work with other people and learn the protocols and learn different things when you go different places. So definitely being versatile and being able to adjust to other people's teaching styles and different personalities all the time.

Georgia seemed comfortable with the challenging nature of different sites. John concurred and added, "I've just learned that you kind of have to adapt no matter where you are, and as long as the patient's safe and you're getting a good image, then you just kind of have to trust yourself." Like Georgia, John also found a level of personal growth and credits increased personal trust as a take away skill from these rotations.

To Susan's advantage, introduction to scores of different imaging techniques and approaches helped her build and sustain a sound working knowledge of practical information. She explained her routine with confidence,

There is not one way of doing things. Certainly, I mean, while one tech may do this, another tech may do that. And you know what definitely I learned from going to different clinical sites, my tendency the first day: I step back, I see how each tech

operates. Because if you can see how they operate, and try to adhere to each of their individual styles, things will go so much more smoothly . . . And I think that's important, being that we're going to all of these different sites because there's not just one way of doing things. And if you are narrow-minded like that to think "okay, this is how I'm going to do it," then you're not going to do well.

Further, she credits her ability to adapt smoothly in different environments to her experiences observing and absorbing different social norms.

With markedly similar experiences, Sarah discussed this same process and how she wanted to quickly become a productive component of the clinical environment while on specific rotations:

When I would go to a different clinic, I spent two days – not trying to get comps, not trying to get numbers. . . . Learning techs, learning how they did things, learning where they put things . . . So when it came to Wednesday, I was ready to go. . .

Sarah's personality thrived on methodical planning for her clinicals and having a regimented plan to each rotation propelled her to be aptly prepared and capitalize on the experience.

Linking consistencies between clinical rotations. For some students, consistency and understanding clinical norms facilitated faster application of classroom knowledge into clinical practice. Looking for new information that was consistently present in each clinical rotation was essential to understanding some of the inherent norms and expectations of the imaging curriculum and overall profession. Georgia noticed, very succinctly, "Most protocols don't change much [between facilities]." Sarah concurred and stated, "I guess the equipment available . . . as far as sponges, tape, positioning, things like that [do not vary greatly]."

Nancy and Susan found that in clinical rotations, the facility staff have a clear idea of what student needs are and how to facilitate the learning needed for competencies. Nancy, while looking off into the distance muttered, “Hmm. I think between them...the most consistent, I think, is an understanding of what you need to learn when you’re in clinic as a student. Whether or not they actually offer that, that’s different.” Susan adds, “They’re all fairly consistent as far as, you know, wanting to help students really getting their hands on, saying, ‘okay, this is what needs to be done’ or ‘don’t do this’ you know, ‘do this.’”

John notes a strong sense of patient safety and oversight of patient exposure as obvious attributes present in the different clinical practices. “I would say everybody’s really good about patient safety. I’ve been really surprised that a lot of people seem – or most places seem to really watch the S numbers and they’ve been pretty consistent with the exception of maybe one spot that shoots a little high but I’ve really been impressed with that.” John further notes that consistent and repetitious introduction of information is essential to making a lasting impression and internalizing the actions so they become second-nature.

As a certified nursing assistant, Carly reveals first-hand knowledge of patient care from a different care context. Having this insider perspective positively affected her actions, respect and understandings of patients:

One of the things I’ve learned is that the patients are human. They are not there to be subjects. You are to touch them, like take care of them as if they’re your own family. And as being a C.N.A., it also helps bring in that broader scope that “how would you like your room to be kept? How would you like people to touch you and position

you? You don't want somebody throwing you around." So that...it has increased my patient awareness.

Though Carly's experiences are influenced by her extracurricular activities as a nursing assistant, she explained that patients are the consistent factor, albeit the most dissimilar characteristic of each clinical location as well. Thomas offered, flippantly, but in good humor, the closing words for this section that expand on the diversity of patients and the consistency between clinical rotations, "I'd say very little."

Dissenting clinical rotations. All ten students interviewed had candid and varied remarks on inconsistencies in clinical rotations that impacted their ability to negotiate classroom knowledge into practical clinical application. The discourse and levels of reflexivity served to increase awareness and hone epistemic reasoning and reflective abilities in order to make better informed clinical decisions. Practice inconsistencies force students to take a holistic view of situations, mull over all the components quickly but effectively and make infallible decisions.

Ann and Thomas commented openly on fundamental issues with professional practice. Ann revealed "... a lot of inconsistency comes actually to radiation protection and cleanliness and sanitation varies from department to department. It seems like each department will focus on something and that's like their main thing." Thomas extends the observation, "Um, I would say sometimes the positioning, sometimes the shielding, sometimes patient interaction, and the history of the patient. Um, collimation, definitely."

Several students noted the challenge that different equipment and different techniques play in their reconciliation of new information. Lynn's experiences tell how this difference challenged her comfort in practice:

Every technique is different. I'll learn one way to do something and then at another rotation, they're like "no, I learned it this way." And I'm like "I can't keep up with all of these different ways to do it." I mean it's helpful to know, but then when you get something stuck in your head and then you try to do it and they try to teach another one. And then you go back and it's like "what did you do here? I don't really remember."

Carly's observations are in sync with Lynn's, but she is more optimistic about the value of these challenges and candid about frustrations she experienced as a student:

But going to the various clinical settings, it's not like you can just sit there and learn one step, which is annoying because you're always going different places whether or not you like it or not. A lot of places treat you much better than students. They treat you as a real tech. . . . [But] not being able to be like "okay, I know this hospital's protocol." I'm used to my routine.

The diversity of patient populations is often as varied as the type and location of medical facilities. Georgia seemed surprised by this concept, "So I'd say that's the most inconsistent thing, like what kind of patients that you're going to get each time."

Three students indicated the different expectations of student involvement at the clinical rotations. Kate revealed from her experience, the differing levels of student autonomy, ". . . some rotations, they'll let you do whatever, and some, they – you know, they have to be there." Exploring this idea further, Susan revealed the frustration and impact of different interpersonal communities of practice on her learning:

Really the only thing I can say that was not entirely consistent again is the interpersonal relationships between the staff. And those relationships affected what

students got out of it . . . that they weren't so much concerned about the quality of work. They weren't as concerned about helping you as a student, you know, excel in your clinical experience.

Nancy takes note of the differing levels of technical rigor within different clinical rotations. As a student who is freshly riveted by classroom instruction, these clinical practice principles are keenly important in establishing sound practice epistemologies and reflective practice skills. She explained:

Uh, I would think that the one thing I have noticed is whether or not [technologists] apply the things they learn in school to daily practice. [Certain locations] reflect a lot more on their practices and try to stick to, you know, using proper technical factors.

You know, considering physics when they take an x-ray. . . But I really think that they are critical when . . . they think about their practice and make those adjustments.

Cleanly summarized, Nancy reflects on the impact of the technologists and the practice environments on student development. Thus, through the voices of the research participants, the challenges the workplace environment deeply impact student's informed decision making abilities.

Navigating uncertainty and complexity. Guided reflection during the interview helped the participants translate how they married classroom and textbook learning for application in various clinical environments. Discussion centered on this research question promptly enabled participants to recognize the reflection opportunities they experienced in clinical rotations. Students were then able to clearly articulate how they were able to negotiate information.

Reconciling book/classroom and application/clinical information. Students were prompted to explain how they reconciled new information learned in a classroom, for practical application in any clinical practice. Reflexivity was apparent in self-awareness and self-critiquing fashions, as students conveyed a general desire for continuous self-improvement.

Georgia relied on established benchmarks of information in order to start and launch into the steps necessary to complete radiography tasks:

[I use] baselines because I definitely don't remember everything in class but if I have a baseline of what you're supposed to do, then I can – from experience. Every patient is not going to be the same. From experience, patient to patient, if I have a baseline I can, you know, go back to that baseline and say, 'okay, that's what you do for the average patient and this is what you would do for a bigger patient or a smaller person.'

Ann, following a similar line of thought, began with a foundation of knowledge from class then challenged its reliability via observation of the clinical settings. "I take what I know or what I've learned in class and I go and then I just sort of follow a technologist for the day and see how they do it." She adds that the observation heightens her calm resolve in attempting new exams.

