FIRST-YEAR EMPLOYMENT EXPERIENCES OF ENTRY-LEVEL RADIOLOGIC TECHNOLOGISTS

by

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Abstract

X-rays were discovered by Wilhelm Conrad Roentgen in a small laboratory in Würzburg, Germany more than 100 years ago. From this discovery, the field of diagnostic medical imaging (radiology) was created and medicine was changed forever. Within the discipline of diagnostic medical imaging itself, many technological advancements were subsequently discovered to include sub-specialties in computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, nuclear medicine technology, radiation therapy, and picture archiving communication systems (PACS), to name a few. These technological advancements have improved the ease and speed with which images are acquired and the clarity of demonstrating anatomical structures and pathologies, all of which aid in accurate diagnosis. However, research findings indicated that many health career educational curricula, including diagnostic medical imaging, are unable to adequately stay abreast of these technological advancements in their educational offerings. Research for this qualitative study was conducted by interviewing 12 entry-level radiologic technologists during their first-year of professional employment to ascertain and identify any disconnects between the educational offerings in the professional curriculum versus the skills and knowledge required for entry-level jobs. First, experiential learning was found to be intrinsic in the matriculation of competency-based clinical education training programs. Second, the apprenticeship theory is supported by a strong mentoring program offered by employers for newly hired, entry-level radiologic technologists during their first year of employment. This qualitative research study determined that the competency-based clinical component of the professional education program and an effective mentoring program were critical to the success of newly hired, entry-level radiologic.

Dedication

This dissertation is dedicated to my aunt, Dr. Fredricka H. Waiters, August 12, 1939 – June 28, 2018 and my mother, Ms. Annie E. Harris, June 23, 1941 – August 10, 2018. I love and miss you both so very much.

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CHAPTER 1. INTRODUCTION

In 1996, Harris conducted research comparing the clinical education component of certificate, associate, and baccalaureate level radiologic technology programs. Little research has been conducted since the 1996 study on the clinical education component of radiologic technology programs. Significant changes have occurred, however, within the educational process of the discipline (DuBose, Barymon, Vanderford, Hensley & Shaver, 2014; Metcalf, Adams, Qaqish, & Church, 2010; Powers, 2015). Certificate level programs have been eliminated from the educational offerings nationwide leaving only associate and baccalaureate degree programs as the entries into the profession (Joint Review Committee on Education in Radiologic Technology, 2014).

A multitude of technological advancements have also occurred within the discipline that have directly impacted the educational process and, subsequently, the entry-level technologist's performance coming into the profession (American Society of Radiologic Technologists, 2015; Bidgood et al., 1998; Howerton & Mora, 2008; Joint Review Committee on Education in Radiologic Technology, 2014). Since the founding of the x-ray, medical imaging has advanced over the past 100 years with other discoveries such as of CT, MRI, mammography, sonography, and nuclear medicine, to name a few. While more content has been added to the professional curriculum, it has been insufficient to bridge the gap between rapid technological advancements and the current curriculum offered in medical imaging educational programs. Recognizing the educational offerings as major stakeholders into the profession, this study provided guidance to improve the foundation for the entry-level professional curriculum, which is currently set at the associate and baccalaureate degree levels.

Medical imaging technologists organize and plan their work as well as evaluate images for diagnostic and therapeutic quality according to the competences and didactic instruction received during their enrollment in their educational programs. This careful planning ensures the production of images of diagnostic quality and ensures the safety of the patients during the procedures (Castillo, Caruana, & Wainwright, 2011). However, during the past several decades, the very rapid development of new imaging modalities and the increasing complexity of these imaging procedures have caused an expansion in the required professional activities of radiologic technologists. As a result, radiologic technologists are spending more time with imaging informatics. The role of the radiologic technologist includes caring for the whole patient during the performance of the radiographic procedures. Therefore, it is imperative the radiologic technologist must exhibit a confidence and competence to insure patient safety and the production of diagnostic quality images.

Background of the Study

According to the Ohio State University School of Medicine (OSUSM) (2016), more than a century ago Abraham Flexner proposed what was then classified as the gold standard for medical education. Flexner's model consisted of two years of coursework in the sciences followed by an additional two years of clinical training in medicine. Medical schools did largely not only adopt this 2 + 2 model of medical education, but so also did other allied health disciplines across the United States. Although the world and medicine have changed significantly over the decades, this approach to medical education has remained unchanged.

In the medical imaging or radiologic technology discipline, educational programs have traditionally followed a similar educational model. Whether an associate degree program or a baccalaureate program, the radiologic technology curriculum consists of concurrent didactic and competency-based clinical coursework (American Registry of Radiologic Technologists, 2016).

Over the years, radiologic sciences education has become student-centered (Holmström & Ahonen, 2016). The competency-based radiologic sciences education programs focus primarily on the knowledge of diagnostic medical imaging and the requisite skills needed to perform diagnostics on radiographic images. The knowledge component requires the student to demonstrate a thorough understanding of theory and principles in radiologic imaging. The skills component requires the student to demonstrate mastery of the radiographic equipment in a safe and efficient manner based on the patient's age, size, history, and physical condition and imaging techniques needed to produce diagnostic quality images. Finally, the competence component of radiologic sciences education requires the student to utilize critical thinking and problem-solving skills when faced with any unpredictable or unconventional situation in the clinical environment (Holmström, & Ahonen, 2016).

In addition to the movement towards student-centered education, radiologic sciences instruction has also become more university-based and less vocationally-based education, as in the 2+2 model. According to the American Society of Radiologic Technologists (ARRT, 2017) curriculum guide, current radiography education should focus on the following broad topics: introduction to radiologic sciences and health care, ethics and law, human anatomy and physiology, pharmacology, imaging equipment, radiation protection, principles of exposure and image production, digital image acquisition and display, image analysis, radiation biology; radiation protection, patient care, radiographic procedures, and pathology. This suggested curriculum content aligns with the ARRT's content specifications for the certification examination in radiography (2017). The ARRT content categories are the following: patient care, safety, image production, and procedures.

However, academic-based curricula design in many allied health programs like nursing, physical therapy, and radiologic technology suffer from gaps between training and preparedness due to rapid technological advancements in the disciplines (Walsh, 2011). Although students are being trained on the fundamental use of medical imaging equipment, additional advancements in equipment design, functionality, speed of image acquisition, and details of anatomy for clinical diagnosis are continually advancing by manufacturers more rapidly than these advancements can reach textbooks (McDonald et al., 2015)

According to a report from the National Advisory Council on Nurse Education and Practices (NACNEP) to the Secretary of the U.S. Department of Health and Human Services and the U.S. Congress (2010), advances in medicine have increased patient longevity and healthcare costs. The demand for imaging procedures has increased exponentially over the past several decades due to advancements in imaging technologies like MRI, CT, and positron emission tomography (PET)/CT and the advancements in medicine that have increased lifespan. Therefore, technological advancements, the aging U.S. population, and workforce shortages in several health profession disciplines have created challenges in adequately and appropriately training students with the knowledge, aptitude, and capabilities to care for a highly complex medical environment.

Literature suggests there is a disconnect between education preparedness and professional skills; this can be seen across many medical fields. For example, according to a report by the American Physical Therapy Association (APTA) (2011), physical therapists have traditionally developed plans of action to address a myriad of physical health concerns by utilizing their vast knowledge of disease and disease processes, injury, and the associated mechanisms of the healing process. Although physical therapy has always been considered a hands-on discipline, over the past decade the increased use of robotics and bionics in the field has led to substantial improvement in patient outcomes (The Commission on Accreditation in Physical Therapy Education, 2017). Nonetheless, the professional curriculum for physical therapy students has not kept up with the technological advancements. Students are still being taught theory and practice while technology continues to advance.

Other literature suggests a disconnect between educational preparedness and the knowledge, skills, and abilities of graduates of other health professions, such as respiratory therapy and radiation therapists (Gutek, 2004; Kowalczyk, 2014; Merriam, 2015; Powers, 2015; Wentz, Hobbs, & Mickelsen, 2014). A study by Harris (1996) examined and analyzed the clinical education component of baccalaureate-level, associate-level, and certificate-level radiography professional preparation programs for employment. The study was conducted based on the following three criteria: a) the JRCERT (Joint Review Committee on Education in Radiologic Technology) accreditation standards; b) the ARRT radiographic procedures content requirements for the national certification examination; and c) a composite entry-level job description for a radiologic technologist. The Harris (1996) study found no significant difference in the educational preparation or the abilities of radiologic technologists' whether they graduated from a certificate-level, associate degree-level, or baccalaureate-level program. Further, Harris (1996) found there was a significant difference in the written documentation of adherence to the JRCERT standards of accreditation of radiography education programs at the baccalaureate degree, associate degree, and certificate-level. This was assessed with the content matrix tool which was based on the actual JRCERT guidelines for accreditation and the procedural content of the ARRT certification in the 2007 examinee handbook. Finally, the researcher used the composite job description to study the correlation between program documents that described the training and clinical education components of the program and a list of skills advertised for entry-level radiologic technology employment.

However, there have been many technological advancements in radiologic sciences since 1996, unfortunately coinciding with the elimination of the certificate level programs. In 1996, the market trends were demanding the need for multi-competent practitioners in medical imaging (American Society of Radiologic Technologists, 2015). While multi-competence was desired by managers and administrators, educators had yet to change their focus towards producing the functionality of a multi-competent practitioner instead of that of an entry-level technologist (Beachey, 1988). This study was a follow up to the study completed by Harris (1996). As a follow-up study, the researcher identified the knowledge, skills, and abilities of new radiologic technologists, in their first professional jobs within the first year of graduation, when the gap between training and practice was most palpable.

The Harris (1996) questionnaire asked the participating program directors of the programs in a survey the following questions concerning their clinical education component of their programs. This instrument asked questions pertaining to the specific operation of each program surveyed (p. 174).

1. In your professional program, are the clinical instructors part or full-time faculty members?
2. How many paid clinical instructors does your program employ?
3. How many volunteer clinical instructors does your program employ?

4. How many clinical affiliates does your program utilize?
5. How many different clinical rotations at different sites does the average student complete during their matriculation in your program?
6. What is the average length of each term in your program?
7. What is the average number of clinical hours does each student experience per week?
8. What specialty rotations (if any) are included in your clinical curriculum?
9. What is the ARRT percentile rank of graduates from your program?
10. What mechanisms, other than clinical competency examination, are utilized to assess the knowledge of students of radiographic procedures in the clinical curriculum?
11. Are your clinical education courses pass/fail, letter grades, or both?
12. If a student fails a clinical course, is the student dismissed from the program?
13. Are there mechanisms in place for students to repeat a clinical education course? If so, please explain. (p. 174)

A context-based analysis in the form of a content matrix was designed according to the pre-established JRCERT guidelines as the evaluating criteria. Information was then gathered from the clinical education course syllabi and each clinical education student handbook that confirmed documentation of adherence to the evaluation criteria. The content matrix served as the standard by which each clinical education handbook was evaluated. The content matrix included the following subject matter:

1. Radiation Protection

a. Biological aspects of radiation

b. Minimizing patient exposure

c. Personnel protection

d. Radiation exposure and monitoring

2. Equipment Operation and Quality Control

   a. Principles of radiation physics

   b. Radiographic equipment

   c. Quality control of radiographic equipment and accessories

3. Image Production and Evaluation

   a. Selection of technical factors

   b. Image processing and quality assurance

4. Patient Care and Education

   a. Ethical and legal aspects

   b. Interpersonal communication

   c. Infection control

   d. Physical assistance and transfers

   e. Medical emergencies

   f. Contrast media

5. Radiographic Procedures

a. Thorax

b. Abdomen and GI studies

c. Urological studies

d. Spine and pelvis

e. Cranium

f. Upper extremities

g. Lower extremities

h. Other

The composite job description was developed from a review of 20 advertisements of actual entry-level radiologic technologists' positions within the 15 states where the programs surveyed were located. Position descriptions were obtained from newspapers, professional radiography journals, and online during the spring of 2007. This composite job description was the standard by which entry-level skills were established. The composite job description included:

Table 1: Composite Job Description Summary

Primary Responsibilities	Secondary Responsibilities (Sub-categories)
1. ARRT credentialed or registry eligible	
2. Graduate of a JRCERT accredited program	
3. 1-2 years' experience as a student technologist	
4. Current CPR certification	
5. Demonstrates knowledge of cross-sectional anatomy	

6. Ability to perform radiographic procedures	Neonatal
	Pediatric
	Adolescent
	Geriatric
7. Ability to perform independent tasks	Portable examinations
	Trauma radiography
	Fluoroscopy
	Surgical procedures
	Routine radiographic procedures
8. Ability to perform non-technical tasks	Patient escort
	Hanging radiographs correctly (if needed)
	Equipment quality control
	Assistance to aides and orderlies (as needed)
	Participate in training and committee work
9. Demonstrate good communication skills	Patients
	Supervisors
	Co-workers
	Other hospital employees
	Physicians
10.Experience in other imaging areas	CT
	Mammography
	Ultrasound

The sample for the Harris (1996) quantitative study consisted of 74 radiologic technology programs located in 15 states. These were states in which at least one baccalaureate-level program was identified according to the 2007 JRCERT list of accredited educational programs. Twenty baccalaureate degree programs, 29 associate degree programs, and 25 certificate programs were randomly selected from these 15 states. For data analysis purposes, programs were grouped according to their class capacity as identified in the 2007 edition of the JRCERT listing of accredited educational programs in radiologic technology. Programs with a class capacity of 1-24 students were classified as small; those with 25 to 50 students were classified as medium; and those with more than 50 students were classified as large.

A panel of content specialists in the field of radiologic technology was assembled. The purpose of this panel was to verify face validity of the instruments and critique content-specific information. This panel consisted of four radiologic technologists: one staff technologist, two radiologic technology educators, and one radiology department administrator.

The Harris (1996) study found there was a significant difference in the written documentation of adherence to the JRCERT standards of accreditation of radiography education programs. Additionally, there was a significant difference in the written documentation of adherence to the procedural content of the ARRT certification examination. Finally, there was no significant difference in meeting the basic employment market requirements for the entry-level radiologic technologist according to a composite job description.