Four participants really focus on what the textbook offered as an ideal patient situation and then dynamically morphed the information as needed to fit the epistemic reasoning and reflection process necessary in practice. Take Carly's practical approach,

Patients are not always going to be textbook patients. And we go into class learning these very specific guidelines that this is how you're going to do it. Okay, so you

walk into clinicals the next day; this patient has a cast on. They're in serious pain. They have a fracture. So how are you going to get that view that the doctor wants? Exactly. So, basically you're just using the basics, the gist. And you always have to, you know, adjust to the patient. And if you have to angle more with the tubes, then so be it.

Extending Carly's practical context, Lynn resolves that the best approach for her is to start with a class or textbook understanding of the situation, then sync into its reality with questions and observations:

Class has kind of taught me how to prepare. Particularly with positioning class, positioning and procedures . . . once you get in there, a lot of times you can't really go by the textbook and so I've gotten a lot of hints from the techs themselves, and tips from them for what they use. A lot of times I'll use their . . . techniques instead of what's in the book 'cause you can't always go by the textbook.

Lynn's example was illustrative of her concern that textbooks cannot offer all variations of the normal and complex learning is furthered with realistic patient interactions.

Susan gave an in-depth example of her reflectivity in the process of linking information to application for ready recall, "[It] is taking this textbook and applying it clinically in a way that makes sense to me. Because when I go back to take a test, those little cues are what I'm going to remember." With mild consideration of the general idea, John extended Susan's thought and casually answered, "Yeah. I guess in a textbook, you have to keep in mind that they're very general situations and they're usually ideal situations and it's not usually ideal in the clinical setting. You kind of have to adjust . . ." Knowing John relies more on a practical approach to his learning, he adds, "Like I say, I'm more analytical and I

kind of have to see things and learn by repetition. And um, reading in a book kind of gives you an idea of what to expect but I'd rather do it.”

Self-initiated, active learning helped Sarah and a fellow student assimilate information from protected classroom and laboratory environments to fast-paced clinical settings:

I mean the labs helped with [applying information] a little bit, I guess. . . . If I was with a partner like [another student] at [a facility], we were fairly new and in a high workflow environment at the [facility] . . . And so there was some downtime. I think it was our lunch, so we both went into an exam room and role-played . . . We went through different things and that helped me. I think it helped [the other student] too.

Lastly, Thomas offers a new spin of student reflexivity. He adopted a questioning stance on his clinical skills and sought ways to improve his understanding and performance by studying radiographs for details beyond the technical scope into the realm of diagnosing:

[I] look at [the radiographs] in detail to make sure I got everything on the image that needs to be on there and then I would look at some pathology too. . . . Sometimes I see it, and sometime it's similar to what we've seen in the classroom. . . So I can try to identify like “hey, is that an osteosarcoma?” The technologist will be like “maybe.”

When further questioned on this personally instigated challenge to push himself and benchmark against his own performance, he coolly described his idea of timing different exams he completed. Nonchalantly, but with visual chagrin, he explained:

I remember going into the room. So the technologist would hand me the requisition and then while I'm setting up the room, they would bring me the patient and then I'd

go ahead and take all the history and all that from the patient identity. And then, while I'm doing that, the technologist would step away and walk down the hallway and then um, like before they would return, I would be done already. So they might be like a couple of steps down the hallway and I'd be calling them back, like "hey, can you check the image?" and they'd be like "man, I didn't even get halfway down the hallway." So that's what made me think of timing myself.

Understanding how students view themselves in the clinical environment assists in understanding the level of comfort each has with retaining information, understanding and fruitfully applying it in practice.

Critically reflective practitioner. During the interview, participants were asked to define the collective term, critically reflective practitioner, based on their experiences and epistemological beliefs at this point in their education process. Nine out of ten students provided an answer, with one never directly answering the question. Several students found this question challenging and required a pause of consideration before answering.

In the following excerpts, three students, John, Ann and Thomas, describe their definitions, embedding the idea that past experiences directly influence the practitioner's current actions. John's definition contended that a practitioner learns with each patient and exam, "I would think it's someone that learns very well from past experiences, be it good or bad." Similar to John's use of prior experience, Ann tangentially included past experience in her definition with embedded knowledge and holistic planning:

I would say that it's someone who really pays attention to detail and does not have a set way in their head on how to run or perform an exam. But looks at the situation completely from a safety standpoint; from an accuracy standpoint; from a physician's

standpoint. Understanding all the information that needs to be gathered and takes, you know, knowledge of previous exams – understanding how things may have worked in previous cases, and really apply it to that situation.

Ann, along with Thomas, indicated her belief that reflection is essential for occupation based performance when she adds, “Not just going in there and doing things by the book.”

Two students framed the definition around a practitioner’s ability to be dynamic and insightful while making informed clinical decisions. Sarah succinctly said, “I would say: ‘a person that can evaluate their own work, criticize themselves, and not take it personally.’ Looking at what needs to be done and if they got it done correctly, um, and in a timely manner and...in a manner that they wanted to.” Separately, Kate extended that definition, saying“... that means someone who is in the clinical setting, but constantly, adjusting themselves to the situations. Not just going to routines and doing but, actually thinking about what they’re doing and changing their techniques to fit the different situations.”

Inclusive of the aforementioned definition components, Nancy included in her definition a level of self-awareness that incorporated the practical epistemology that radiologic science students are striving to build:

I think, in my experience, in my own personal experience in what I’m doing right now, what I find is that the people who never assume that they know it all throughout their...their career, and they’re always willing to learn more, um, and basically challenge themselves to do so. . . But constantly asking yourself if you are, you know, doing the best that you can do and um, if you’re using the tools that surround you to the best of their – you know, your ability.

These excerpts suggest that participants navigate complex and uncertain situations with varied approach, but with fundamental skill sets required of a maturing radiologic science student.

Chapter Summary

The purpose of this chapter was to display the narrative data obtained during semi-structured interviews. Ten participants were interviewed in this study and were all rising seniors, or second professional year students in the same baccalaureate radiologic science program. Each student was interviewed one time for this study with an approximate total of 18 contact hours.

The data collected was presented via themes and sub-themes, related to each of the three original research questions. These themes and sub-themes were presented in narrative form to capture thick, rich descriptions from the participants. The data presented provides information supporting the original purpose of this study, which was to explore how senior radiologic science students reflect in practice and how this reflective practice informs their abilities to solve complex problems in the clinical environment.

When compared to the three original research questions, the main findings first indicate that senior radiologic science students specifically learn reflective practice skills by engaging patients, interacting in different communities of practice and through concurrent sharing and realization of information. Next, when exploring the processes students use to reflect in clinical practice, the findings demonstrate that learning occurs simultaneously through engaging and reflecting, students valuing performance mentoring in clinical environments and harnessing critical incidents. Finally, expanding on how students learn to negotiate information from classroom and clinical instruction to make informed clinical

decisions reveals that students rely on decision enabling resources, being able to assimilate information from classroom to clinical practice, experiencing varied clinical rotations in order to bolster learning and learning to navigate uncertainty and complexity.

Chapter Six presents the conclusions drawn from this research. The conclusions presented offer insight into the implications and future recommendations on developing reflective student practitioners.

CHAPTER SIX

Summary, Conclusions, Implications and Recommendations

This work is intended to explore how ten rising senior radiologic students reflect in practice to solve complex problems. The purpose of this narrative research was to explore the clinical experiences of the participants in the culmination of their first-professional year in the program, as they advanced in both clinical and academic growth. Three research questions were employed to guide this study:

1. How do rising senior radiologic students learn to reflect in practice?
2. What application do rising senior radiologic science students make of reflective practice in clinical practice?
3. How do rising senior radiologic science students learn to negotiate knowledge from classroom and clinical instruction to make informed clinical decisions?

This chapter presents a summary of the study findings, conclusions, implications for research, practice and policy, and recommendations for future research.

Summary of study findings

A basic narrative inquiry research design was used to investigate the aforementioned research questions. Using purposeful sampling, all rising second professional year students in a local baccalaureate radiologic science program were interviewed, comprised of eight women and two men. Participant ages ranged from 21 to 33, with six students being categorized as traditional students and four as non-traditional students.

Ten participants engaged in semi-structured interviews over the course of three weeks, requiring approximately 18 field work hours. The primary data were analyzed inductively using a constant comparative method (Bogdan & Biklen, 2002; Glaser & Strauss,

1967). In conjunction with interviews, secondary data were analyzed from informal interviews with academic instructors, curriculum guidelines, clinical competency guides and associated professional data on radiologic science professions. No participant observations in clinical settings were conducted in this study; however, observation of non-verbal communication during participant interviews provided important insight into student responses. In order to ensure trustworthiness of the research process, data triangulation, investigator bracketing, and member checks were used.

Each research question yielded its own themes and sub-themes. Question one offered three themes and six sub-themes; question two garnered three themes and eight sub-themes; and question three yielded five themes and ten sub-themes. Overall, the data collected and analyzed provided rich detail and insight into the purpose of this study on how rising senior radiologic science students reflect in practice to negotiate complex problems in the clinical settings.

Research question one explored how students reflect while in practice. When delving into the data, three themes emerged with associated sub-themes. The first theme explores students building their reflective practice skill sets by engaging patients and contains sub-themes of a) *applying embedded knowledge* and b) *employing evidence*. The second theme, interacting within communities of practice, i.e., different clinical environments, contains three sub-themes, including a) *interacting with staff technologists*, b) *interacting with professors*, c) *interacting with other students in the clinical environment*. Theme three refers to logical reasoning and contains one subtheme, *correlating information*.

Research question two investigates the processes students use to reflect in clinical practice. Theme one reveals how students learn through simultaneously engaging and

reflecting. Investigating further, the sub-themes consist of a) *valuing performance* and b) *mentoring in the clinical environment*. Theme two, applying maturing practice epistemology, includes two sub-themes, a) *mapping and integrating experiences* and b) *critically reflecting to hone epistemology*.

Research question three addresses the negotiation of information from classroom and clinical instruction to make informed clinical decisions. The data collected addresses engaging decision enabling resources, with sub-themes of a) *consulting formal resources* and b) *utilizing clinical staff as resources*. The next theme explores the assimilation of information from classroom to clinical. The sub-themes that manifested include a) *acknowledging learning styles*, b) *inhibiting information assimilation* and c) *engraining information through clinical experiences*. The third theme embarks upon impacting informed clinical decisions via clinical experiences, with sub-themes of a) *varying clinical rotations to bolster learning*, b) *linking consistencies between clinical rotations* and c) *dissenting clinical rotations*. The fourth emergent theme explores navigating uncertainty and complexity and includes two sub-themes, a) *reconciling book/classroom and application/clinical information* and b) *critically reflective practitioners*.

Conclusions

Three main conclusions were drawn from the research findings of this qualitative research study. First, when exploring the process of learning to reflect in practice and the application of reflective practice, a key conclusion is the interrelatedness of these learning journeys. Second, events that promote reflexivity stimulate and deepen learning of clinical reflective practice and its application. Third, experiences within health care communities of

practice sustain, cultivate and structure the development of reflective practice and complex problem solving in students.

Conclusion one: The interrelated steps to becoming a reflective practitioner. The first conclusion to be drawn from this narrative inquiry study is the interrelatedness of learning reflective practice skills and the applications of those skills. Learning and application are two separate journeys that intersect in the realism of the clinical environment. Each journey begins in the classroom and continues via socialization into dynamic clinical environments. This socialization process is comprised of learning values, practice constants and norms associated with the radiologic science profession, the continued pursuit of maturing practice epistemologies and the prospect of developing individual professional identities (Schön, 1983).

The journey of professional socialization often begins before entering a profession, as demonstrated through the development from personal to student epistemologies. This transformational development is the culmination of combined personal beliefs and norms, of family and society influences, of intelligence and perseverance. According to Hofer and Pintrich (1997), most personal epistemological theories acknowledge belief development from naïve to mature and sophisticated. Honing the student epistemological development segues into the emergence of practice epistemology when paired with reflective practice. This process is intensified by both formal undergraduate education, with specific coursework in the profession of interest and realistic experiences offered via clinical applications (Kegan, 1994).

Higgs, Richardson and Dahlgren (2004) extrapolate this concept of learning values and norms of a profession in their definition of professional socialization of health care

students, in order “. . . to reflect on ways they recognize and respond to the changing demands of health care” (p. 12). Professional socialization is the journey where developing reflective practice skills and the application of the skills take place. Supplemented by engrained basic technical knowledge and skills, students grow through interactions with communities of practice and health care situations bound by the role frame practice constants, as defined by Schön (1983). Professional socialization is not an outstanding event, but a perpetual process embarked upon with the first day in the clinical setting, if not before.

Clinical reflective practice is a relevant example of an ability that emerges in this focusing process. Radiologic science students begin as young, undergraduate learners with basic problem solving abilities. Through the formal radiologic science curriculum, students are formally introduced to the professional practices and the role reflection plays in solving imaging procedures and challenges. Following intensive internship experiences, students have a stronger understanding of clinical reflective practice that will continue to be developed through in the remaining formal education and then in daily professional practice. It is evident that components of this developmental process are both implicitly and explicitly influenced.

Similarly, in order to grow practice epistemology to heightened levels of both understanding and application, students have to know profession-specific knowledge and how that knowledge is relevant in daily practice. It is a maturation process that accompanies identification of knowledge in order to create or make new meanings and refine its use in practice (Higgs, Jones, Edwards, & Beeston, 2004). As reflection abilities improve and the student’s knowledge base expands, heightened application of practice epistemology manifesting through reflective practice begins to evolve.

Although the intent of this study was to determine individually how students learn to reflect in practice and then apply reflective practice in the clinical environment to tackle complex problems, the overall data sustain a synergistic relationship of these two phenomena, depicted as an interdependent nature of two processes. Further, learning and application, in most instances, is influenced by the similar aspects, incidents and situations in the student narratives, although learning reflective practice skills seemed to develop quicker than learning to apply reflective practice in action for these rising second professional year students. A number of factors support this finding. First, according to van Manen (1997), students initially learn lower levels of reflection, such as reflecting on book knowledge quickly for foundational technical information (i.e. positioning skills and technical imaging factors). Second, strengthening student epistemologies and a working knowledge base occurs over time and is not readily available for application. Third, participation in clinical environments builds both the necessary hard, technical skills and soft, interpersonal interaction and communication skills necessary to confidently and independently reflect on a higher level in clinical environments (van Manen, 1997). Lastly, the speed in which the clinical environments operate was noted to be an influential factor on student's ability to reflect in action.

When asked to describe how students reflect, rising senior students articulated, not reflected upon, the literal means necessary to make informed clinical decisions, including positioning skills, conceptual understanding of technique factors and basic patient care activities. Having the ability to articulate reflection in action develops over time as their clinical knowledge expands, progressing from vertical to iterative models of reflection (Mann, Gordon, & MacLeod, 2007). According to constructivist theory, as defined in the

context of student's reflecting on experiences to construct personal understanding, meaning is context dependent and serves to heighten reflective student abilities (Tippins, Tobin, & Hook, 1993). The actual process of reflective practice occurs when these literal skills are coupled with psychological and human aspects of the profession-engaging with both patients and staff. Most of the student narratives relate their reflection experiences to a patient or staff centered event that challenged the unwritten soft skills that they must master before truly developing a full practice epistemology.

Further, the shaping of professional identities is an outcome of refined reflective practice. Student participants in this study failed to verbally articulate the differentiation between learning how to reflect or application of reflective practice and learning to become radiologic technologists (Argyris & Schön, 1974). It is the culminating experience of applying tacit knowledge to clinical application that challenges students to assume the persona of a practicing technologist. Three different attributes emerge from this developing new role for the students: having heightened responsibility for patient care and clinical performance as the clinical experiences proceed; embracing the zeal of the profession by overcoming challenges and experiencing passion of each imaging role; and gaining confidence in performing reflection in action that moves the novice student towards becoming a critically reflective practitioner over time.

The idea of accountability in learning and clinical performance is a strong motivator for students. With increasing clinical experience brings greater responsibility in the clinical activities, as evinced in several student narratives. This evident increase in accountability was a powerful driver for learning both technical skills and interpersonal skills in a myriad of different clinical contexts. Cust (1995) posits that this increased self-direction in meta-

cognitive development bolsters student problem-solving, reflection and evaluation abilities. The paths to increased accountability included volunteering to complete exams, questioning procedures for in-depth understanding and self-directed learning through readings, role playing and reviewing scenarios. All of these actions garnered opportunities to share reflective approaches to practice, to grow from other's wisdom as well as formulate new personal understanding and different contexts.