Need for the Study

There are often disconnects between theory and actual clinical practice across many disciplines, including the health professions (Allsopp, DeMarie, Alvarez-McHatton, & Doone, 2006; Hoffman, 2004; Pijl-Zieber, Barton, Awosoga, & Konkin, 2015). In many instances, it is due to the inability of academia to stay current with technological advancements (Eggleston, 2014). This occurs because equipment companies, manufacturers, and developers of new technology are continuously attempting to find a better technique or equipment design that lends itself to increased patient safety or the production of higher quality diagnostic images for interpretation.

Technologists in their first professional year of employment are transitioning being a student to being a technologist. During this first year of professional employment, the technologists can draw on the roles and tasks that were recently required of them as a student versus the skills required by an employer for in an entry-level technologist position. The disconnect between theory and actual clinical practices certainly holds true for the field of radiologic sciences (Bidgood et al., 1998; Bushong, 2013; Dinan et al., 2010; Howerton & Mora, 2008). Currently, little to no research on the work experiences of the entry-level radiologic technologist during their first year of professional employment exists (Metcalf et al., 2010). The gap in the literature centers on the specific challenges that radiologic technologists experience in their first-year of employment (Garrett, 2005; Andersson, Christensson, Jakobsson, Fridlund, & Broström, 2012; Vanckaviciene, Macijauskiene, Blazeviciene, Basevicius, & Andersson, 2017). The need for this qualitative study arises because educational programs in radiologic technology may not be revised and updated rapidly enough to reflect technological advancements in the discipline.

Purpose of the Study

The purpose of this study was to discover the first- year employment experiences of radiologic technologists, the meaning they ascribed to these experiences, and how these experiences were related to optimal or sub-optimal outcomes in diagnostic medical imaging. New graduate radiologic technologists in their first professional year of employment were ideal for this study as they had recently completed formal educational training and were fully aware of the educational rigors as well of the knowledge needed to successfully pass the ARRT certification examination. Additionally, as new graduate radiologic technologists in their first year of professional employment, participants in this study were transitioning from the student role to the technologist role and could easily identify what was taught in their professional program and what the employment expectations were of an entry-level technologist. Therefore, the new graduate technologist could offer one valuable perspective regarding whether there are gaps between educational training and performance requirements.

Significance of the Study

Utilizing a basic qualitative research model, this study described the first-year employment experiences of new radiologic technologists (Merriam & Tisdell, 2015). The researcher discovered, better defined, and opened up questions for additional research. Additionally, the researcher analyzed the experiences of the entry-level radiologic technologists. Finally, the researcher examined the entry-level role requirements and the educational needs of the professional training program of radiologic technology students. By utilizing interviews, this researcher identified optimal versus sub-optimal performance experiences during the first professional year of employment of radiologic technologists.

As the researcher expected, the study supported the concepts and assumptions articulated in the theory of apprenticeship. In the field of education, the apprenticeship theory blends formal and informal educational preparation in order to form and develop a blueprint that represents one understanding of reality (Austin, 2009; Bouta & Paraskeva, 2013; Stewart & Lagowski, 2003). The apprenticeship theory is a comprehensive understanding of the parts of a discipline and how those parts are interconnected and understood within the discipline. This theory of learning addresses the educational preparedness of the student and the teacher. As the learner develops a mental formation that incorporates the complexities of the environment, the learner will begin to be able to perform similarly to their peers. Once the learner's ability improves sufficiently and the development is accepted by the instructor, the learner will be acknowledged and accepted as a colleague. The apprenticeship theory directly addresses the competency-based clinical education component of educational programs in radiologic sciences.

The potential implications emerging from this original qualitative study should be confirmed by a quantitative research agenda. Once researchers determine that the findings are generalizable, then policy and practice changes may be suggested Qualitative research is valuable because it investigates issues in-depth, in a manner that could not be done quantitatively. Hence, this qualitative research examined deeply the first-year employment experiences of new graduate radiologic technologists, and thereby spurred additional, related research. Although the literature addressing this issue in the field of radiologic sciences is limited, several other medical disciplines are regularly reviewing their curriculum and its practical implications to include future trends (American Physical Therapy Association, 2011; CAPTE, 2017; Metcalf et al., 2010; Ohio State University School of Medicine, 2016). Further implications may suggest the creation of prototypes that could influence educators, students, and employers in the discipline. Additionally, changes in how and when the professional educational curriculum is modified may also be identified. This original qualitative study confirmed the need for such changes.

Research Questions

With the study's purpose in mind, which was to study the first-year employment experiences of entry-level radiologic technologists, these questions emerged.

Main Question:

What are the first-year employment experiences of entry-level radiologic technologists?

Sub questions:

1. What are the special challenges that radiologic technologists experience in their first-year of employment?
2. What meanings do radiologic technologists ascribe to their work experiences?

3. How are these experiences related to optimal or sub-optimal outcomes in diagnostic medical imaging?
4. What role did educational preparation play during the first year as a radiologic technologist?
5. What are the day-to-day experiences of radiologic technologists in a typical imaging department?

Definition of Terms

The following terms were used in this study. For this research study, the definitions of these terms are:

American Registry of Radiologic Technologists. The largest credential/licensing agency for radiologic technologists (American Registry of Radiologic Technologists, 2017).

The American Society of Radiologic Technologists. The leading professional organization for radiologic technologists (American Society of Radiologic Technologists, 2017).

Educational Preparedness. Djukic et al. (2013) defined educational preparedness as the state of readiness educationally, as well as having the requisite skills, for employment upon graduation from a professional program in an entry-level position.

Employment Experience. The range of possible employment experience is broad and benefits from delimitation. For the purpose of this study, employment experience is a composite of many factors, notably: (a) educational preparedness and (b) the ability to perform the duties outlined in the entry-level job description.

First-y ear. The first twelve months of professional employment after graduation. For the purposes of this research, eligible participants will have at least six months' experience, but not more than 12 months.

Joint Review Committee on Education in Radiologic Technology (JRCERT). The leading organization credentialing educational programs in the radiologic sciences (Joint Review Committee on Education in Radiologic Technology, 2017).

Medical Errors. Starmer et al. (2014) defined a medical error as an adverse event, near miss, or deviation from a planned action of care for a patient. A medical error may or may not cause harm.

Multi-competent. White & McKay (2004) defined multi-competent as a healthcare professional having been trained in and manifesting skills at performing more than one function, often in more than one discipline.

Radiologic Technologists. According to the ARRT (2016), the term radiologic technologist is a general term for defining competency-based, educationally prepared American Registry of Radiologic Technology (or equivalent) credentialed personnel. That work includes one or more of the following modalities in a medical imaging or x-ray department: diagnostic radiology (x-ray), magnetic resonance imaging (MRI), nuclear medicine technology, computed tomography (CT), vascular interventional radiography, cardiac interventional radiography, mammography, dual-energy x-ray absorptiometry (DEXA), picture archive and communication systems (PACS), radiation therapy, and sonography (ultrasound).

Sub-optimal Outcomes in Diagnostic Medical Imaging. The production of medical images that are of a quality less than the standard. These non-diagnostic quality images could potentially lead to a false-negative or a false-positive diagnosis by the interpreting physician (Suetens, 2017).

Research Design

This study used a basic qualitative research design. Scientific research, as defined by Lodico, Spaulding, and Voegtle (2010), Creswell (2013), and Farrelly (2013), is a method of inquiry or investigation that utilizes various techniques to acquire reliable, empirical, credible, measurable, and verifiable knowledge or information concerning a phenomenon. According to Miles, Huberman, & Saldana (2014), qualitative research is a non-numerical method of scientific inquiry that aims to comprehensively explain the understanding of human nature. Qualitative research typically investigates the how’s and why’s of decision making. Further, qualitative research produces information about the specific case(s) being studied and can only speculate on more general conclusions. The qualitative method of scientific inquiry is particularly appropriate in the social sciences. Strengths of utilizing a qualitative study include the following:

- It provides individual case information.
- It is especially responsive to specific situations and conditions.

  Its researchers are especially receptive to changes that may occur during the study.
- It can be carried out with a small budget and in a short amount of time.

In the arena of qualitative research, the goal is to increase understanding about human interaction and social phenomena. Scholars attempt to explain the processes through which individuals create meaning. This is done by utilizing empirical observations. Only with concrete incidents of human conduct can investigators clearly evaluate the human condition (Bogdan & Biklen, 2007, p. 43).

According to Merriam and Tisdell (2015), in basic qualitative research, knowledge is gained continually as the researcher interacts with the participants and makes meaning of the experiences and activities in which they are engaged. The basic qualitative research model consists of describing how those studied interpret their experiences, how their worlds are designed, and the subsequent meaning attributed to their experience (Merriam & Tisdell, 2015). This basic qualitative research consisted of interviews with radiologic technologists to identify their experiences during their first year of professional employment. The interviews involved semi-structured, open-ended questions. These semi-structured research questions were designed based on the current literature and they were field tested prior to conducting the actual, proposed research study.

Assumptions and Limitations

Assumptions

The primary assumption underlying this study was that the participants sampled responded with honesty about their first-year employment experience. There were no incentives or threats offered to participants for inclusion in or declining to participate in the study. Additionally, it was assumed that participants did not feel they were coerced or that their participation would have an influence on their employment. The researcher had neither direct nor indirect involvement in the selection of candidates for entry-level positions nor any input into the performance appraisal of entry-level technologists. Finally, the researcher assumed that the participants' felt that their candor was not contrary to their self-interest. It was also assumed that the first-year employment experiences were significant in the foundation of a professional career in radiologic technology. Additionally, it was assumed that first-year; entry-level radiologic technologists would be receptive to p Standard language used in the field participating in a study about their chosen profession. It was also assumed that an adequate number of entry-level radiologic technologists would participate in this study. Finally, it was assumed that the sample utilized was generalizable to the entire population of radiologic technologists who are employed at a pediatric facility.

Limitations

This research study, as designed, did not address employers' needs for entry-level radiologic technologists nor the effectiveness of the curriculum in a radiologic technology program. The researcher did not have any input into the hiring or training of the newly hired graduate radiologic technologists who participated in this study. Neither educational nor clinical administrators were interviewed. This study was designed to elicit the responses of the preparedness of entry-level technologists only.

From the participants' perspectives, the self-reported first-year employment experience data of the participants were limited to the few months of employment. Also, the participants were relatively inexperienced as radiologic technologists and may not have completely adjusted to the role of technologist versus that of a student. It should also be noted that 10 of the participants graduated from the same radiologic technology educational program. Therefore, their responses and competency as an entry-technologist could be biased based on having the same instructors and similar clinical experiences during their matriculation. Similarly, with all participants employed at the same pediatric facility, the responses provided may be a unique perspective, akin to the overall culture of the employer. Finally, because several participants matriculated at the same institution, there may be a limit to the conclusions drawn about how and what training needs that may need to change.

Finally, based on the small sample size for this study, the researcher could not make large generalizations about the population of all entry-level radiologic technologists. Therefore, questions may be raised that can be explored in future studies.

Delimitations

This study did not include medical imaging personnel not credentialed by the American Registry of Radiologic Technologists (ARRT) or an equivalent credentialing agency. Also, the participants did not have any previous employment experiences in the discipline. Finally, this study did not include any radiologic technologist with more than one year of professional experience.

Organization of the Remainder of the Study

Chapter 2 will consist of analysis and synthesis of the current literature on this subject. Chapter 3 will consist of a discussion of the research methodology and the research procedures utilized for this study, including the following: selection of participants, instruments utilized, data collection, data analysis, and ethical considerations. Chapter 4 will provide an analysis and presentation of the data collected as described in Chapter 3. Finally, Chapter 5 will provide a discussion of the study’s implications, and recommendations for further research on the topic.

CHAPTER 2. LITERATURE REVIEW

The purpose of a literature review was to add to the literature in a discipline with purposeful research (Onwuegbuzie, Leech, & Collins, 2012). The purpose of this qualitative research study was to discover the first-year employment experiences of radiologic technologists in order to understand how well prepared they were to perform in the professional settings and whether educational programs were able to stay abreast with technological advancements. Allsopp et al., (2006) and Luck and Gillespie (2017) suggested there are often disconnects between theory and actual clinical practice across many disciplines, including the health professions. In many instances, it is due to the inability of academia to stay current with technological advancements in their discipline (Eggleston, 2014).

The disconnect between theory and actual clinical practices held true for the field of radiologic sciences specifically (Bidgood et al., 1998; Bushong, 2012; Dinan et al., 2010; Howerton & Mora, 2008). What was unknown or missing from the literature regarding radiologic technologists was a discussion of the specific challenges that radiologic technologists experience in their first-year of professional employment, as well as a discussion of whether a disconnect exists between their educational preparedness and the desired knowledge needed for employment (Garret, 2005; Andersson et al., 2012; Vanckaviciene et al., 2017). Currently, little to no research on the work experiences of the entry-level radiologic technologist during their first year of professional employment exists (Metcalf et al., 2010). The need for this qualitative study arose because educational programs in radiologic technology may not be revised and updated rapidly enough to reflect technological advancements in the discipline and curricular content.

Methods of Searching

The researcher utilized the Capella University library to access several databases for the literature review. These databases included: Chronicle of Higher Education, Dissertations at Capella, Education Database (formerly ProQuest Education Journals), ERIC, Nursing & Allied Health, ProQuest Central, PubMed Central, SAGE Journals Online, and Summon. Key search terms utilized included, but were not limited to, the following: qualitative research, quantitative research, first employment year, health professions education, employee satisfaction, and allied health. Additionally, the following radiologic technology professional organizations were utilized: American Registry of Radiologic Technologists (ARRT), American Society of Radiologic Technologists (ASRT), and the Joint Commission on Education in Radiologic Technology (JRCERT).

Theoretical Orientation for the Study

Frameworks enable researchers to make theoretical qualifications and sort out thoughts surrounding the problem to be studied (Bordage, 2009). Each framework chosen to support a study may highlight a part of the problem being studied. However, several frameworks may be relevant to an entire, single study (Bordage, 2009).