Attaining a zeal for the profession directly influences how developed, honed and applied reflective practice skills may be. If students feel connected to the clinical environment, whether the connection is to patients or the community of practice, then navigating complexity and ambiguity becomes a meaningful challenge that promotes learning to reflect. Similarly, if students seek success, then avoiding embarrassment and sub-standard work performance are also motivating factors to develop a firm grasp of reflective practice. Of great relevance to this research is the understanding that clinical experiences can be extremely humbling to novice students since challenging and questioning practice can be daunting. Further, according to Ghaye and Lillyman (2000), engaging in a self-evaluation process, similar to the critical incident analysis exercises in this research, may lead to a range of emotions and uncertainties that must be addressed before students can achieve positive, long-term growth.

Lastly, a confident student is often positively encouraged to seek out learning opportunities or to attempt non-routine exams. In clinical situations where students were asked to perform autonomously, most students preferred to attempt the exam independent of a technologists' guidance, thus affirming a level of self-confidence in their abilities. Candidly, students quickly amended the reality of needing occasional assistance and would

seek that as necessary. When participants felt confident about their reflection they were overwhelmingly more confident to request competency examinations and to discuss situations without the risk of being negatively critiqued for their actions. Through practice, focused attention and constructive feedback, participants improved clinical learning as depicted in participants' narratives. This is especially important for communicating reflection, as increased confidence led to increased discussion of reflections and critical thinking, which in turn revealed minor instances of faulty reasoning and the opportunity to explore new meaning instead of perpetuating mistakes.

Conclusion two: Promoting reflexivity stimulates and deepens learning of clinical reflective practice. The second conclusion to be drawn from this study is that specific incidents, events and learning situations promote student reflexivity that stimulates and deepens learning of reflective practice necessary to ultimately become a critically reflective practitioner. This approach to learning incorporates critical thinking and critical incident theory, as well as the use of constructivist theory to engage prolific thought and holistic conceptualization.

According to the curriculum guide for radiography programs by the American Society of Radiologic Technologists (2007), academic programs must foster opportunities to develop skill sets that will prove beneficial for all professionals throughout their practice. Highly espoused curriculum tenets include self-reflection and critical thinking, which are deemed necessary and formidable tools in a field that faces rapid, dynamic demands of emerging technological advances and the need to avoid worker obsolescence. If future graduates are expected to manipulate, compare and discern sources of information and take action based on this acquisition of new information and knowledge, then that future

technologist-now an advanced radiography student, must ascertain strong intellectual development (ASRT, 2007). Intellectual development, otherwise referred to as critical thinking (Glaser, 1985), reflective judgment (King & Kitchener, 1994) and conceptual complexity (Harvey, Hunt, & Schroder, 1961; Miller, 1981), must enable students to frame patient care events beyond the basics and judiciously act upon new found perspectives.

Participants in this study did not commonly refer to critical thinking as learning to assimilate information and form answers through reasoning; communication of this reasoning merely manifests through their acts in clinical practice. Defined through the lens of critical incident or specific events, critical thinking determines the meaning and significance of events for students and is applied as a way to solve problems (Halpern, 1989; Scriven & Paul, 1987).

As depicted in published research by King (2000), Hofer and Pintrich (1997) and Pascarella and Terenzini (1991), college is a period of positive student growth in critical thinking. The critical incident research narratives collected from students for this research further demonstrates positive growth in critical thinking, as students were challenged with a broad array of clinical situations.

Students in this research were able to clearly identify significant events of heightened reflective practice that occurred during clinical rotations. During the recollections, it was easy to discern the heightened awareness of their clinical reflection abilities and these moments of raised awareness coincided with periods of rapid development of reflective skills. When each participant was asked to recall a significant event during the semi-structured interviews, their acute awareness of present learning was obvious, allowing each student to discuss the event in detail and further reflect on the overall experience and

outcome to make new or enhanced meaning (Dewey, 1933). Students ultimately realized their increasing competency and comfort in a technologist's role; however, their narratives did not explicitly acknowledge this improvement of critical thinking or reflective practice during the event.

The use of critical incident technique in this research was conceptualized as an approach to assess student critical thinking and reflective abilities to solve complex problems. Significant events, both patient and non-patient related, positively impacted student learning in some aspect, though not all events were positive or gratifying. Students reported systematically reflecting on complex patient scenarios that presented opportunities to challenge tacit knowledge and skills within nebulous or unexpected circumstances. It was not a step-by-step review seeking errors and omissions, but a process of personal growth and understanding of the specific situation, in order to grow from unanticipated challenges and supplement their own reflective skills in order to move to higher level or premise reflection (Mezirow, 1991; van Manen, 1997). This demonstrates the importance reflection has on learning, as the students were familiar with the "checklist" of conducting procedures, but lacked situational awareness of the unique circumstances of the patient and other impacting variables.

For each participant, the critical incident event piqued some level of self-evaluation or reflexivity. Surmising that all participants exhibited some level of reflection, thus eliminating the label of non-reflective from this research, categorizing the level of reflexivity was based on the individual participants. Reflexivity is characterized as honing reflection through critical, self-assessment and looking for areas of self-improvement that will transfer to practice. For those with an inquisitive nature, high reflexivity appeared to be an embodied

characteristic, inherently evident in routine practice and reflection in action (Schön, 1987). This constant questioning stance was further honed through interaction with patients, technologists and the experiences in the radiologic science undergraduate program that expanded their experience-based knowledge foundation (Cust, 1995; Dahlgren, Richardson, & Kalman, 2004).

The use of critical incident analysis to expand experience-based knowledge is best framed through the lens of constructivist theory. According to Tippins, Tobin and Hook (1993), constructivist theory compels the learner to interpret and make personal sense of knowledge gained from their experiential world. Further, this new meaning develops when compared to previously constructed knowledge set in a scheme of social interactions (Biggs, 1993; Vygotsky, 1978). This mirrors the narratives provided in this research where students construct new understanding from clinical experiences, but deep comprehension of this information is found to be dependent on the learning context or culture. Hence, information transforming into personal knowledge is not deemed useful when presented out of context or with no perceived significance to the learner's needs (Maclellan, 2005).

When students perform in clinical environments, they are the center of their unique learning environment, only coached by a teacher or supervising technologist. Adapting a constructivist lens to clinical learning, one would surmise that learning is a mutual process between students and facilitators that should be a participatory relationship to generate knowledge. According to Higgs (1993a), model clinical programs foster such a nurturing environment for students by striking a balance between facilitated learning and self-directed learning. In direct correlation to Moon's (1999) theory that deep knowledge facilitates high level information integration, learning that is meaningful to students and encourages a sense

of individual accountability entrains generated knowledge into deep learning. This research demonstrates that active participation truly epitomizes constructivist learning concepts as the student independently makes decisions, redirects as needed and promotes greater self-confidence in their epistemological beliefs. In turn, knowledge is transferred to deeper levels of information retention and future application.

The presence of clinical facilitators, including faculty, staff technologists and other clinical mentors, serves to guide and frame the learning contexts, not encourage dependence on those individuals to reflect on or comprehend information for the student. Advancing in clinical practice, strengthening personal epistemology and developing a clear understanding of professional practice all influence a learner's readiness to self-regulate learning and broaden confidence in clinical practice. As students develop complex skills, such as critical thinking and reflective practice, their epistemological maturity develops in tandem, implying they are ready to engage in continual or increased complex activities, given more autonomous responsibilities and less structured guidance to learn. As determined in this research, it is the mutual existence of critical thinking and suspension of assent that fosters a critically reflective process in students (Halpern, 1989; McPeck, 1983).

The role of clinical support, whether they are colleagues who offer scaffolding or educators who offer salient guidance, is not diminished as students move into more autonomous and advanced clinical capacities. It is quite the opposite, as this research points out; the need for continual assessment is necessary for skill maintenance and to avoid complacency. The harried pace of the clinical environment and demands of the health care system on staff lessens the ability to provide structured feedback or guidance. However, as clearly demonstrated in the data collected for this research, critical reflexivity becomes a self-

regulating tool to mitigate emerging difficulties, limitations and to ensure the utmost of clinical performance in patient care and imaging (Eva & Regehr, 2005).

Students possess a level of personal accountability and self-assessment that is not easily acquired or developed. Instead, it is context specific and situationally bound for most of their academic journey (Eva & Regehr, 2005). Thus, the importance of judicious, constructive and reliable feedback is a necessary expectation for students in clinical environments. Students often seek a clinical ‘mentor’, framed as a person with whom the student can closely relate or is most comfortable working with due to personal style or professional values and beliefs. Working with specific individuals in a mentoring approach is to gain perspective and knowledge, though the role of the mentor is often implicit and not explicitly defined. Through the use of nebulous, inferred characteristics, student participants were able to self-select and reveal technologists from whom they learned appropriate clinical practices, as well as identify individuals from whom they did not want to learn. Several participants divulged characteristics of technologists they did not want to learn from or emulate in critical incident narratives and acknowledged these individuals were not generally selected for mentoring. As Billett (2001) portrays, “It is important to be aware that workplace learning is not simply imitative . . . it can be interpretative and reflective, and even critical” (p. 38).

Conclusion three: Experiences within health care communities of practice foster development of reflective practice and complex problem solving. For student learning, the role of communities of practice is a strong and necessary avenue that marries tacit knowledge to practical understanding and application. Communities of practice are defined as sets of individuals who share a commonality—a passion for, concern of or set of problems

revolving around a specific topic and thus continually engage to better understand and apply their knowledge (Wenger, McDermott, & Snyder, 2002). Further, communities of practice may include staff, educators, patients, families, colleagues and other health professionals of different modalities.

From this research, student participants illustrated the connection of communities of practice (CoP) to development of reflective practice in pronounced detail, allowing direct connection to the community of practice literature. Accordingly, the following points link the findings of conclusion three to the community of practice literature, a) communities of practice, in the context of these radiologic science students, present professional norms and beliefs that students must understand in order to become effective practitioners; b) through increased participation in CoP that host shared goals and activities, student autonomy is scaffold by interplay within a safe environment that is mutually supportive and constructively critical of their performance; c) CoP in radiologic science clinical environments are diverse and multi-disciplinary, to include other healthcare professionals on the team that are solving often ill-structured problems; and d) students share social experiences, both positive and negative, experienced within CoPs that offered a social context to learning from others in a workplace setting.

When discussing communities of practice, Lave and Wenger (1991) offer a perspective of ingratiation of students into the fold,

Legitimate peripheral participation provides a way to speak about the relations between newcomers and old-timers, and about activities, identities, artifacts, and communities of knowledge and practices. It concerns the process by which newcomers become part of a community of practice. A person's intentions to learn

are engaged and the meaning of learning is configured through the process of becoming a full participant in a sociocultural practice. This social process included, indeed it subsumes, the learning of knowledgeable skills. (p. 29)

According to the rising senior radiologic science students in this research, reflective practice in this study occurred largely during participation and collaborative learning within the boundaries of specific communities of practice, influenced by varied social and political contexts of health care settings. Communities of practice, as characterized by Wenger, McDermott and Snyder (2002), include group critical thinking, sharing historical and social resources, having a shared sense of direction and a common understanding of learning.

Rising senior radiologic science students participate in multi-disciplinary clinical communities of practice that possess these traits. Since these clinical communities of practice are not solely radiology based, students operate in a multi-faceted reflective context where the shared goal is not merely radiology norms, but the collective shared meaning and culture of the team to better assist patients. Understanding each community of practice within the study participants' clinical sites reveals the contexts that shape student practice knowledge and reasoning skills and sequentially, forms the basis for their cognitive reflection.

Work teams form a community of practice, in which knowledge is shared, shaped and constructed collaboratively with students. Members of the work teams offer specific skill sets and different but necessary knowledge that benefits the team that is engaging in shared professionalism based on the demand of a specific health care situation (Wenger, 1998). Student participant learning within these worksite communities of practice is directly impacted by dynamic learning situations that are entrenched in the realism of health care.

Thus, not all work team experiences will be positive. The term community confers a sense of warmth and comfort—a positive and nurturing connotation; however, participant stories presented a gamut of community of practice contexts and experiences, not entirely positive. Some actually inhibit the student's ability to glean new meaning and practice in specific clinical rotations. In the case of the rising second professional year radiologic science students, engaging in meaning-making from all experiences influences their developing professional practice identity as future radiologic science technologists.

Learning within different communities of practice offers varying circumstances to apply knowledge and make new meaning from each event and interaction with people. The foundational work for forming a professional practice identity, which motivates learning, correlates with professional responsibilities that students encounter, including accountability, autonomy and patient care responsibilities. Student learning is further heightened when situations challenge their reflective practice and critical thinking to new levels beyond their zone of proximal development and insert them into situations that cannot be addressed independently but as a health care team (Vygotsky, 1978).

Student radiologic science participants are not acculturated to the social, political and cultural influences on communities of practice and gain invaluable experience by rotating through a diverse set of health care institutions. Knowledge creation through situated cognition allows students to learn while basking in the insights of others from a larger community of practice (Fenwick, 2003). According to Crotty's (2003) perspective of constructivism, development of new understandings transpires via social interactions. As determined from this research, understanding and cognizant awareness of the dynamics associated with work teams and communities of practice engages a constructivist tact and

will enable students to use the workplace culture as an influential modifier in their development of a critically reflective posture.

Radiology communities of practice are not predicated upon merely radiology practice, but on providing holistic patient care to individuals during exams. Thus, students do not have the opportunity to focus solely on promoting their reflective practice and critical thinking skills solely in the context of the radiologic sciences. To manage the transition from classroom to clinical and applying knowledge appropriately in order to become a working component of the community of practice, student participants seek to emulate other radiology professionals in order to 'fit-in'. Part of student progression from newcomer to old-timer is the adoption of clinical mentors within an existing community of practice. Mentoring, whether individual or group informed, was unofficially identified in the clinical worksites of which these rising senior radiologic science students were members. Almost all students gravitated towards individuals who mirrored their personal and/or practice beliefs, in order to gain the necessary abilities they needed or lacked in order to demonstrate required clinical skills (ASRT, 2007). In all examples of mentoring, students reflected on radiology professionals as preferred mentors, though student participant engagement in multi-disciplinary teams offered a variety of opportunities to learn from other non-imaging professionals.

When student participants adopt a mentoring approach to clinical learning, they are exposed to the possibility of learning incorrect information, techniques or social skills contrary to those that are necessary in practice. Failing to learn holistically, from forward thinking and prolific professionals, can instill undesirable practice norms, inadequate practice skills and inappropriate professional values (Salomon & Perkins, 1998). Since students are

highly impressionable, they seek to learn both hard and soft skills that will enable them to succeed in clinical practice, thus they are more likely to absorb practice habits and professional strategies of an institutional community of practice or collective group. Stifling the development of autonomous reflective practice and critical thinking and replacing it with linear memorization or mechanizations of practice defeats effective learning from communities of practice, conveys the notion that students must be presented with the opportunity to discern correct from incorrect learning in clinical environments (Amini, 2010).

Implications for research, educational curricula, educators and mentors, professional practice and policy

The findings of this study offer implications for research, educational curricula, educators and mentors, professional practice and policy. These implications support the original purpose of the study which was to explore how rising senior radiologic science students reflect in practice to solve complex problems.

This research is unique to the topic of holistic reflective practice in radiologic science clinical education and this specific participant group within the radiologic sciences. Little radiologic science research exists on the topic of reflective practice, specifically reflection in action and critical thinking that develops into critically reflective practice as a facet of a maturing practice epistemology.

Implications for research. When reviewing the available literature for reflective practice and critical thinking in relation to radiologic science students, it was evident that very scant qualitative literature has been published on this topic. The use of narrative inquiry, specifically with semi-structured interviews, elicited rich details of student

experiences that would not have been reviewed in academic practice or clinical competency activities. The use of critical incidents with narrative inquiry proved to be a highly effective means of unlocking conversation with this specific generation of students and truly provided a panoply of information. Thus, this research presents added support of qualitative research to convey significant findings that have a bearing on the profession and serve to heighten understanding and application in academic curricula.