This basic qualitative research described the first-year employment experiences of new radiologic technologists. The researcher attempted to surface the experiences of entry-level radiologic technologists, the entry-level role requirements, and the educational needs of the professional training program of radiologic technology students. By interviewing each participant, the researcher attempted to gain insight into the first professional year of employment of radiologic technologists.

This basic qualitative research, utilizing a basic qualitative research model, described the first-year employment experiences of new, entry-level radiologic technologists (Merriam & Tisdell, 2015). The researcher attempted to discover, better define, and to perhaps spur additional research into the experiences of entry-level radiologic technologists, the entry-level role requirements, and the educational needs of the professional training program of radiologic technology students. By utilizing interviews, this researcher attempted to identify optimal versus sub-optimal performance experiences during the first professional year of employment of radiologic technologists.

The researcher expected that the study would provide plausible confirmation and support for the concepts and assumptions articulated in the theory of apprenticeship. In the field of education, apprenticeship theory emphasizes learning through the synthesis of traditional classroom and experiential educational experiences. This synthesis allows learners to develop mental maps that correspond to their learning experiences, both in the classroom and outside of it (Austin, 2009; Bouta & Paraskeva, 2013; Stewart & Lagowski, 2003). The apprenticeship theory is a comprehensive understanding of the parts of a discipline and how those parts are interconnected and understood within the discipline. The apprenticeship theory of learning addresses the education of both the student and the teacher. As the learner develops a schema that begins to incorporate the intricacies of the environment, they will be more capable of performing similarly to their peers. Once the learner's ability improves sufficiently and the development is recognized by the teacher, the student will become accepted as a peer. The apprenticeship theory directly addresses the competency-based clinical education component of educational programs in radiologic sciences.

Simply put, critical thinking is the way adult learners learn (Murray & Kujundzic, 2005). Defining critical thinking involves including both the process and the outcome. However, the ultimate goal of critical thinking is to make careful, reasoned decisions by evaluating evidence.

According to Dunn, Halonen, and Smith (2009), critical thinking is not limited to simply one function. Rather, in the field of psychology, Dunn et al. (2009) suggested that critical thinking also includes the learning processes of focus, commitment, and encouragement in the development and learning of new ideas. The aforementioned tasks could be accomplished through recognizing patterns, tackling problem solving through creative or scientific approaches, adapting to new perspectives, and finally through formative evaluation. Halpern (2003) defined critical thinking "as the use of those cognitive skills or strategies that increase the probability of a desirable outcome … thinking that is purposeful, reasoned and goal directed" (p. 6). The goals in this section were to review the literature on critical thinking, identify the best practice strategies for facilitating critical thinking, and finally elaborate on three strategies while promoting the effectiveness of these strategies for improving critical thinking skills in the adult learner (Chen, 2014).

Thinking is an introspective or philosophical act of utilizing one's mind to make rational and objective evaluations of a situation or phenomenon. Therefore, critical thinking would be a deliberate act of thinking. According to Nosich (2009), there are eight elements of reasoning (critical thinking) that produce thinking that is proven and credible. These elements include:

1. The purpose of reasoning;
2. The question at the center of the reasoning;
3. The assumptions being made about reasoning;
4. The implications and consequences of reasoning;

5. The information obtained from reasoning
6. The concepts gained by reasoning
7. The conclusions drawn from reasoning; and
8. The interpretation of the conclusions drawn from reasoning.

Additionally, Nosich (2009) describes the six standards of critical thinking in terms of distinctness or clarity, veracity or mastery, value or relevance, completeness or sufficiency, scope, or independence of thought and finally rigor or accuracy.

Brookfield (1987) distinguished between theories and actuality as the difference "between what is supposed to happen and what appears to be taking place" (p. 151). It seeks to distinguish how humans are freed from the things (e.g., customs, influences, etc.) that have forced them into developing certain beliefs, morals, or values. Merriam, Caffarella, and Baumgartner (2007) define life-changing or transformational learning as the foundational alterations in the way one views himself or herself in the global environment where we live. Therefore, critical thinking is one of the elements that must be present before an individual can undergo the process of transformational learning.

Fogerty (1995) described critical thinking as a series of functional actions that utilize the engagement of subject specific skills or activities to achieve a desired result. This is accomplished through the application of logic, analysis, and/or interpretation in a context-free process (Ellis, 2016). Facione (1998) provided the most illuminating and purposive definition of critical thinking as a deliberate, self-policing acumen which culminates in meaning, examination, appraisal, assessment, and the supposition of symbolic, theoretical, scientific, criterion-specific logical or circumstance-dependent mental analysis upon common sense, sapience or intuitive intelligence is established.

However, Brookfield (1995) substituted the term or phrase ‘critical thinking’ with the term or phrase of ‘critical reflectivity’. Further, Brookfield (1995) defined ‘critical reflectivity’ as the acquisition of new knowledge by means of casting or drawing from one’s own mental picture of himself or herself by redefining pre-established traditional customs, altering one’s self image, questioning pre-established, embodied standards (behavioral and moral) and re-developing all behaviors from a new viewpoint.

Durand (1999) defined four steps in the critical thinking process: a) describe the purpose or aim of the action or goal of the process; b) define the representation of the occurrence identified in the process; c) define all potential solutions or options to the process (regardless of whether they are far reaching); and d) cull all options and choose the most appropriate option. The following sections will elaborate on strategies for facilitating critical thinking skills in the adult learner.

Levy (1997) defined critical thinking as “a systemic cognitive strategy to examine, evaluate, understand events, solve problems, and make decisions on the basis of sound reasoning and valid evidence” (p. 236). With the complexity of this higher order skill, actually teaching critical thinking involves the development of appropriate strategies that not only engage the learner deeply but subsequently cause them to think deeply. Ultimately, for learners to develop critical thinking skills they must learn how to take constructive criticism, make sound decisions, and collaborate with others (Chan, 2013; Morrall & Goodman, 2013)

Therefore, critical thinking may be understood as a process of problem solving in which the learner deliberately thinks to obtain a certain result. Critical reflection requires the learner to analyze their judgments based on prior knowledge that has defined their values, beliefs, and behavior, which have actually shaped them into who he or she is as a person. When reflecting and thinking critically the learner questions pre-formed theorizations, thereby causing the learner to grow intellectually as a person.

Wade and Tavris (2002) and Wade (1995) suggested that dispelling the mystery surrounding critical thinking is the first step. The process of dispelling the mystery surrounding critical thinking includes the following:

1. Raising questions;
2. Concisely naming the issue;
3. Carefully reviewing the evidence provided;
4. Considering all assumptions and biases inherent with the problem to be solved;
5. The learner eliminating any emotional ties to the problem;
6. Avoiding oversimplifying the issue at hand;
7. Considering other interpretations of the problem; and
8. Remaining open and objective to uncertainty.

According to Dunn et al., (2009) and Bugg (1997) some of the most effective strategies for developing critical thinking and metacognition skills in the adult learner included some of the following activities or learning strategies:

1. Journaling;
2. Incorporating activities that involve reviewing current literature and include summary writing exercises – classroom assessment techniques;
3. Engage in group discussions and/or case studies;
4. Collaborate in work/create cooperative learning opportunities; and
5. Include reflection activities.

The remainder of this section will elaborate on the critical thinking strategies of journaling, group discussions, and cooperative learning. Blake (2005) summarized journaling as a method of active learning utilized to assist with the process of learning through reflection. Reflective learning is a process of self-examination where a learner keeps a written accounting of his/her learning experiences. With this written account, the learner can reflect on the essence of the learning process and grow by making connections between those experiences. Additionally, the learner is able to gain perspective on specific situations and develop a sense of critical thinking to interpret these events. Journaling can also be viewed as an avenue of assessment for learners.

Journal writing is a flexible instructional tool, useful across disciplines. Although many instructors utilize journaling as a classroom icebreaking activity, it can also be effectively used to give students the chance to discuss their ideas on paper, divulge their emotions, invite creative ideas, practice or develop writing skills, and make observations that are typically accepted without criticism (Blake, 2005; Mattsson, 2016).

Journal writing has the potential to produce academic opportunities for a learner to:

1. Solve problems by considering varying perspectives;
2. Examine and re-examine relationships between and among others;
3. Reflect on one's own personal goals, values, and ideals;
4. Summarize the experiences and opinions related to the before and after of instruction; and
5. Develop academic and personal growth.

Where there are positive outcomes, there are also potential negative outcomes. The use of journals can produce two potential negative outcomes that include:

1. The potential for constructive criticism to be actually viewed by the learner as simple criticism bringing on hurt feelings.
2. The educator may utilize too much time on journaling. This issue can be addressed by limiting journal writing activities to out of class activities or only a few minutes during each class meeting.

According to Blake (2005) and Woodbridge and O'Beirne (2017), academic journaling should be oriented towards making all journal entries relate personally to the topic being discussed during instruction. The instructor can request that the learner provide a summary of learning or reflect on a particular question or questions after the instruction has ended where the student is requested to reflect, process and organize his or her thoughts about the material covered.

Group discussions are another avenue for learners to enhance their learning experience by motivating, fostering, and encouraging the learner's intellectual ability by developing autonomous habits. The use of group discussions can create opportunities for learners to practice and hone several rhetorical skills that include articulatory acuity, defending one's position on a particular topic, consideration for appreciating differing viewpoints, and finally appreciating the values of thoroughly evaluating evidence (Brookfield, 1995).

According to Jeong (2001) and Pena-Shaff and Altman (2015), while group discussions could certainly provide avenues for discovery and exploration, group discussions could also produce anxiety. Group discussions, by their nature, can be unpredictable based on the level of engagement of the participants. Occasionally, group discussions can require an instructor to relinquish control, to a certain extent, over how and when students are introduced to new information and how it is absorbed. However, careful planning by the instructor can aid in ensuring that group discussions are always intellectually stimulating and encouraging exploration while avoiding tangents. When facilitating discussions, it can be beneficial for instructors to take into account cognitive, social, emotional, and physical factors that might affect the productive exchange of ideas (Browne & Keeley, 2007; Wang, 2017).

Some of the cognitive factors that should be considered when engaging in group discussions include:

- Develop and accurately communicate learning objectives;
- Plan a strategy for issues that may arise from a group discussion;
- Ask pertinent questions;
- Provide explicit direction;
- Maintain focus;
- Bring closure at the end of the session.

Some of the social and emotional factors that should be consider when engaging in group discussions include:

- Demonstrate relevance of the group discussion activity;
- Encourage equal participation from all learners by expressing to them the importance of their opinion and contribution to the discussion;
- Make certain that high-quality participation is rewarded;
- Bring closure at the end of the session by evaluating the overall process.

The primary physical factor that should be considered when engaging in group discussions is simply developing a classroom culture that facilitates a group discussion dynamic. The primary cognitive factor that should be considered when engaging in group discussions is to adequately and appropriately determine and communicate learning objectives prior to beginning the activity.

For the group discussions to accomplish its goal, the purpose of the activity must be clearly articulated prior to beginning the activity. Beforehand, the goals and purpose of the discussion must be appropriately outlined. The instructor should first address what information and ideas that must be discussed; second, he or she should address what skills, knowledge, perspectives, or sensibilities the learners should obtain once the discussion group has concluded; and finally, ensure that the goals of the group discussion are consistent with the course objectives and values (Alfaro-LeFevre, 2009; Victor-Chmil, 2013). At the end of the group discussion process the learner should be able to:

- Articulate the arguments generated by their group and other groups while providing sound evidence to support the arguments;
- Evaluate the group argument and compare it with the arguments of others;
- Discuss the implications of each argument;
- Formulate arguments and counter-arguments to support their position.

According to Schrire (2006) and Swart (2017), when a learner succinctly envisioned the purpose of the discussions, it should become simpler to create engaging queries and develop strategies to aid in the facilitation of interesting discussion. Also, communicating the goals, learners should be able to find the focus and engage fully in participation.

Another factor to be considered in developing a productive group discussion was to be certain to ask good questions. The focus on the questions tends to initiate a discussion as well as the inclinations needed to search actively for in-depth analysis, thorough understanding, and additional clarity to investigate further the topic. (Schrire, 2006). Before beginning, the instruction should be mindful of the different types of questions to be asked and the intellectual abilities that will be required to answer the questions. According to Jeong (2001), the following is a list and range of question types that should be considered:

- Exploratory and probing questions that challenge conventional knowledge;
- Challenging questions that probe assumptions, conclusions, or interpretations of subject matter;
- Relational questions that generate comparative analysis of concepts and concerns;
- Distinguishing queries that focus sharply on motivations or causes;
- Questions that demand learners draw conclusions or actions;
- Causal questions that calls for learners to identify relationships between actions, events, or ideas;
- Expansion questions that broaden the discussion;
- Hypothetical questions that challenge facts or issues;
- Key questions that aim to identify the focal issue(s);
- Summary queries that need synthesis of the discussion activity.

The aforementioned question types can be mapped back to Bloom's taxonomy of learning (Austin, 2009; Lee, Dawson, & Cawthon, 2016). The questions demonstrate increasing levels of cognitive complexity for the learner moving from simple recall to more complex synthesis and analysis.

Finally, in the group discussion environment, it is imperative that the instructor develops a positive, safe climate for discussion. If group discussion is to be utilized effectively in the course room, active participation must be encouraged from the first day of class. Finally, it is imperative that a climate of safety and comfort is established to encourage intellectual risks, freedom of expression, and mutual respect.

Critical thinking helps you to make important choices in a rightful manner after taking into consideration complete background information and the available options. A critical thinker employs a systematic process by taking into consideration all the important factors and elements that are relevant to the situation/decision at hand, educates himself/herself with all the realities and facts, understands all the available options, evaluates their merits and their respective impacts on his/her life as well as on the lives of the people around him, and finally chooses the option with the most positive impacts on his and other people's lives (Gelder, 2005).

Our lifetime experiences and knowledge develop our intuition, reasoning, and common sense, which are three very important things that, if utilized, can be of great help in making rational choices in our lives. Critical thinking, in plain terms, is about consciously employing and utilizing our intuition, reasoning, and common sense. It equips us with factual information. There are two kinds of information: one is based on facts and the other one is subjective and based on opinions. Critical thinkers know the difference between these two and separate them while making their decisions. Decisions based on subjective information can be disastrous in the long term as subjective information is not based on facts, but rather on opinions. Life is all about making decisions and leading a successful life is all about making right kind of decisions. We make numerous important decisions in our life, most of the time on daily basis. So, employing the right kind of knowledge to arrive at the right kind of options is the key to make the right decisions; critical thinking helps us to do this (Pithers & Soden, 2000).