Further research is necessary to fully engage this topic. First, future recommendations should explore the impact of age on the honing of reflective practice. Since the literature and research suggests that mature epistemologies develop with increased life experiences, then it can be assumed that older or non-traditional students have heightened reflective practice and complex problem solving abilities. Second, past educational experiences of students, specifically students that have previous non-radiologic science baccalaureate or graduate degrees, provide a stronger knowledge base and thus a firmly rooted personal epistemology that bolsters their practice epistemology and reflective practice skills. Lastly, to further explore the correlation of epistemologic development to maturing reflective practice skills, a qualitative, longitudinal study would be an effective means to investigate the development of students' sophisticated problem solving techniques.

Implications for curriculum. Findings of this research have bearing on the learning and teaching of clinical reflective practice and critical thinking. Although espoused in the curriculum requirements from the American Society of Radiologic Technologist, according to the student participants in this research, reflective practice is not verbally characterized as a learned skill in the classroom. University curricula, although embedded and implicit in class lessons, needs to formally include the explicit teaching of reflection and critical

thinking to develop critically reflective practice abilities. Further, academic curricula should seek to deepen a sense of confidence that fosters communication of reflection in clinical practice and in turn, invoke reflective practice philosophies, instead of potentially practicing outdated methodologies and non-reflective actions. According to Baird (2008), inculcating reflecting modeling in radiography programs is essential to guarantee that graduates move beyond simply perpetuating the profession, but instead improve it. Reflective modeling, as gleaned from the student interviews in this research, could include group simulations of patient care scenarios; root-cause analysis of failed clinical situations, both patient and staff-related; and literary case study analysis and its practical application to student clinical experiences. Richardson (1999b) extends Baird's thought and posits that future graduates must possess skill confidence in order to solve patient problems in dynamic health care contexts.

In curricula design, the concepts of content, instructional and learning strategies and expected outcomes are purposefully defined to foster deep learning (Biggs, 1999, 2003). Congruence between hidden versus explicit curricula is integral in bridging any potential gaps between classroom and clinical learning (Shepard & Jenson, 1990). Strategies to develop effective reflective practice skills and dedicated time to hone these skills should be included as explicit core components of the radiologic science curriculums.

Lockyer et al. (2004) posit that strategies to bolster reflection could be incorporated into learning practices via student portfolios and reflective journaling. Further, the use of critical incident analysis to explore events stemming from clinical practice could be implemented both individually and in small group settings. Facilitating an incident de-brief within a group setting helps brainstorm ideas to mitigate non-routine circumstances and allay

student unease from the situation through discussion. The use of critical incident analysis provides great insight into student's clinical learning scenarios, through the lens of addressing realistic patient care scenarios in authentic clinical learning environments.

Implications for educators and mentors. From this research, it can be concluded that there are a gamut of ways to be reflective, practice reflection and link tacit knowledge with critical thinking to make informed decisions when attempting to solve ill-structured problems. Reflective abilities are unique to each student and influenced by the setting and context of the event or challenge. Clinical instructors become the mechanism for classroom introduction to clinical practice and have unique opportunities to convey the importance of clinical experiences and to motivate students to actively engage in these positive learning environments.

Incorporating regular performance reviews, or clinical competency reviews, would incorporate constructive feedback conversations and applicable practice wisdom to enhance students' future performance. Performance reviews could include student critiques of holistic radiologic technologist practice in a specific clinical environment or focused review of staff's actions in regard to pointed examples or cases. This review would encompass the events of interest as well as lessons learned and suggestions for improved practice. Students could also catalog the "textbook" components of clinical practice and perform comparison studies of different clinical environments, illustrating the perceived strengths and weaknesses in his or her learning contexts.

Establishing learning environments within health care communities of practice, assuming the mentoring or formal supervision process is shared, should ensure student learning. Medical facilities, both large and small, are often faced with large volume patient

loads which both intentionally and unintentionally relegate student participation and learning to a low priority. The clinical staff reprises the role of exemplar for maturing student epistemologies as well, presenting individual opportunities for role modeling, discussion and team collaboration. Establishing an orientation for staff who will mentor students will introduce the radiologic science program's expectations of clinical staff who inform student decision making abilities and convey to the technologist his or her important role in shaping the newest generation of developing professionals. In turn, it is imperative that medical institutions support staff and health care professionals in prioritizing both informal and formal mentoring roles that facilitate teaching of developing radiologic technologists.

Since staff members personify the clinical instructor role for students in realistic clinical settings, mentors need to consider the impact of their actions, values and work ethic have on mentees. Thus, it is imperative to comprehend the detriment to student learning that is conveyed when students feel marginalized or unnecessary in the clinical context.

Implications for practice. Development of a reflective practitioner, especially a critically reflective practitioner, is the culmination and application of an extensive knowledge base, honed technical skill sets, reasoning, high level information integration and marked understanding of health care communities of practice. Radiologic science students, who are being groomed to be members of the health care community, must strive to reflect both automatically and deliberately, requiring attention to detailed reasoning, critical thinking and assessment. This reflective process must be present in casual, reflexive situations as well as those beyond the performance comfort zone. It is this process that challenges their professional scope of practice, and actively questions actions based on valid decision making and examination of patient evidence and situational context.

As students become more comfortable and experienced in clinical practice, reflective practice is subsumed to become “second nature” for these individuals. However, the need to differentiate reflexive action from complacency is essential. Students must adopt a critical stance in the application of reflective practice to bolster credibility and relevance of their actions and decisions. Further, students must be confident enough to communicate the tacit knowledge and informed judgments that support their decisions within each community of practice. This will help establish their professional practice identity and reduce any erroneous inferences about reflective practice from other’s observations.

This research further identifies the importance of communities of practice, the socialization process and the important roles that other health care practitioners play on developing student reflective practice. Different clinical communities of practice, both formally identified and not, provide opportunities for student participation, discussion and assessment. Highly supportive learning environments should support developing student practitioners in their chosen career path. If presented the opportunity, students and staff could benefit from shared learning opportunities, specifically continuing education endeavors that are mandatory for staff and highly educational for students. Facilitating a shared learning environment would offer scholarship opportunities from multiple participant perspectives, fostering greater discussion and insight of the topic. Ultimately, students and staff share the occasion to learn not only from the instructor, but from one another as professionals heightening their practice epistemology.

In a profession challenged regularly with the demands of new or advanced imaging technology, students, as well as active staff, must first be technically adept professionals. Then, they must fearlessly learn to act inquisitively, build collaborative relationships and

negotiate the meaning of professional practice necessary to communicate critically and reflectively in context. Critical incident analysis could easily be adapted in continuing education endeavors to challenge both students and staff in the clinical environment, to engage participants in a discourse on past events and lessons learned. This reflective modeling tool facilitates personal meaning making for participants via reflection on action, displaces complacency of actions through reflexive activities and provides varied practice perspectives.

Lastly, a technologist must reflect in practice in order to grow his or her practice epistemology via authentic clinical scenarios. With experience and maturity comes a more holistic and profound understanding of the profession. Thus, a technologist needs to be a practicing professional for a period of time before he or she truly gleans the nuisances of the profession and develops a respect for its complexity and dynamic existence. Radiologic Science curriculums are not tasked to teach “creative radiology” classes that offer realistic insight, practice wisdom and epiphanies that inherently develop with time and experience. Instead, it behooves the profession to engage the practicing technologists in activities that foster reflection on action, that dissect clinical practice intricacies for broadened application and serves as an ongoing reminder that learning never ends.

Implications for policy. This research presents specific implications for policy that are directly related to the credentialing of radiologic technologists. In 2007, the American Registry of Radiologic Technologists announced a time-limited certification plan for technologists’ certificates issued from 2011 forward (ARRT, 2007). In January 2011, the CQ 2011: Continuing Qualifications rules were implemented as the professional credentialing organization sought new ways to bolster their mission of promoting high patient care

standards (ARRT, 2007). The review process is meant to assess continued qualifications of credentialed technologists, however, the methods of review are not fully vetted and are subject to revision and full implementation.

Actively engaging practicing technologists in practical activities that assess reflection in and on action would provide a documented mechanism for ongoing technologist assessment. Through the use of reflective modeling, professional portfolios and critical incident assessment via journaling, technologists would possess an archive of learning events that demonstrates their continued learning while practicing in the field. These practical tools benefit facility management in reviewing staff competency and performance and become a means for practicing radiologic technologists and developing students to perpetuate their learning.