A focused mind is a powerful tool. With a focused mind one can tap into his/her subconscious which can aid in building great things. Always remember that an inventive and creative mind is always a focused one. An unfocused mind leaves room for other things which most of the time do not matter. Through critical thinking, we should focus our minds on the important elements of the situation and mindfully ignore the unimportant ones. Thinking critically with a focused mind is one way of accomplishing goals set in one's life or learning environment (Paul & Elder, 2006).

Critical thinking is integrated into diverse content areas within the professional radiologic technology curriculum. This integration includes the competency-based clinical education component. Within radiologic technology, instructors must be multifaceted: teach fundamental theory, technical concepts, clinical competencies, and other skills that potential employers expect of recently graduated learners. Additionally, the professional curriculum, although rigorous, allows faculty the flexibility to meet the needs of all communities of interest in the professional program, while also satisfying the accreditation standards' requirements for the certification examination when applicable.

Critical thinking concepts are imperatives in education. Nosich (2009) stated that practitioners within a discipline do not simply possess information. These practitioners and professionals must know how to synthesize and disseminate this information. "They know how to think *about* the field, and they know how to think *within* the field" (Nosich, 2009, p. 97). Therefore, it is imperative that students must learn why they do what they do. Therefore, both critical thinking and critical reflection are transformational. Merriam et al., (2007) defined transformational learning as "dramatic, fundamental change in the way we see ourselves and the world in which we live" (p. 130).

In the clinical setting, skilled radiologic technologists apply higher-level reasoning skills to their professional duties. Student technologist must integrate knowledge of anatomy and physiology, disease processes, and computers with imaging and diagnostic capabilities. Because each patient is unique, many factors must be considered to balance the differences. After students obtain images, they must have the capacity to implement critical thinking further to assess the imaging, determine whether they have produced quality, diagnostic radiographic procedure, and if needed, revise technical procedures to obtain a quality repeat examination. Students must be able to think on their feet to work with varying pathological conditions (Kowalczyk, 2014).

Experiential learning can be defined as a process of assimilating information through one's experiences that encourages critical thinking (Dickman, Milligan, & Kodadek, 2013). There is direct application of experiential learning with the didactic and clinical education components of radiologic sciences education (Grace, Innes, Patton, & Stockhausen, 2017; Joint Review Committee on Education in Radiologic Technology,, 2017). The student learns through acquiring knowledge and skill from outside experiences, for example the didactic course room (Experiential Learning Center, University of Colorado Denver, 2017). The components of experiential learning contain the following components: reflection, conceptualization, experimentation and finally the development of concrete experiences, as illustrated in Figure 1 (Kolb, 1984).

Figure 1. ***Kolb's Experiential Learning Cycle***

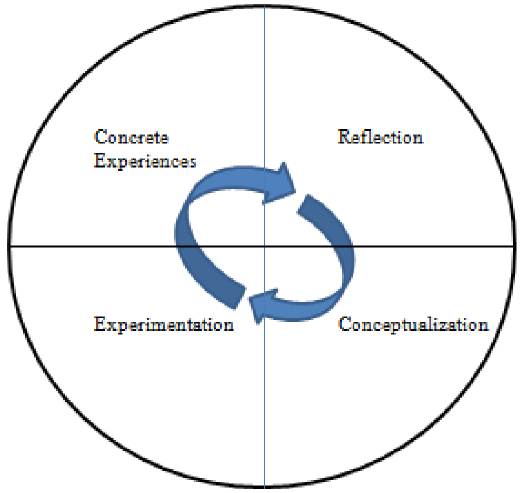

Figure 1. Kolb's Experiential Learning Cycle is a visual rendition of Kolb's experiential learning theory. The image was created by the author of this work but based on Kolb (1984).

According to Sternberg and Zhang (2001), experiential learning originates "in the experiential works of Dewey, Lewin, and Piaget. Taken together, Dewey's philosophical pragmatism, Lewin's social psychology, and Piaget's cognitive developmental genetic epistem9ology form a unique perspective on learning and development" (p. 2).

Review of the Literature

The purpose of this study was to explore and understand the first-year employment experiences of entry-level radiologic technologists. This basic qualitative research used the theory of apprenticeship to frame the study. The apprenticeship theory supports the competency-based educational program design for the discipline of radiologic sciences. This literature review explored the history and importance of the discipline of radiologic science in medicine, current practices in the field, and radiologic sciences education.

History

The development of diagnostic imaging (e.g., x-ray) was one of the most significant medical advancements of the 20th century. This technology forever changed the way diseases and pathological conditions are diagnosed. Before the emergence of diagnostic medical imaging, diagnosis was rather primitive. If early colonists were shot with an arrow or a gun, or had a broken bone, a doctor would have to probe the wound with their fingers. When using their sense of touch failed, the physician, with the use of his stethoscope, would then try to ascertain the extent of the injury. Although their intentions were noble, these methods employed by early physicians were often ineffective, additionally providing a great opportunity for error, infections, and death (Scatliff & Morris, 2014).

One of the more notable deaths due to inadequate medical advancements was the death of President James Garfield, shot in 1881. His physicians explored the entrance wound with their fingers and could only estimate where the bullet was lodged in his spine. Many physicians attempted, unsuccessfully, to remove the bullet from the president’s spine. Although President Garfield was cared for by the top physicians of his time, he still died because the physicians were unable to locate and remove the bullet (Scatliff & Morris, 2014).

The oldest and most widely used medical imaging modality throughout the world is the x-ray. The x-ray is ionizing radiation discovered in 1895 by the German physicist Wilhelm Conrad Roentgen. X-rays were discovered by accident when Roentgen was working with a cathode ray tube in his lab in Wurzburg, Germany. He named this discovery x-rays because “X” is the algebraic symbol for the unknown. The first x-ray image ever taken was of Roentgen’s wife’s hand. The use of x-rays became popular quickly in a variety of settings. Shoe sales, photography, and medicine were several of the first occupations to use x-rays in their practice. However, this was prior to anyone being aware of the hazards that x-ray exposure also carried. The first x-ray examinations were created by directing x-rays through a body part onto a piece of film inside an image receptor or cassette. In the early 1900s, a head x-ray might include no fewer than 11 minutes of time to account for an exposure. The chest x-ray created the reality in which tuberculosis – a widespread cause of death in the early 1900s – could be detected early. Today, modern x-rays are created in milliseconds with a fraction of the x-ray dose that was originally used 100 years earlier (GE Healthcare, 2014).

By 1910, physicians began to purchase x-ray equipment to be installed in their medical offices for their own personal use. Initially, the physicians operated the x-ray equipment in their offices themselves. Soon afterwards, many physicians realized that it was all but impossible for them to finish the required tasks of a medical practice and operate the x-ray equipment. Therefore, many physicians at this point began to employ someone, usually an office assistant, to handle the task of operating the x-ray equipment. These office assistants, or x-ray equipment operators, often had no training in healthcare anatomy or pathophysiology (American Society of Radiologic Technologists, 2016; Tye, 2013)

These early x-ray pioneers were often females. They were expected to operate the machinery and perform necessary, preventive maintenance on the equipment. They worked diligently with lack of interest in the radiation without any personal protection. Thus, their death toll due to overexposure to x-rays was extremely high. Unfortunately for the early pioneers in x-ray, it took about 20 years post-x-ray discovery by Roentgen that precautions including the use of protective lead garments, like lead aprons and film badges or dosimeters became widely used. Today, not only are lead aprons worn routinely by radiologic technologists, but film badges are worn and read monthly to assess the amount of radiation the technologist is exposed to (American Society of Radiologic Technologists, 2016).

In the early 1900s, Ed C. Jerman became one of the first to advocate for formal education on the topics of x-ray exposure and protection. Ultimately, he became known as the founder in education in the field of x-ray technology. In 1889, Jerman was employed by the Physicians' and Surgeons' Supply Company where he developed the "Jerman Static Machine" (Jerman, 1925). This machine was large enough to be used as a power source for x-ray equipment. As a salesman, Jerman went on to train technicians on the proper use of and basic radiation protection practices applicable to the use of x-ray equipment. In 1917, he became the head of the educational department at the Victor X-ray Corporation, the medical division of the General Electric (GE) Corporation. He taught many men and women to serve as demonstrators of x-ray equipment, and later published one of the first textbooks for x-ray operators. He was co-founder of the American Society of X-ray Technicians in 1920, the forerunner to the American Society of Radiologic Technologists (American Society of Radiologic Technologists, 2016; Jerman, 1925).

The expansion of radiology quickly developed and spread until the initiation of World War II. During WWII, there was widespread use of x-ray imaging equipment and other ubiquitous equipment and useful medical devices. W. Nelson Beck, a young navy pilot referred to as "Cadet Gadget" created many useful devices. After the war, Beck went to college and later joined the staff at Argonne National Laboratory as a physicist. It was in 1957 that Beck discovered the use of ultrasound, also known as sonography, for diagnostic purposes. The primary principle of sonography involved placing a small transducer against the patient's skin near the area where the injury or illness was suspected, such as an internal organ like the kidneys. With the implementation of the transducer, high frequency flowed, and inaudible sound waves were created that could penetrate the body and bounce off other internal structures.

The transducer detected sound waves and revealed contours of the organs as the waves bounced off other internal structures like bone and fat. In sonography, the ultrasound machine obtains sound waves and then converts them into imaging using a computer and reconstruction software (Imaging, imaging, imaging, 2007).

In the 1950s, Houston's M.D. Anderson Cancer Center radiologist Robert Egan, developed an x-ray tube designed primarily for the imaging of the breast and chest cavity. Dr. Egan's creation produced mammographic images that were simple to produce and reproduce, which directly contributed to improved detail in the images. Egan also recognized the necessity of training to create and deliver quality diagnostic images to help radiologists provide accurate interpretations and diagnosis of the resulting images (Imaging, imaging, imaging, 2007; WHO, 2014).

In the 1970s, computed tomography (CT), coronary angioplasty, and digital radiography (DR) were introduced. Computed tomography was the first x-ray scanning modality to be implemented with digital imaging techniques. The word tomography is Greek in origin, with the prefix "tomo" meaning "slice" or "section" and the suffix "graphia" meaning examination of CT was conceived of and designed by Godfrey Hounsfield, a British engineer, and Allan Cormack, a South African physicist, in 1972. CT imaging (also referred to as CAT scan) used a digital computer to view an anatomic sectional image of the body (GE Healthcare, 2014). Initially, it took hours to acquire image data to produce one slice and then more than a day to reconstruct the data into a single image. Today's CT scanners can produce data for an image in less than a second and the reconstruction is simultaneous. To honor Hounsfield's discovery and his contribution to the field of radiography, he was awarded the Nobel Prize in Physiology or Medicine in 1979. and was knighted by the Royal Family of England in 1981 (DiChiro, 1979).

The 1980s saw further advancements in imaging with the development of the first Magnetic Resonance Imaging (MRI) scanner. The 1950s provided the advent of the primary principle that encompasses MRI: different substances resonated at various magnetic field strengths. Research into MRI as it is used today began in the 1970's. By 1980, the first MRI of the brain was performed in England at the EMI Central Research Laboratories. Finally, the technology became commercially available and clinically used in the United States in 1984 after approval by the Food and Drug Administration (McRobbie, 2013).

By the mid-1980s, 3-Dimensional (3D) image processing using digital computers began. 3D images of bones and organs could be created by using either the CT or MRI scanner. Also, in the mid-1980s, Positron Emission Tomography (or PET scanners), were developed by several University of California scientists. PET is a type of nuclear medicine scan that involves cross sectional data being obtained and then reconstructed with the use of the CT scanner. PET scanning is useful in diagnosis of certain disorders of the brain like tumors, diseases of the heart, or lung cancer. Before the development and subsequent use of the PET scanner, nuclear medicine imaging of the lung was performed by the inhalation of a radionuclide (a radioactive, injectable pharmaceutical), followed by placing the patient under a gamma camera to produce images (GE Nuclear Medicine, 2004).

In 1993, MRI saw even further advancements. Before 1993, the closed bore design of MRI scanners routinely caused patients to become claustrophobic. Moreover, it was intolerable or non-accessible for severely obese patients. One of the new designs by Siemens provided for a larger area and an open bore, thereby causing not only less anxiety for the claustrophobic patient, but also providing side loading for greater accessibility for the obese patient (Siemens, 2017).

Many of the developers of the radiologic equipment were unconnected to healthcare-related professions. Early radiographic imaging was considered a type of photography. Early individuals who used the technology were often associated with professional photography. Early technology was often owned and operated by businesspeople in the disciplines of chemistry and engineering. Physicians would send their patients to these businesspeople to obtain x-rays for diagnostic purposes (ASRT, 2016). These imaging discoveries are now firmly the province of medical imaging.

The first credentialing examination in radiologic technology was administered to Sister M. Beatrice Merrigan on November 17, 1922. The first credentialing examination consisted of 20 essay questions and a practical examination where Sister Merrigan was required to deliver a set of radiographic images. She received official notification on December 26, 1922 that she was the first examinee to earn the distinction of being a registered x-ray technician.

The American Registry of X-ray Technicians (ARXT) spawned from the Registry in 1936. The Radiological Society of North America (RSNA) and the American Society of X-ray Technicians (ASXT) appointed the ASXTs board. Over 2,400 registered technicians at work by 1940.

In the 1960s, the Registry expanded its examinations and certifications to cover Nuclear Medicine Technology and Radiation Therapy. During that decade, the Registry renamed itself as the American Registry of Radiologic Technologists, a name which encompassed the triad of disciplines one could qualify within, had 56,000 registrants in radiography, nuclear medicine technology and radiation therapy.

In the 1990s, the ARRT expanded its examination offerings to include cardiovascular-interventional technology and mammography. The organization continued adding fields as technology advanced. As the 1990s ended, ARRT started administering computer-based examinations instead of traditional paper exams. Ninety years after it had been founded, there were more than 330,000 registered professionals (radiologic technologist, or R.T.s), who demonstrate the ongoing relevance of the organization.