Recommendations

This research contributes to the body of literature present on reflective practice within the radiologic sciences. In order to address the conclusions presented and to foster effective development of reflection in radiologic science students, the following recommendations are made: 1) through continued use of qualitative research design, additional research studies should be completed on radiologic science student reflective practice development, understanding and application and the findings compared to the results presented in this study; 2) academic curricula must adopt a stronger stance on explicitly including reflective practice as an articulated skill that students must master before assuming the role of a professional radiologic technologist. Purposeful activities must be developed and conveyed so reflection in and on action is not assumed but critically challenged in academics. The implied meanings of radiologic technologist versus radiologic technician are clearly

demarcated in the presence of critically reflective practice; 3) synergistic education opportunities should be developed between radiologic science program members, both staff and students, and staff of clinical facilities; building a positive, rewarding relationship full of open communication will better serve the students in clinical rotations by bolstering their comfort, building their personal confidence through engagement and offering a better venue for constructive criticism; 4) develop formal mentoring opportunities for students and staff in different clinical communities of practice, including reverse-mentoring activities. Building a new form of communication that dispels the socio-political and clinical context hierarchy will not only bolster student engagement with professional staff and put that relationship in a different light but will also stress the importance of student's soft, or people skills; 5) focus more research on the role of reflective practice in different learning communities, or the lack thereof, and the impact of surface learning on the overall student development of critical reflective practice.

Chapter Summary

This chapter began with a brief review of the methodology used to pursue this research and the associated research questions. Three conclusions were derived from the data and presented: 1) the interrelatedness of learning reflective practice skills and the applications of those skills; 2) specific incidents, events and learning situations promote student reflexivity that stimulates and deepens learning; and 3) health care communities of practice sustain, cultivate and structure the development of reflective practice and complex problem solving. Further, a discussion of these conclusions and their relationships to research, radiologic science educational curricula, educators and mentors and professional practice was provided. Recommendations were derived from the study data to perform more

qualitative research in conjunction with this topic to adequately determine how best to facilitate learning to be reflective while mastering all the other expectations of the academic curriculum and communities of practice.

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Appendix A

North Carolina State University is a land-grant university and a constituent institution of The University of North Carolina

**Office of Research
and Graduate Studies**

NC STATE UNIVERSITY

Sponsored Programs and
Regulatory Compliance
Campus Box 7514
2701 Sullivan Drive
Raleigh, NC 27695-7514

919.515.2444
919.515.7721 (fax)

From: Carol Mickelson, IRB Coordinator
North Carolina State University
Institutional Review Board

Date: June 24, 2010

Project Title: How Undergraduate Radiologic Science Students Reflect in Practice

IRB#: 1531-10

Dear Ms. Orders,

The research proposal named above has received administrative review and has been approved as exempt from the policy as outlined in the Code of Federal Regulations (Exemption: 46.101. b.2). Provided that the only participation of the subjects is as described in the proposal narrative, this project is exempt from further review.

NOTE:

1. This committee complies with requirements found in Title 45 part 46 of The Code of Federal Regulations. For NCSU projects, the Assurance Number is: FWA00003429.
2. Any changes to the research must be submitted and approved by the IRB prior to implementation.
3. If any unanticipated problems occur, they must be reported to the IRB office within 5 business days.

Please forward a copy of this letter to your faculty sponsor, if applicable. Thank you.

Sincerely,

Carol Mickelson
NCSU IRB

Appendix B

North Carolina State University INFORMED CONSENT FORM for RESEARCH

TITLE OF STUDY: How Rising Senior Radiologic Science Students Reflect in Practice: A Narrative Analysis

Principal Investigators: Amy Orders

Faculty Investigator: Dr. Tuere Bowles

What are some general things you should know about research studies?

You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. The purpose of research studies is to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. Research studies may also pose risks to those who participate. If you do not understand something in this form, it is your right to ask questions of the researchers for clarification or additional information. A copy of this consent form will be provided to you. If at any point in time, you have questions about your participation, you are encouraged to contact any of the above named researchers.

What is the purpose of this study?

The purpose of this study is to explore how senior radiologic science students reflect in practice.

What will happen if you take part in the study?

If you agree to participate in this study, you will be asked to participate in approximately a one- hour, in person interview at a campus location or other location convenient to you. You will be asked to sign a consent form for participation, once we review it. All information collected on the audio recording will be transcribed to a hardcopy document for review and analysis; a copy of that transcription will be provided to you for review, to ensure the validity/reliability of the information before publication.

Risks

There are no foreseeable risks or discomforts for study participants. All names and identifying information will be redacted or appropriately coded so no individual participants can be identified. The interview time will be minimized to the absolute time necessary, so as to minimize impacts on your other commitments. There are no “correct” answers to your personal narratives, the intent is to review information objectively and seek candid details.

Benefits

This study will help others better conceptualize how undergraduate radiologic science students reflect in action in clinical situations. Participants will be provided with the final

Appendix B continued

written report of the interview and will have access to the final dissertation as well. Conclusions drawn from this study could be used in academic courses and clinical internships, to better facilitate the student learning possible. The overall intent is to enrich student learning and promote skills that will ensure future employment options.

Confidentiality

The information in the study records will be kept confidential. Data will be stored securely in locked offices and via secure computer files. We will not mention your name or any identifying information in the written reports, oral presentations or publications of this project. Your full names will not be recorded, and any physical documents retained will be destroyed 5 years after the project ends.

Compensation

You will receive compensation for your participation via a \$25 gift card to Target stores.

What if you are an NC State Student?

Participation in this study is not a course requirement and your participation or lack thereof, will not affect your class standing or grades at NC State. Your instructors will not see the results of this study. All participant grades will be masked.

What if you have questions about this study?

If you have questions at any time during this study, please contact the Principal Investigators listed:

Amy Orders, Doctoral Student
2620 Wolf Village Way, Box 8007
NCSU Campus
Raleigh NC 27695
919-515-5208

What if you have questions about your rights as a research participant?

If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this study, you may contact Deb Paxton, Regulatory Compliance Administrator, Box 7514, NCSU Campus, 919-515-4514.

Consent to Participate

“I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to discontinue participation at any time without penalty or loss of benefits to which I am otherwise entitled.”

Participant Signature: _____ Date: _____

Investigator Signature: _____ Date: _____

Appendix C

North Carolina State University

Title of Study: How rising senior radiologic science students reflection in practice:
A narrative analysis

Interview Guide

Pseudonym of Participant: _____

Interviewer: Amy Orders

Time of Interview: _____ am pm Date of Interview:

Location of Interview:

Greet the participant. Review participant consent form, demographic questionnaire, and critical incident activity worksheet.

Introductory Statements and Opening Questions:

Think back when you first considered this institution for your undergraduate experience.

1. At that time did you know you wanted to major in radiologic sciences?
2. Tell me the story about how you became interested in radiologic sciences.
3. What most attracted you to the radiologic science program at this institution?

For a moment, imagine a prospective student applying to this program asks you to introduce yourself and describe your experiences here.

4. In a few words, what would you tell that prospective student about what you have valued/enjoyed the most?
5. What would you tell that prospective student about what you have valued/enjoyed the least?
6. How would you describe yourself as a student?
7. What are your strongest academic skills?
8. What are the academic areas that you seek to improve?
9. What do you think are your strongest personal characteristics?
10. What are your professional aspirations?

RQ 1- How do senior radiologic students learn to reflect in practice in order to solve complex problems?

- 1- Describe how you approach a routine imaging examination (like a chest x-ray), from start to finish.
- 2- What is included in the exam preparation?
- 3- What technical aspects are needed or considered?
- 4- What patient considerations must be addressed?
- 5- What factors support your imaging routine? Conversely, what factors hinder your imaging routine?

Appendix C continued

- 6- Can you think of a situation where you were in a clinical setting and experienced a real challenge? Describe that situation to me, from the beginning to the end.

RQ 2: What application do rising senior radiologic science students make of reflective practice in clinical settings?

- 1- Tell me about your clinical experiences.
 - a. What exams do you routinely perform?
 - b. What exams are you most comfortable with?
 - c. From your rotations, what is your preferred imaging modality to date?
- 2- How do you know what steps should be taken to complete an x-ray?
- 3- Tell me a time when you did not have all the tools and information needed to perform the exam. What happened?
- 4- Give me an example where you were in a clinical setting and experienced a difficult exam, the steps you took to complete it and how it was a challenge to you. Describe the example with great detail.
- 5- Was the outcome successful or failure? Please explain.
- 6- What of your actions were responsible for that outcome?