Current Practice

The American Registry of Radiologic Technologists (ARRT, 2016) is one of several credentialing bodies for radiologic technologists in the U.S., as outlined in Table 2. Graduates of accredited radiologic technology programs are required to successfully complete didactic coursework and demonstrate clinical competence in performing diagnostic, radiographic procedures. The knowledge gained in the didactic coursework must be applied in the competency-based, clinical aspect of training (Adler & Carlton, 2015). The purpose of demonstrating clinical competence is to verify and ensure that graduates of accredited radiologic technology programs can perform radiologic procedures independently, consistently, and effectively when exposing patients to ionizing radiation to produce a diagnostic quality image. This premise is the foundation for all the medical imaging modalities, regardless of credentialing body.

Table 2. Credentialing Bodies in Diagnostic Medical Imaging

Area of Imaging Specialization	Credentialing Bodies
Breast Sonography	ARRT, ARDMS
Cardiac Interventional Radiography (CIR)	ARRT
Computed Tomography (CT)	ARRT
Dual Energy X-ray Absorptiometry (DEXA)	ARRT

Magnetic Resonance Imaging	ARRT, ARMRIT
Mammography	ARRT
Nuclear Medicine	ARRT, NMTCB
Positron Emission Tomography (PET)	NMTCB
Picture Archiving Communication Systems (PACS)	ABII, PARCA
Quality Management	ARRT
Radiation Therapy	ARRT
Radiography (x-ray)	ARRT
Registered Radiologist Assistant (RRA)	ARRT
Sonography (Ultrasound)	ARRT, ARDMS
Vascular Interventional Radiography (VIR)	ARRT, ARDMS
Vascular Sonography	ARRT, ARDMS

The following list identifies the name of the credentialing bodies associated with each of the modalities in diagnostic medical imaging in Table 2 above:

- ARRT is the American Registry of Radiologic Technologists.
- ARMRIT is the American Registry of Magnetic Resonance Imaging Technologists.
- ARDMS is the American Registry for Diagnostic Medical Sonography.
- NMTCB is the Nuclear Medicine Technology Certification Board.
- ABII is the American Board of Imaging Informatics.

The Imaging Modalities

X-ray. The basic principle of x-ray involves a beam of electromagnetic radiation produced by an x-ray tube passing through a selected body part. The x-ray tube is enclosed within a lead-lined metal housing. Radiation is a much shorter wavelength and higher frequency than visible light (Adler & Carlton, 2016).

The image may be created on film inside a cassette or displayed on a monitor. Because some human tissues are thicker than others, the degree of thickness/thinness determines the extent of the x-rays that will pass through them. For example, bones allow few x-rays to pass through because they are extremely dense. Bones appear white on x-ray film because of this. If tissue is denser like bones, it will absorb more x-rays and cause it to appear white on developed film. If the density of the tissue is low, the x-ray energy passes through the body and strikes the film. With this scenario, the area where the x-rays strike the film will appear black when the film is developed. The picture is also referred to as a radiograph, and is useful in diagnosis of diseases (Nascimento, 2014).

Because ionizing radiation can be potentially harmful, x-ray studies need only be executed when there is a specific medical need and are only performed after a direct request of a physician. Today, x-ray film is becoming a thing of the past since digital systems can store the pictures. The digital images may be viewed on computers and shared around an individual facility or even around the world (Were, 2013).

Patients may become concerned about the amount of radiation that is received during an x-ray examination. The dose is kept relatively low yet is known to have some harmful effects on living organisms. The diagnostic benefits outweigh the possible risks to the patient. And people often obtain more radiation from natural sources than they do during medical exams. Healthcare workers who are pregnant may also be concerned about the amount of radiation they and their fetus may receive (Lougheed, 2015).

To rule out pathologies, enhance pathologies, or to increase the chance of a correct diagnosis, contrast media may be used with x-ray studies. Contrast media will be used to aid in distribution of the radiation through organs or tissues that are not normally visible to x-ray studies performed without contrast media. For the most part, pharmacological contrast media is introduced orally, rectally, or into the blood stream (Lougheed, 2015).

Computed tomography (CT). In addition to standard x-ray method, a picture of a section through the body may be taken by a tomography process. CT imaging is sometimes called CAT or Computed Axial Tomography. The procedure uses x-rays along with a detector or a series of detected mounted in a rotating frame. Together with a digital computer, detailed cross-sectional images are produced. Multiple pictures are obtained as the detector is moved around the body. Current technology can acquire a single image in less than a second and can then reconstruct that image on the computer screen instantly (Scatliff & Morris, 2014).

The patient is placed inside a cylindrical shaped tube, while the x-ray device rotates around the body and takes pictures from a range of angles. The detector then records the pictures and the computer reconstructs a cross-sectional image. This cross-sectional picture is also referred to as a ‘slice’ (Seeram, 2015).

CT scans were originally used for neurological exams of the brain. Today they are utilized for many different studies and they may be done with or without contrast agents. It has become possible to distinctively single out blood vessels with CT, called angiography, when enhanced with a contrast media (GE Healthcare, 2017).

The most recent advances in CT technology are spiral or helical, multi-slice, and electron-beam CT. For spiral CT, a whole section of a patient is scanned, and it produces a spiral rather than separate slices. This process is considerably faster than a conventional CT.

By reprocessing the data obtained from a spiral CT it is feasible to produce new slices at different angles through the body. The advances in digital computers have provided new technologies in health care.

Multi-slice CT scanners are more progressive; they require thinner slices for better image quality. The multi-slice scanners are available in two, four, six, eight, and 16 slice models. The revolutionary multi-slice scans perform at high speeds with fast acquisition times that allow many studies to be run in a single breath hold, which may reduce artifact, thereby giving a better result. Multi-slice scanners are commonly available in hospitals, outpatient imaging centers, physicians' offices, surgical centers, and clinics; radiologists, urologists, gastroenterologists, and oncologists use these devices. CT imaging has seen many advances since its introduction – software advancements and expanded clinical diagnosis (GE Healthcare, 2017).

CT scanning in combination with PET scanning is useful to accurately diagnose the stages of cancers. It often requires multi-step radiography approach – a combination of PET scan and whole-body CT scanning. During a two-year period, patients who were determined by colonoscopy to have primary colorectal cancer were studied to compare whole-body PET/CT colonography vs. CT alone. In preliminary studies they were found to be equivalent (Kim, 2014).

Magnetic resonance imaging (MRI). In addition to light and sound, magnetism can be used in diagnostic imaging as well. In the 1950s, investigations began on how different materials resonate at different magnetic fields, this research continued until the Food and Drug Administration approved Magnetic Resonance Imaging (MRI) for use in 1984 (Hoffmann, 2013).

Magnetic Resonance Imaging is the most rapidly advancing imaging technique today. MRI provides detailed scans of sections of the body. Hydrogen atoms within the body can be affected by the magnetic field of the MRI (Long, Rollins, & Smith, 2015). Electromagnets create a magnetic field during the MRI examination. This magnetic field then aligns the protons in hydrogen atoms in the body. Radio waves that are produced knock the protons out of their temporary alignment. Each time the radio waves stop, the protons realign. The difference in these times is used to generate a diagnostic image (Long, Rollins, & Smith, 2015).

Contrast medium with magnetic properties may be used in MRI. MRI produces computer-processed images of soft tissue, with a very high resolution for detecting various pathological conditions. Contrast-enhanced MRI allows much smaller tissue changes to be identified. Tumors of 1-2 centimeters in size may be detected via MRI. With the addition of contrast medium, it is usual to discover even smaller tumors. Because MRI images are high resolution, they are useful for areas like the brain or central nervous system. It is also useful for breast cancer detection or examination. In addition to today's contrast enhancing agents for general use, there are organ specific agents available. These organ-system specific contrast agents are actively taken up into the cells in the organ in question. The information obtained from the images gives allows the clinician a better diagnostic tool (Olmaz et al., 2013).

One drawback to MRI is that metals are unsafe in the magnetic environment. Additionally, use of electrical devices or currents distorts MR images. So, patients on ventilators, have indwelling pacemakers, or any type of metal fragments within their body (shrapnel, joint replacements, etc.), cannot safely be introduced into the magnet (Long et al., 2015).

Mammography. Mammography examines breast tissue for changes and abnormalities using radiation. The radiation creates an image of the breast on film. The technology was first innovated in the 1920s but has continuously improved since then. Mammography can detect abnormalities in the breast that are too small to be felt or seen (Koch, 2016).

To obtain the best quality film possible, it is important to have as much as possible of the breast tissue visible on the image receptor, usually radiographic film. For this to be possible, the breast needs to be compressed or flattened against the image receptor. This aspect of the mammogram creates discomfort or pain. Although uncomfortable, it is temporary, and it creates the greatest possibility for detecting cancer at an early stage (Scheel et al., 2017)

Even under best imaging circumstances, not all breast cancers may be identified early via mammography. The size, density, and location of a tumor all play a role in detection. However, mammography is still the best diagnostic examination today for identifying non-palpable breast masses. Mammograms are performed during annual exams for screening purposes and then as a diagnostic tool (GE Mammography, 2017).

Mammography has also progressed to digital processes where a computer records images of the breast in a database rather than on a radiographic film. The major advantage to this change includes the facts that, when read on a monitor rather than on hard copy films, the contrast and brightness can be changed, and parts of the image can be made larger. These advantages and the ability to compare images by imposing one on top of another to check progression or change may make digital a better option for finding abnormalities in dense breast tissue (Fausto et al., 2016).

According to the American Cancer Society, women age 40 years and over should receive annual mammography screening (Loberg, Lousdal, Bretthauer, & Kalager, 2015). According to the American College of Physicians, women between 40 and 49 should have mammography screenings only after a medical professional determines the patient's extent of risk.

Ultrasound. The imaging modality of ultrasound uses high-frequency sound waves, not radiation. Various tissues, whether they are normal or have pathology, reflect these waves differently. The echoed or reflected sound is developed by a computer to produce a real-time image that is then displayed immediately on a computer screen. Ultrasound is capable of assessing many areas of the body (Szabo, 2013).

The principle for ultrasound mimics underwater sonar, such as when an object emits an ultrasonic wave via the human body at a velocity of approximately 1,500 meters per second. The sound wave is refracted or broken up. Then, an element of the wave is reflected back to the ultrasound machine and identified by the machine. The time taken for the reflected wave to return indicates the depth of the tissue within the body. This is how a diagnostic medical image is obtained (Szabo, 2013).

Presently, a computerized ultrasound tomography technique is in development that could help reduce breast cancer false-positives from mammography. False-positives are one of the main disadvantages of mammography. According to researchers, eighty percent of biopsies return negative results. These unnecessary biopsies create psychological and financial burdens. With traditional mammography it is difficult to see some masses in women with dense breast tissue. The researchers are developing a new method of breast imaging known as Computed Ultrasound Risk Evaluation or CURE. The CURE system does not use harmful radiation and does not compress the breast (Szabo, 2013).

Bone densitometry (DEXA). Bone density scanning is also called dual-energy x-ray absorptiometry or DEXA scanning. Dual-energy x-ray absorptiometry, otherwise known as

DEXA or bone density scanning, is a superior type of x-ray technology that measures bone loss. It is quick and non-invasive; therefore, it does not require any anesthesia. The amount of radiation is low. It is approximately one-tenth of conventional x-ray studies. DEXA is the first-line standard today for determining bone density, making it an invaluable tool in the diagnosis of osteoporosis. Patients with osteoporosis, predominately post-menopausal women, demonstrate a slow, inexorable loss of calcium that causes the bones to thin and become brittle. Healthcare practitioners use DEXA to track the effectiveness of treatment for bone loss, including osteoporosis (Dondelinger, 2014).

Central and peripheral DEXA equipment are the two forms of this technology. These assess different parts of the body. Central DEXA determines hip and spinal bone density and this piece of equipment is usually located in hospitals. The peripheral DEXA measures density in the heels, wrists, or fingers of a patient and these may be available in mobile units or the community (Dondelinger, 2014).

With peripheral DEXA, the bone density test sends a fine, invisible, low-density x-ray beam over the patient. The bones examined receive two energy peaks: one absorbed by soft tissue and the other by bones. The machine subtracts the total amount of energy minus the soft tissue amount, yielding the patient’s bone mineral density. Software in the DEXA machine calculates and shows the bone density measurement on a computer. (Dondelinger, 2014).

There are some limitations to bone densitometry. DEXA is useful for measuring bone density but has limited use with patients who have spinal deformities or individuals who have had surgery related to the spine. The existence of osteoarthritis or compression fractures of the vertebrae may also have a detrimental impact on the correctness of the testing. CT scanning would be recommended for such patients. Radiologic procedures performed on patients with underlying pathologies may offer problems for even a seasoned practitioner. Alternative patient positioning may be required to prevent further pain caused by the patient's response to disease processes. Certain diseases may also change the density of structures being radiographed and may require the practitioner to alter their techniques. Other diseases can affect normal immune response; therefore, patients with immunocompromised may require protective isolation procedures to prevent the patient from acquiring the disease from the radiologic technologist (Adams, 2014).

Radiation therapy. Radiation therapy. Radiation therapy is a treatment for non-malignant conditions and malignant cancers via x-ray or radionuclides. The use of energy or ionizing radiation kills cancer cells and shrinks tumors. Radiation therapy treatments may be curative or palliative – to control symptoms when a cure is not possible (Gianfaldoni et al., 2017)

Brachytherapy is an example of radiation therapy utilized to treat cancer; it is also called internal radiation therapy. Brachytherapy involves the placement of radioactive substances directly inside the body. Compared to an external application of radiation, brachytherapy placement permits the doctor to use more radiation to treat a more limited area more efficiently than if externally applied (Palmer, Bradley, & Nisbet, 2014). Brachytherapy is useful in treating cancers all through the body, including the prostate, cervix, ovaries, breast, gallbladder, uterus, vagina, and other areas. If used temporarily – the radioactive substance will be placed inside or near a tumor and allowed to stay for a certain amount of time before being removed. Permanent brachytherapy is also referred to as seed implantation. A seed about the size of a grain of rice is permanently placed in or near the tumor. Within weeks or months, the seeds become inactive from a radioactivity standpoint and remain inside the body. After weeks to months, the radioactivity of the seeds will fade away – these seeds will remain inside the body (Gianfaldoni et al., 2017).

Nuclear medicine technology (NMT). Nuclear medicine consists of diagnostic assessments that produce images of body anatomy and function. To develop the images, energy that is emitted from a radioactive substance, administered to the patient, is detected (van Leeuwen & de Jong, 2014). Although patients fear the word 'radioactive' and correlate it with hazard rather than diagnosis, the reality is that the radiation doses used in nuclear medicine are no riskier than those used in x-ray (Barrenechea, 2013).

The nuclear medicine procedures are much more sensitive, and the technologists that perform these studies are able to acquire a good image if only a small amount of the injected substance binds to the organ that is being investigated. Urination then excretes the radioactive material. Studies may be performed on the brain (during a seizure), in the heart during an exercise stress test, or in the kidneys, lungs, bones, or even the thyroid (Cho, Kim, & Song, 2017). One advantage to nuclear medicine studies is the ability to gain information about the function of an organ or tissue rather than just the anatomy itself.

The substance that is given to the patient is called a radiopharmaceutical agent or tracer. The material in time collects in the organ and gives off energy as gamma rays. The machinery called a gamma camera, then identifies the rays and works with a computer to produce images and measurements of the organ or tissue that is being studied (Gutfilen & Valentini, 2014).

Nuclear medicine studies are useful in the diagnosis or treatment of heart disease. Though a cardiac angiography focuses on images of the heart beating along with blood vessels, a stress thallium nuclear medicine study will show the function of the cardiac muscles. In stress thallium studies, two types of data are acquired. First, the patient must do vigorous exercise on the treadmill or exercise bike to stress the heart. This is followed immediately by the nuclear medicine examination. Then the patient is given time to rest. Once the patient is back to normal resting rate, a second nuclear study is performed so the physician can compare the stressed heart study to the resting heart study. The physicians will be able to find areas that may have been previously damaged by heart attacks or areas that have insufficient blood supply for blocked arteries. Other studies can show the heart muscles wall movement or study the heart's chambers (Barrenechea, 2013).

Picture archiving communications systems (PACS). The advances in technology have created Picture Archiving and Communications Systems also referred to as PACS. PACS allows users to view scanned images of x-ray efficiently. Healthcare professionals can quickly view images on the computer and other electronic devices and compare images with one another easily. PACS creates a more efficient delivery of patient care. For the past 100 plus years, x-ray, MRI, and CT films have been the primary mode of taking, storing, and reading radiographic studies; PACS will allow for an almost film-less system.

Additionally, this will eliminate all the costs associated with the purchase of and the storage of the films. PACS will handle a wide range of modalities, including radiotherapy, CT, MRI, nuclear medicine, angiography, cardiology, fluoroscopy, ultrasound, dental and symptomatic mammography. This new technology will also have a positive effect on specialties that use both fixed and moving images. Finally, clinicians have their images available more rapidly, which can lead to speedier diagnosis and results (Joshi, Narra, Joshi, Lee, & Melson, 2014).

Radiologic Sciences Education

Educational preparation for the profession is offered in hospitals, colleges, universities, vocational-technical institutes, and the U.S. Armed Forces. Hospitals employ the majority of radiologic technologists and prefer to hire only those with formal training. However, it should be noted that seven states and the District of Columbia currently do not require licensing of radiologic technology professionals to operate x-ray equipment (ASRT, 2016). Formal training programs in radiologic technology range in length from one year in the U.S. Armed Forces to four years at the baccalaureate degree level. All U.S. Department of Education recognized programs of study in the radiologic sciences lead to a certificate from hospital-based programs, an associate degree from two-year institutions, or a bachelor's degree from 4-year programs. All of them also provide eligibility to sit for the national certification or credentialing examination. Two-year associate degree programs are the most common educational path (Bureau of Labor Statistics, 2017).

The Joint Review Committee on Education in Radiologic Technology (JRCERT) accredits most formal training programs for the profession. One of seven regional accrediting agencies regionally accredits other programs. The seven regional accreditors are Middle States Commission on Higher Education, New England Association of Schools and Colleges, Higher Learning Commission, Northwest Accreditation Commission, Southern Association of Colleges and Schools, Western Association of Schools and Colleges, and Accrediting Commission for Community and Junior Colleges (U.S. Department of Education, 2017). As of 2017, the JRCERT has 602 accredited programs in radiologic technology. Entry into an accredited program requires a GED at a minimum, and several prerequisite general education courses. Coursework in sciences is helpful, especially physics, anatomy, chemistry, and biology. All programs, whether a certificate, associate degree, or bachelor's degree, provide both didactic and clinical instruction in patient interactions and management, radiation physics and radiobiology, image production, and radiographic procedures (ARRT, 2017).

Whether attending a certificate, an associate, or a bachelor's degree program, writing and critical thinking skills are highlighted. Strengthening critical thinking skills is an essential aspect of any curriculum in education, and the practice must be cultivated throughout the educational program. This occurs through adding writing assignments to courses, which is no easy task for the instructor. Providing writing assignments for radiography courses takes time and planning, but it is essential. Writing assignments become a means of learning and discovering, thereby encouraging cognitive and intellectual development. It is crucial for educators to design stimulating and challenging assignments that relate to course material but also help students to become better writers (Adams, 2015)

Critical thinking skills are also an essential component of any educational program in the radiologic sciences. Kowalczyk and Leggett (2005), a radiologic technology program clinical instructor from the Ohio State University, highlights the importance of critical thinking in the field. All radiographers must analyze, evaluate, and synthesize all patient interactions to assess the best course of action with each patient interaction. Kowalczyk explained that it is imperative that radiography educators understand how critical thinking skills are obtained during the educational process, particularly the didactic portion, to help each student reach his or her highest potential as a radiologic technologist.

Harris (1996) conducted a study to explore the clinical education component of baccalaureate-level, associate-level, and certificate-level radiography professional preparation programs for employment and found there was no significant difference in the educational preparation of these graduates. This conclusion was drawn through analyzing the results of four instruments utilized in the study: a questionnaire, a content matrix, a composite job description, and a review of the procedural content of the ARRT certification examination. The questionnaire was composed of 15 open-ended questions specific to clinical education. The content matrix was designed to assess whether programs were compliant in their clinical education course syllabi and their clinical education handbook documentation according to the pre-established JRCERT guidelines. The composite job description was developed from a review of 20 advertisements of actual entry-level radiologic technologist positions from the fifteen states where the programs surveyed were located. Finally, the procedures content review of the ARRT certification examination was assessed from the course syllabi and clinical education handbook of each program surveyed.

The researcher found there was no significant difference in the first-time pass rate on the ARRT certification examination between radiologic technology graduates from baccalaureate, associate, or certificate degree levels. All but one program out of the fifteen programs surveyed reported a 90% or higher first-time pass rate for graduates on the ARRT certification examination. There was no significant difference in the written documentation of adherence to the JRCERT standards of accreditation of radiologic science programs at the baccalaureate, associate or certificate degree levels. There was no significant difference in meeting the necessary employment market requirements for the entry-level radiologic technology between baccalaureate, associate, or certificate level programs. Furthermore, there was no significant difference in the written documentation of adherence to the procedure content of the ARRT certification examination at the baccalaureate, associate, or certificate level radiologic programs. Since 1996, there have been many technological advancements in the discipline. Additionally, certificate-level programs have been eliminated. In 1996, the market trends were demanding the need for multi-competent practitioners in medical imaging (ASRT, 2015), which certificate level programs did not support.

Andersson et al., (2012) suggested that competency "indicates perceived skills and performance knowledge related to being able to and having the ability to do something" (p. 636). More, competence has the critical thinking, knowledge, and technical expertise to perform a task with a desired and measurable outcome. Regarding lack of competency, when a radiologic technologist lacks the requisite skills to perform a diagnostic procedure, an increased risk for patient injury arises.

Synthesis of the Research Findings

Literature was limited to identifying the first-year employment experiences of radiologic technologists specifically. However, research from other allied health disciplines including nursing, occupational therapy, and physical therapy provided illuminating secondary sources on the topic. Most of the literature focuses on nursing and the stressors that lead to burnout in the early years of employment.

In nursing, to practice to the full extent of their education, the Institute of Medicine (2011) recommended higher-level academic degrees. It is suggested that higher level degrees provide nursing students with more academic time to become competent in nursing skills and to develop confidence in performing the requisite tasks.

According to Tryssenaar and Perkins (2001), in the field of occupational therapy, professionals in their first-year of employment experienced several critical phases in their transition: excitement and anxiety, getting used to the daily realities of work, and learning to adapt. When educators recognize and understand phases in the transition process from student to professional, they are able to provide support for learners, including providing relevant practice and mentoring for future professionals—while always keeping the curriculum grounded in theory.

In a study by Solomon and Miller (2005), the new graduate physical therapists felt anxiety and inadequacy in their transitions from student to practicing professional during their first-year of professional employment. New physical therapists often experienced feelings of being overwhelmed, from addressing insurance-related issues, to working with the difficult or challenging patient. The researcher found that providing the new graduate physical therapists during their first year of professional employment with a supportive environment of role models and mentors aided the novice therapist in learning and quickly adapting to their new professional role.

The importance of competency-based education and critical thinking appears to be the focus of educators in the radiologic sciences. The field is rapidly advancing technologically, however, and students and new graduates must be able to use their knowledge to perform in their entry-level roles successfully. This concept supports the apprenticeship theory of learning in that the students learn how to perform radiographic procedures in the laboratory, while in the clinical setting the students first observe procedures being performed by the clinical instructor or the preceptor, then finally the student is required to perform that procedure on an actual patient.

Critique of Previous Research Methods

Literature was limited to support first year employment experiences in radiologic sciences. However, upon reviewing the archives of the ASRT journal Radiologic Technology, one article specifically addresses the foundation of this research; radiologic sciences education and employment opportunities (Weening, 2012). Weening estimates how raising the minimum educational requirements for the profession will, in the short-term, affect employment opportunities of graduates. The research by Weening (2012) found that increasing the minimum educational requirements for radiologic sciences graduates to the associate degree had an inconsequential impact on their employment opportunities. However, the research did not specifically identify the first-year employment experiences of radiologic technologist nor did it discuss their preparedness for the entry-level position.

Additionally, the research by Harris (1996) conducted a comparative analysis of the clinical education component of certificate-level, associate-degree level and baccalaureate-degree level educational programs in the radiologic sciences. A comparative assessment was done per program type and class capacity. The four instruments that were compared were a questionnaire, a content matrix, a composite job description, and the procedural content of the ARRT certification examination. Statistical tests were also performed to determine if there was a significant difference in the overall averaged scores.

This quantitative study (Harris, 1996) found there was no significant difference in the clinical education component of certificate-level, associate-degree level, and baccalaureate-degree level educational programs in the radiologic sciences. Moreover, this study found there was no significant difference in meeting the basic employment market requirements for the entry-level radiologic technologist, according to a composite job description between baccalaureate, associate, and certificate radiography programs graduates. Also, there was no significant difference found in the written clinical education curriculum at the baccalaureate, associate, or certificate level radiography program. Overall, there was no significant difference in the written clinical education curricula of radiography programs by program type or class capacity. However, certificate level programs scored on average consistently better in documentation of the JRCERT standards and the procedural content of the ARRT certification examination. Finally, the study suggested further research on the employment of new graduate technologists to ascertain if their formal training was consistent with the market demands of the entry-level technologists according the job duties in the job description.

Summary

Enabling a new graduate to assimilate from being a student, under the influence and direction of a seasoned employee or mentor, into the workforce as an entry-level employee, solely responsible for all aspects of their job duties, can be a challenge (Meyer, Raffle, & Ware, 2014; Parker, Giles, Lantry & McMillan, 2014). This study analyzed the first employment year experiences of radiologic technologists in order to understand that challenge better. This qualitative study has the potential to advance the scientific knowledge on this topic, through discovering the challenges these technologists face, and the gaps in their educational and clinical experiences that could potentially lead to patient injury.

CHAPTER 3. METHODOLOGY

Purpose of the Study

The purpose of this study was to discover the first-year employment experiences of radiologic technologists, the meaning ascribed to their experiences, and how their experiences could be related to optimal or sub-optimal outcomes in diagnostic medical imaging.   This research aimed to uncover if there was a disconnect between updating the radiologic sciences curriculum and the rapid technological advances that occur within the discipline.

Research Question

The purpose of this qualitative study was to explore the first-year employment experiences of entry-level radiologic technologists. Questions were derived from the purpose of the study.   These questions served to identify the first-year employment experiences of entry-level radiologic technologists.

Main Question:

What are the first-year employment experiences of entry-level, radiologic technologists?

Sub questions:

1. What are the special challenges that radiologic technologists experience in their first year of employment?
2. What meanings do radiologic technologists ascribe to their work experience?
3. How are these experiences related to optimal or sub-optimal outcomes in diagnostic medical imaging?
4. What role did educational preparation play during the first year as a radiologic technologist?

5. What are the day-to-day experiences of radiologic technologists I a typical imaging department?

Research Design

This study used a basic qualitative research design. Scientific research, as defined by Lodico, Spaulding, amd Voegtle (2010) and Thorne and Truant (2016), is a method of inquiry or investigation that utilizes various techniques to acquire reliable, empirical, credible, measurable, and verifiable knowledge or information concerning a phenomenon. According to Carr (1994), qualitative research is a non-numerical method of scientific inquiry that aims to explain an in-depth understanding of human nature. Qualitative research typically investigates the how's and why's of decision- making. Further, qualitative research produces information about the specific case(s) being studied and can only speculate on more general conclusions. Qualitative methods of scientific inquiry are particularly appropriate in the social sciences. Strengths of utilizing a qualitative study may include the following:

- It provides individual case information.
- It is especially responsive to specific situations and conditions.
- Researchers are especially responsive to changes that may occur during the study.
- Qualitative research can be carried out with a small budget and in a short amount of time.