RQ 3: How do senior radiologic science students learn to negotiate knowledge from classroom and clinical instruction to make informed clinical decisions?

- 1- What one thing have you learned the most from by varying clinical settings (examples include major medical centers, outpatient clinics, etc.)? How has the information (new learning) been consistent? How has the information (new learning) been inconsistent?
- 2- How do you reconcile this information for practical application in any clinical practice?
- 3- In clinical, what information do you rely the most on, “book” information or “practical” information? Why?
- 4- In your own words, what does it mean to be a critically reflective practitioner?

Probing questions to gain details from critical incident questions:

- a. What clinical rotation were you in?
- b. What type of work setting was it, a hospital, clinic, ER, doctor’s office?
- c. Was this your first experience of this kind?
- d. What was the challenging part to you?
- e. How did you address the challenge?
- f. What was the outcome?
- g. Was the outcome to your satisfaction?

Appendix C continued

- h. What did you glean from this challenge?
- i. Why did you approach this challenge like this?
- j. What would you do differently now?
- k. How did the outcome impact your practice methods?
- l. What resource would you need to face this challenge again and be effective?

Closing Questions

- a. Can you give me a metaphor for one critical incident you experienced, such as “Figuring out this problem is like what . . .”?
- b. What are you looking forward to most as a practicing technologist?
- c. What advice would you give new radiologic science students about clinical?
- d. In your opinion, what makes a good radiologic technologist?
- e. Is there anything else you would like to share that we haven’t discussed?

Appendix D

North Carolina State University

TITLE OF STUDY: How rising senior radiologic students reflect in practice: A narrative analysis.

Investigator: Amy Orders, Doctoral Student
Faculty Advisor: Dr. Tuere Bowles

Participant Observation Field Notes

Pseudonym: _____

Date of Observation: _____

Location of observation: _____

Start Time: _____ am pm

OBSERVATIONS:

1. Appearance of participant (physical characteristics, distinguishing characteristics, clothing, approximate age, gender)

2. Verbal behaviors and interactions (tone, response to questions)

3. Physical behaviors and gestures (non verbal cues, body movements, overall patterns when responding, outcome comfort level)

4. Personal space

5. Other pertinent observations/field notes

Appendix E

North Carolina State University

Date: June, 2010

Dear Radiologic Science Program Director:

I am a Doctoral student in Adult and Community College Education at North Carolina State University. As I begin my dissertation, I would like to request your assistance with the research component of my work, as I am interested in exploring how senior radiologic science students reflect in clinical settings. I find there is a distinct gap in the literature on this specific topic and I am keenly interested in providing research to support the radiologic science education process and activities.

For this research, I am interested in interviewing senior radiologic science students in your program. Senior students have been selected because of their advanced clinical experiences in hospitals, ambulatory care centers and physician offices, following completion of their first year in the radiologic science program and an extended summer externship.

Student participants will be asked to participate in one, in-person interview with me at a mutually agreed upon location. I would prefer to conduct the interviews at your facility, to minimize interview participant anxiety in unfamiliar locations. Each interview will take no longer than one hour and will consist of a series of open-ended questions.

It is expected that these interviews will take place during the late summer and early Fall months of 2010. If you are interested in participating in this endeavor, please contact me via e-mail at amy_orders@ncsu.edu or by phone at 919-515-5208 at your earliest convenience, or no later than July 1, 2010.

I greatly appreciate your time and consideration of this request. I feel this research will be of great benefit to our profession. I look forward to hearing from you soon.

Regards,

Amy Orders

Appendix F

Research studies related to reflective practitioners presented in Chapter 2

Author(s)	Publication Date	Brief study description
Mamede & Schmidt	2004, 2005	202 Brazilian Physicians reflection in action practices used to address complex problems
Pinsky, Monson, & Irby	1998	Review of reflective practices in 48 clinical instructors in medicine
Pinsky & Irby	1997	Reflective practices of medical school clinical instructors to learn from unsuccessful teaching experiences
Klemola & Norris	1997, 2001	Review of reflective practices of 16 anesthetists during operating procedures
Gustafsson & Fagerberg	2004	Review of reflection in nursing students
Teekman	2000	Studied 10 registered nurses in non-routine nursing situations and their reflective actions in decision-making processes

Research studies related to the nature of reflective thinking

Author(s)	Publication Date	Brief study description
Boenick, Oderwald, de Jonge, van Tilburg & Smal	2004	Reviewed 195 fourth year medical students for reflection on ethical dilemmas
Kember & associates	2000	Developed a 16-question tool to assess reflective thinking in undergraduate and graduate students in select allied health professions and nursing
Hallett	1997	Interviews 26 nursing students and supervisors for their views of reflective practice in community based work environments
Williams & Wessel	2000	Reviewed journal entries of 48 physical therapy students for reflective thinking
Wong, Kember, Chang & Yan	1995	Analyzed 45 nursing student essays for reflective learning effectiveness
Pearson & Heywood	2004	Studied 110 general practice resident's personal portfolios to track reflection
Larrson, Lundberg & Hillergard	2008	Reviewed 15 radiographer's use of image production knowledge in PACS
Niemi	1997	Explored reflective thinking of 110 medical students in their pre-clinical years, using content analysis on their learning logs and identity status interviews

Appendix G

Coding Excerpt

Excerpts of Participants' Words and Phrases	Codes	Concepts	Themes
...First thing I'll look at is...the age, just because you need to know what size IR to use.	Engrained information	Applying embedded knowledge	Engaging patients
I've ordered pocket Merrill's ...	Refresher resources		
I try to have that foundation from the books...	Didactic learning		
Like a book, you know, can tell you stuff but not specifics...	Processing skills		
...I'll bring out an IV pole to get their arms out of the way	Practical application		
...Retrieve and read the requisition; initially and methodically prepare the exam room...	"Clinical" approach	Employing evidence	
...and he seemed ok when I went and got him...	Patient context		
...definitely working with the patient and taking care of the patient and not just doing what's supposed to be done...	Weighing priorities		
Well, first of all I got some help because I didn't know what to do at first...	Consulting resources		
...being able to read body language...	Observation		
You do what's comfortable for the patient; relate with their patients...	Patient empathy	Interacting with staff technologists	Interacting with communities of practice
...my classmate and the technologist devised a way...	Teamwork		
...I just sort of follow a technologist for the day and see how they do it.	Positive experiences		
...go in the room and ask questions...	Open communication		

...[techs are] a well of information all right there in one thing....	Staff as resources	Interacting with staff technologists continued	
...technologists that are not willing to work with you...	Conflict with staff		
...the technologists I'm working with are so good that I can see myself working in that kind of environment...	Students need to feel valued		
...they handed me a requisition and they said-here, go do it...	Building confidence		
...and Professor C thinks that I'll be a good person to like coax them and help them want to do it...	Resource and access	Interacting with professors	
...seeking guidance from professors...	Communication to promote confidence	Interacting with professors (cont.)	
...you can walk in there anytime and talk about anything...	Student/professor relationship		
...I did actually have to have a conversation with one of my instructors. Only because it had escalated to that level...	Conflict management		
...I was with classmates who still needed to do their chests, so I would pass them along to the classmates who needed the numbers.	Support mechanisms	Interacting with other students in the clinical environment	
...we both went into an exam room and role-played.	Student-friends as resources		
I'm very much putting myself into my student relationships and other classmates and everything.	Workload management and coping		
There are a lot of people I've made friends with at the places and we really get along.	Consultation among peers		
Understanding all the information that needs to gathered	Problem solving	Correlating information	Logical reasoning
...I'm a part of a team ...	Group thinking		

<p>...Outpatient knee. You get your requisition, you get all your cassettes and scan 'em all in. Set up for AP, bilateral standing, lateral/side, angle as needed, and um, then you do the tunnel view and the Merchant's.</p>	<p>Assessing components of an exam</p>	<p>Correlating information continued</p>	
<p>...you are adjusting what you have learned to fit a different patient population. It's never going to be the same.</p>	<p>Diversity of exams</p>		
<p>Not just going in there and doing things by the book.</p>	<p>Realistic decision making</p>		
<p>But looks at the situation completely from a safety standpoint; from an accuracy standpoint; from a physician's standpoint.</p>	<p>Understanding cause and effect</p>		