In the arena of qualitative research, the goal is to increase understanding of human interactions and social phenomena. Scholars attempt to explain the processes through which individuals create meaning. (Bogdan & Biklen, 2007, p. 43). According to Merriam and Tisdell (2015), in basic qualitative research, knowledge is gained continually as one interacts and makes meaning of the experiences and activities in which they are engaged. The basic qualitative research model consists of describing how those studies interpret their experiences, how their worlds are designed, and the subsequent meaning attributed to their experiences (Merriam & Tisdell, 2015). This research study consisted of interviews with radiologic technologists to identify their experiences during their first year of professional employment. The interviews involved semi-structured, open-ended questions. These semi-structured research questions were designed based on the current literature and were field tested prior to conducting the actual research study.

This research was a qualitative study of radiologic technologists who had been hired for an entry-level position within their first year of graduating from a professional educational program in radiologic technology. Entry-level radiologic technologists were particularly situated to uncover and provide an in-depth examination of the day-to-day experiences in a typical imaging department via the basic qualitative research model (Merriam & Tisdell, 2015).

The goal of this study was to conduct face-to-face interviews with participants. The researcher utilized open ended, semi-structured questions to allow participants to elaborate (Salant & Dillman, 1994). Additionally, when interviews are utilized for qualitative research, the researcher should attempt to avoid guiding the participant(s) into responses he/she desires to prove or disprove the research question. In utilizing interviews in conducting qualitative research, the researcher should attempt to avoid at all cost any obtrusions into the process (Lodico et al., 2010). These interviews were conducted in an area away from the participants' department to ensure privacy in order to be free of daily work routines and other distractions.

Target Population and Sample

Population

The population for this study included ARRT credential radiologic technologists during their first year of professional employment. According to the American Registry of Radiologic Technologists (ARRT, 2017a), there are approximately 325,000 registered (credentialed) radiologic technologists in the United States.

Sample

According to Polit and Beck (2013), in qualitative research, saturation determines sample size. When using qualitative methods, the researcher must choose samples that are large enough to ensure that sufficient information is collected while simultaneously too large a sample that may cause trends in the data to repeat themselves is avoided. (Mason, 2010; Morse, 1995; and Morse, 2000). Polit and Beck (2013) stated that a study of this type should have a sample size of five to 25. However, Morse (2008) stated that a qualitative study should have a minimum of six participants. Additionally, Onwuegbuzie and Collins (2007) stated a sample size of 12 to 15. Finally, Bertaux (1981) stated 15 is the minimum acceptable sample of participants needed for all qualitative research. Therefore, this researcher determined the sample size for this study would be 12 newly hired radiologic technologists who had at least six months' experience, but not more than 12 months' experience, in an entry level position (Marshall, Cardon, Poddar, & Fontenot, 2013). This researcher selected 12 as it is half the maximum number of participants recommended by Onwuebuzie and Collins (2007) but twice the lowest number of participants recommended by Morse (2008).

Procedures

Potential participants were identified by the educator (the researcher) in the radiology department because all new hires are required to complete departmental, new employee orientation which is taught by the educator. The orientation session could be a group session of

2-4 new employees, or individual session depending on the new employees' date of hire. At the end of the departmental, new employee orientation session, the educator mentioned the study to the employees. After orientation, a convenience sampling of potential participants was identified by the researcher. As employees, the researcher had access to the organization-wide employee email and physical mailing addresses of the new hires. The researcher requested permission to access email addresses on the institutions' consent form that was signed by a hospital administrator. The researcher accessed the email addresses of the potential participants from the employee website. An email was then sent to the identified newly hired personnel meeting all of the aforementioned criteria, explaining the nature of the study, and requesting their voluntary participation in the study with a consent form attached. The inclusion criteria for participation in this study was 12 newly hired radiologic technologists who have at least six months' experience, but not more than 12 months' experience, in an entry-level position. When 12 participants were identified, recruitment was discontinued. Once, the researcher received the signed consent form from the participants; a final email was sent to the identified participants with the date, time, and place for their interview.

The interviews for this study were conducted in the conference room in the radiology department. The conference room was a private, secure, comfortable, familiar environment (but an area distinct from the daily functions of department) for the participants and its use ensured confidentiality and privacy so that disclosing potentially sensitive information would not be questioned.

The researcher interviewed each participant individually, after obtaining his or her signature on the study consent form. Each interview took approximately 60 to 90 minutes (depending on how much the interviewee shared during this process). The researcher adhered to the following steps during the data collection phase of this proposed study:

- A consent form was provided to the first twelve qualifying participants explaining the nature of the study and ensuring their voluntary, confidential participation in the study via email.
- Additionally, participants were informed that participation in this study would not be shared, would not affect their employment, and they could withdraw from the study at any time.
- A follow-up email denoting the date and time of each participant's interview was sent.
- Interview times were 60 to 90 minutes each with 30 minutes separating each interview to maintain confidentiality.
- Each interviewee was assigned a unique number to maintain confidentiality.
- The interview information was kept on an encrypted flash drive, which was locked in a desk where the researcher had the only key when the data was not being deciphered.

Prior to beginning the interviews, the researcher introduced herself, explained the nature of the study, read a confidentiality statement, and then showed each participant his or her signed voluntary consent form that had been emailed to the researcher. The consent form included a statement explaining that participants could voluntarily withdraw from the study at any time.

Participant Selection

The participants were asked to voluntarily participate but they could decline without any reprisal. New employees were asked until the required number of participants had been reached.

The researcher had no direct supervisory authority over any employees in the department. The researcher worked exclusively for the department director.

The population for this study included American Registry of Radiologic Technologists (ARRT) credentialed radiologic technologists, or equivalent, during their first year of professional employment working at a hospital in the southeast region of the U.S. The criteria for participation in this study included 12 newly hired radiologic technologists who had at least six months' experience, but not more than 12 months' experience, in an entry level position. The term radiologic technologist is a general term for defining competency-based, educationally prepared ARRT, or equivalent, credentialed personnel who work in a medical imaging or x-ray department in one of the following modalities: diagnostic radiology (x-ray), computed tomography (CT), magnetic resonance imaging (MRI), nuclear medicine technology, vascular interventional radiography (VIR), cardiac interventional radiography (CIR), mammography, dual-energy x-ray absorptiometry (DEXA), picture archive and communication systems (PACS), 3D imaging, radiation therapy, and sonography (ultrasound). All participants were at least 20 years old, as federal regulations require that all individuals employed as radiation workers must be 18 years of age or greater and all educational programs in the field are at a minimum two years in length.

Participant exclusion criteria for this study included:

1. Not a new graduate radiologic technologist;
2. Has not successfully passed the American Registry of Radiologic Technologist (ARRT) or equivalent, credentialing examination;

3. Has worked in the field of radiologic technology for more than one year (12 months' post-graduation from their educational program).

Protection of Participants

This researcher understood and took very seriously the importance of managing conflicts of interest. To this end, the researcher took all necessary steps to eliminate all conflicts throughout all phases of the research study. The researcher is an ARRT credentialed radiologic technologist with more than 30 years of experience with 20 of those years as an educator in the discipline and thus thoroughly understands the conflict of interest implications. The researcher was last employed as an educator in the discipline in 2012. Therefore, none of the study participants would have had any interaction with the researcher as an instructor in their educational program prior to their employment as an entry-level technologist. The researcher set aside all pre-understandings, preconceptions, and biases to conduct a non-biased study.

Data Collection

Data included a purposive, convenience sample of 12 newly hired radiologic technologists during their first year, defined as the first 12 months of professional employment, working in a hospital in central Alabama. A purposive sample was selected because the newly hired radiologic technologists during their first year, first 12 months, of professional employment were being studied. A purposive sample is a homogeneous sample where the participants have the same or similar characteristics (Polit & Beck, 2010). Additionally, a convenience sample is a type of purposive sample where the participants are close in proximity and available to participate in the study. This allowed the researcher easy access to the participants (Creswell, 2007; Merriam & Tisdell, 2015; Patton 1990). As a subset of the population of ARRT credentialed radiologic technologists, this convenience sampling included participants (new graduate, newly hired radiologic technologists) from a central Alabama hospital. The sample included participants from any of the following modalities within the field of diagnostic medical imaging: x-ray, CT, MRI, nuclear medicine, sonography, and radiation therapy. The researcher utilized an audit trail to provide evidence and documentation of the sequence of activities, operation, procedures, and events to substantiate the trustworthiness of this study (Guba, 1981; Merriam & Tisdell, 2015; Polit & Beck, 2010. Considering the size of the sample, the researcher estimated the entire data analysis for this project took approximately 120-170 hours if it had been performed manually. Therefore, the researcher reserved the right to utilize a qualitative data analysis software program, such as Atlas.ti, to analyze the data and maintain the anonymity of the participants. However, the researcher did not use the Atlas.ti software for this research.

Data Analysis

The data for this qualitative study were gained through conducting interviews with the newly graduated, newly hired technologists in a radiology department (Creswell, 2013). Creswell (2007) states, "data analysis involves … developing an analysis from the information supplied by the participants" (p. 184). The researcher utilized the following steps in analyzing the data:

- During the interview process, a voice recording device was used to record the participants' responses to interview questions. The data were then transcribed through careful and repeated listening. Because of the relatively small sample size, the researcher could simultaneously collect data and analyze answers.
- According to Lodico et al. (2010), it would take approximately six to eight hours to transcribe a 60-minute interview or nine to 12 hours to transcribe a 90-minute interview.

The researcher began the data analysis by reading and re-reading the data to gain a deeper understanding of the information obtained.

- Reading and writing memos. Memoing is a concept that lays out substantive ideas about the interviews and that provides insight into the proposed research. Through this process, key words and phrases were developed that were assigned core categories (Polit & Beck, 2010).
- Establishing relationships among variables and categorizing the code names. The coding structure centered around the actions being either patient factors, technologist factors, software or hardware factors, and the like. Coding is conceptualizing the first level of abstraction by identifying the anchors of the collected data for the review process (Polit & Beck, 2010).
- Next, the researcher identified and defined key concepts.
- From the key concepts, the data were further analyzed by concept mapping.
- Concept mapping depicted suggested relationships between concepts.
- With a synthesis of the data collected, the researcher was able to answer the interview questions and identify patterns/connections (Merriam, 2015).
- With any research, there are several cautions that should be taken when analyzing the data. Do not generalize the results of this data collected as the responses provided for this study can only clarify and explain this cohort.
- Address any limitations this study may present.
- The time of day of the observations, interviews, and administering the questionnaires (busiest during shift change) may be a factor. If the interviews are conducted during a busy work time, the participants may be distracted and not attentive to the research, due to needing to return to the department to assist with patient work flow.

- Fear of retaliation by the department director or manager towards the technologist if unfavorable comments (regardless if true or false) about the department are provided.

Credibility, Dependability, and Transferability

The processes of affirming trustworthiness and credibility in qualitative research were necessary (Leedy & Ormrod, 2005; Patton, 1990; Polit & Beck, 2010). For this study the researcher utilized the audit trail for affirmation of the trustworthiness and credibility. Although reliability and validity are not addressed in the same way in qualitative research as in quantitative research, Guba (1981), Darawsheh and Stanley (2014), Leung (2015), and Noble and Smith (2015) suggested the following to ensure the trustworthiness and credibility of data:

1. Credibility – equivalent to internal validity in quantitative research. Credibility can be established by utilizing several of the following strategies: using proven research methods in similar projects, prolonging engagement within the culture prior to the onset of the research, convenience sampling of participants, eliminating or negating researcher bias, and peer scrutiny. Because the researcher has been a radiologic sciences educator for more than 20 years, her expertise and knowledge of the discipline, accreditation process, competency-based education, and the content specification of the credentialing examination, lent to the credibility of this proposed research. Data collection by the researcher was accurate to the extent of the abilities of the researcher. To assist in improving the accuracy of the data collected, member checking was utilized where the researcher provided the written participants with their summary to check the authenticity of the work (Lincoln & Guba, 1985). Finally, the researcher built rapport with the participants and upon completion of the data collection, the researcher reviewed the transcripts of the data collected with each of the participants.

2. Transferability – equivalent to external validity and generalizability in quantitative research. By offering thick descriptions of the study's site, participants, and procedures used to collect data, the researcher painted a picture for future practitioners to apply this research to other environments.

3. Dependability – equivalent to reliability in quantitative research. Establishing dependability was accomplished by utilizing detailed methods of data collection, analysis, and interpretation. The purpose was to make the research auditable and future researchers able to follow the study. The researcher ensured that she provided rich descriptions of all components of the data collection process and that they were accurately recorded.

4. Confirmability – equivalent to objectivity in quantitative research. To ensure confirmability, during data collection the researcher ensured that there was a detailed audit trail to explain how decisions concerning the data were made throughout the study.

Instruments

The Role of the Researcher

The role of the researcher was to remain impartial and simply collect data associated with the study (Leedy & Ormrod, 2005; Patton, 1990; Polit & Beck, 2013). The researcher was a radiologic sciences educator for more than 20 years and has preconceived notions about the educational process but not the first-year employment experiences of new radiologic technologists. Therefore, any preconceived notions are simply via personal experience and have not been realized in any research form. Any preconceptions were not brought into the interview processes by removing prejudices, biases, and preconceived ideas from brackets and experiences.

Guiding Interview Questions

The following is a list of the questions that were posed to the newly hired, entry-level radiologic technologists:

1. Why have you chosen radiologic technology as your career choice?
2. What do you like about the profession?
3. What are some of the experiences you had as a radiologic technologist during your first year of employment?
4. What are the special challenges you faced in your first year of employment?
5. How do you feel you were adequately- educationally and clinically- prepared to perform the job duties on the first day of employment as an entry level radiologic technologist?
6. Can you identify any skills or knowledge that you did not have but was required for employment in your entry-level position?
    a. Can you describe what were these skills deficits?
    b. Where do you think these deficits were missed?
7. What is an experience where things went great or poorly in your duties as an entry-level technologist?
    a. Why do you think things went well or poorly?
    b. Did you have a mentor to speak with about this incident during or after the procedure was completed?
8. What is an experience where you were complimented on how you performed a procedure?
    a. How do you describe the success of what you've been doing?
9. What is an experience when you were given guidance by a senior technologist or manager while performing a radiographic procedure?
    a. Had you seen this before in your training?

10. During your first year of employment, have you ever experienced or personally been involved where a medical error occurred?
    a. If so, describe the medical error that you witnessed.
    b. What did you do when you identified a medical error?
    c. What was the outcome of the event?
11. In your experiences as an entry-level technologist, do you feel you were prepared and knowledgeable adequately to address medical errors?
12. Upon accepting this entry-level position, did your supervisor (or his/her designee) provide you additional training for this job?
    a. What did the additional training include?

The interview questions underwent an expert review prior to beginning the study. The expert review consisted of four management level radiologic technologists with more than 30 years of experience in the field. By having the questions reviewed by experts prior to the study, the researcher was able to ascertain the content validity of the interview questions, identify the appropriateness of the questions devised for the participants, and receive any suggestions for their improvement.

The expert reviewers were first sent an email requesting their participation. Upon agreeing to participate, the expert reviewers were sent the interview questions to examine the validity of the research questions and ascertain if the questions were appropriate for this basic qualitative research study. The panel of experts consisted of two diagnostic radiologic technologists, one computed tomography technologist, and one magnetic resonance imaging (MRI) technologist. All members of the expert panel agreed the questions were very good for this research study.

In conclusion, the research questions all appeared to be valid. However, the researcher identified that the panel of experts for this field test were all from a pediatric facility. Finally, it should also be noted that all the participants are from a pediatric facility.

Ethical Considerations

This researcher understands the educational requirements of an entry-level radiologic technologist as she has been an ARRT credentialed radiologic technologist for more than 30 years and an educator in the discipline for more than 20 years. The researcher set aside all pre-understandings, preconceptions, and biases to conduct a non-biased study.

According to Creswell (2013), to achieve a non-biased study, the researcher should explain to the participants the following facts:

- Deleting or eliminating data from a research study is unethical.
- Deleting or eliminating data will compromise the validity, reliability, credibility, and trustworthiness of the researcher.
- If a participant chooses to voluntarily withdraw from the study, the researcher will eliminate the data collected from that participant.

The researcher did not delete or eliminate any data collected. However, if a participant had voluntarily chosen to withdraw from the study, the researcher would have eliminated this data. No participants withdrew from this study. Further, Bogdan and Biklen (2007) suggested the role of the researcher is to report his/her findings as they were collected. Again, if not the researcher would jeopardize his/her credibility and trustworthiness to the funder and his/her peers.

The following are potential ethical issues that the researcher was aware of and were considered, prior to conducting this study:

- the rights of the participants were compromised
- fabrication and/or falsification of data
- loss of confidentiality of the participant
- misleading or inaccurate findings
- loss of confidentiality
- violation of the IRB approved guidelines of the study

The researcher did not discuss the findings with any other participant. Additionally, each participant's privacy was preserved by de-identifying the data. The researcher did not fabricate or falsify any data. The researcher scheduled interviews with adequate time between interviews, so participants would not have any interaction with each other, thus maintaining their confidentiality and anonymity. By following the rules described above, the researcher ensured that there was no potential for violating the privacy of the participants and/or compromising the outcome of this study by tainting other participants' data. This dilemma also would have violated the IRB's proposal approval process. By discussing the participants' actions with another participant, there could have been a loss of anonymity of the participant's privacy and potentially the publication of inaccurate findings (Polit & Beck, 2013).

Summary

For this basic qualitative research study, 12 newly hired, ARRT credentialed, entry-level radiologic technologists employed their first professional employer post-graduation, were interviewed utilizing semi-structured questions and audio recordings. Themes, categories, and topics emerged, and the data were organized during the data collection and analysis phases of this study.

Chapter 4 will present the data gathered during this study. Finally, chapter 5 will provide discussion, implications, and suggest areas of future research study.

CHAPTER 4: PRESENTATION OF THE DATA

Chapter 4 is a discussion of the results of 12 semi-structured interviews of entry-level radiologic technologists. This chapter provides a report of the data collected without evaluation. This chapter begins with an introduction of the study and the researcher. Additionally, a description of the sample participants is discussed in detail. A discussion of the research methodology and data analysis follows. Finally, the researcher will present an analysis and the results of the collected data by each interview question and by each research question.

The qualitative data were collected to examine the first-year professional employment experiences of entry-level radiologic technologists. Data were collected through face-to-face interviews. The data were then analyzed using manual content analysis.

Introduction: The Study and the Researcher

As a former educator and administrator in radiologic sciences educational programs, at the time of writing the researcher had more than 20 years of experience with students and faculty at various educational institutions across the country. Additionally, the researcher had an additional 12 years of clinical experience employed at several facilities as a radiologic technologist, CT technologist, mammographer, imaging educator, and administrator.

In 1968, the American Society of Radiologic Technologists (ASRT), the professional organization for radiologic technologists, in cooperation with the federal government, began the pursuit of establishing licensure and national standards that would govern the profession of radiologic technologists. The Consumer-Patient Radiation Health and Safety Act was passed in Congress in 1981 without action from the House. The Consumer Assurance of Radiologic Excellence bill (CARE) was presented to the House of Representatives numerous times. The Senate passed the CARE bill in 2006, but the House adjourned prior to action being taken on the bill. After many decades of presenting bills to the House of Representative and all of Congress without success, in 2014 the ASRT shifted its focus to establishing state-level educational standards. In 2017, the pursuit for national standards for the profession continued (ASRT, 2017).

The American Registry of Radiologic Technologists (ARRT) is the organization that credentials radiologic science professionals nationally through the establishment of examination content. In cooperation with the ARRT, the ASRT, the premier professional association for radiologic technologists, has developed a curriculum guide for educational programs in the radiologic sciences to develop their curricula. The ASRT updates and revises these curricula guides on a five-year cycle.

Description of the Sample

The population for this study included participants who were American Registry of Radiologic Technologists (ARRT) credentialed radiologic technologists, or equivalent, during their first year of professional employment working at hospital in the southeast, specifically Alabama. The inclusion criteria for participation in this study were the following: the 12 participants were required to be newly hired radiologic technologists who had at least six months' experience, but not more than 12 months' experience, in an entry level position. The term radiologic technologist is a general term for defining competency-based, educationally prepared ARRT, or equivalent, credentialed personnel who work in an medical imaging or x-ray department in one of the following modalities: diagnostic radiology (x-ray), computed tomography (CT), magnetic resonance imaging (MRI), nuclear medicine technology, vascular interventional radiography (VIR), cardiac interventional radiography (CIR), mammography, dual-energy x-ray absorptiometry (DEXA), picture archive and communication systems (PACS), 3D imaging, radiation therapy, and sonography (ultrasound). As stated earlier, all participants were at least 20 years old, as federal regulations requires that all individuals employed as radiation workers must be 18 years of age or greater and all educational programs in the field are at a minimum two years in length.

In this section, the researcher will discuss details of each participant interview.

Participant 2017-01. This interview was conducted on July 7, 2017. This participant was a 20-year-old male who completed an associate degree within a community college's radiologic sciences program. Participant 2017-01 is following in the footsteps of their mother who is an x-ray (diagnostic radiographer) and CT technologist.

Participant 2017-02. This interview was conducted on July 12, 2017. This participant was a 45-year-old female who attended a community college for their educational training in the radiologic sciences. This participant was a stay-at-home parent who was pursuing a first career after their children had left home.

Participant 2017-03. This interview was conducted on July 19, 2017.This participant was a 23-year-old female who completed an associate's-degree program. Participant 2017-03 had completed a Bachelor of Science degree in psychology but was unable to secure employment. Therefore, the participant decided to return to school to pursue a health professions career.

Participant 2017-04. This interview was conducted on July 24, 2017. This participant was a 21-year-old female who recently graduated from a local associate degree radiologic technology program. Participant 2017-04 had applied to the program once before being accepted but was not selected because of a non-competitive GPA with the other applicants that year. This participant had prior work experience in retail.

Participant 2017-05. This interview was conducted on July 27, 2017. This participant was a 21-year-old female who graduated from a community college. This participant had one year of experience in a nursing program before enrolling and graduating from the associate-degree's radiologic technology program. Finally, the participant had prior work experience as a nursing assistant.

Participant 2017-06. This interview was conducted on August 3, 2017. This participant was a 25-year-old male. Participant 2017-06 was the graduate of a baccalaureate-level radiologic technology program. This participant has planned to pursue a degree in medicine in the future.

Participant 2017-07. This interview was conducted on August 10, 2017. This participant was a 30-year-old female. Prior to completion of their associate degree in radiologic technology, the participant worked at a local hospital as a nursing assistant for eight years.

Participant 2017-08. This interview was conducted on August 16, 2017. The participant was a 43-year-old female. Additionally, at the time of the interview, this participant had recently retired as a local police officer with 25 years of experience. The participant has three children. The youngest child has special needs and has spent a considerable amount of time in the hospital and specifically in radiology. Participant 2017-08 completed the associate-degree radiologic technology program to begin a second career after retirement from the police force.

Participant 2017-09. This interview was conducted on August 22, 2017. This participant was a 22-year-old female. This participant had no prior work experience. This participant's parents mother and father are both physicians. Participant 2017-09 has always had a desire to help others and found radiology fascinating as a child when accompanying their parents to the hospital.

Participant 2017-10. This interview was conducted on August 25, 2017. This participant was a 27-year-old male. Participant 2017-10 had seven years of prior work experience as an active duty U.S. Army medic. Upon discharge from the military, this participant used GI bill funds to pursue an associate degree in radiologic sciences.

Participant 2017-11. This interview was conducted on August 28, 2017. This participant was a 24-year-old female. Participant 2017-11 always had a desire to pursue a career in health care and applied to both the radiologic sciences and diagnostic medical sonography programs. This participant was accepted and completed the associate degree program in radiography.

Participant 2017-12. This interview was conducted on August 31, 2017. This participant was a 23-year-old male. Prior to completion of the associate degree program in radiologic sciences, this participant worked in hospitality for four years.

The tables below demonstrate a demographic representation of the participants in this study based on gender, race, and age.

Table 3. Participant Demographics - Gender

Male	Female
4	8

Table 4. Participant Demographics - Race

Black	White	Hispanic	Asian
4	5	2	1

Table 5. Participant Demographics – Age

20-29	20-39	40-49	50+
9	1	2	0

Research Methodology Applied to the Data Analysis

This study used a basic qualitative research design. Scientific research, as defined by Lodico et al. (2010), is a method of inquiry or investigation that utilizes various techniques to acquire reliable, empirical, credible, measurable, and verifiable knowledge or information concerning a phenomenon. According to Carr (1994), Polit and Beck (2010), qualitative research is a non-numerical method of scientific inquiry that aims to explain an in-depth understanding of human nature. Qualitative research typically investigates the how's and why's of decision making. Further, qualitative research produces information about the specific case(s) being studied and can only speculate on more general conclusions. Qualitative methods of scientific inquiry are particularly appropriate in the social sciences. Strengths of utilizing a qualitative study may include the following:

- It provides individual case information.
- It is especially responsive to specific situations and conditions.
- Researchers can be especially responsive to changes that may occur during the study.
- Qualitative research can be carried out with a small budget and in a short amount of time.

In the arena of qualitative research, the goal is to increase understanding about human interactions and social phenomena. Scholars attempt to explain the processes through which individual create meaning (Bogdan & Biklen, 2007, p. 43). According to Merriam and Tisdell (2015), in basic qualitative research, knowledge is gained continually as one interacts and makes meaning of the experiences and activities in which they are engaged. The basic qualitative research model consists of describing how those studied interpret their experiences, how their worlds are designed, and the subsequent meaning attributed to their experience (Merriam & Tisdell, 2015). This basic qualitative research consisted of interviews with radiologic technologists to identify their experiences during their first year of professional employment. The interviews involved semi-structured, open-ended questions. These semi-structured research questions were designed based on the current literature and they were field-tested prior to conducting the actual, proposed research study.

Presentation of Data and Results of the Analysis

Ten of the twelve participants were graduates of associate degree programs. The remainder were graduates of baccalaureate degree programs. The group was ethnically diverse, but there were twice as many females as male participants. Most of the participants were between the ages of 20 to 39 years old. The responses to all the questions were very similar. The following section is a summary of the participants' responses to the interview questions.

Interview Question 1. The first interview question posed to the participants was "Why did you choose radiologic technology as your career choice?" Eleven of the twelve participants had previous work experience in some type of service profession. All twelve participants identified that they had a desire to "help other people" and they were "interested in working in the medical profession" as a response to question one.

Interview Question 2. The second interview question posed to the participants was "What do you like about the profession?" The participants identified that they liked working with and helping ill patients, in a capacity other than nursing, as the primary response to this question. Interviewee seven stated she liked the "hands on interaction with patients". Additionally, the profession of radiologic technology was identified as a field where a collaborative work environment between colleagues and student technologists was necessary by all participants.

Interview Question 3. The third interview question posed to the participants was "What are some of the experiences you had as a radiologic technologist during your first year of employment?" The responses to this question were varied. The responses ranged from personal interactions with co-workers, to patient-related experiences, and technical issues related to the operation of the equipment utilized to perform radiographic examinations. Several participants commented on the relationships that they developed among colleagues as a positive experience. Also, the respondents identified working with and teaching students, the next generation of radiologic sciences professionals and the intricacies of the profession as a way of giving back and molding the future of the profession. For those who related patient-related experiences, respondents reported that "helping the sick" was a very rewarding experience in the profession. Finally, the respondents identified difficulties with operating a myriad of equipment from various vendors as the prominent equipment-related experience during their first year of professional employment in the radiologic sciences. It should be noted that equipment purchases by an institution vary widely. Equipment purchase considerations include cost, intended use, radiologists' preferences, regulatory requirements, and compatibility with existing systems.

Interview Question 4. The fourth interview question posed to the participants was "What are the special challenges you faced in your first year of employment?" Quite often, an imaging department will have a variety of radiographic equipment purchased from several different vendors. Therefore, participants reported that "…working with a variety of equipment and learning the appropriate technical factors necessary to produce diagnostic quality images" was the primary response to this question. Two respondents stated that "learning how to effectively communicate with physicians, nurses, co-workers, the patients, and families" was the most prominent challenge they faced during their first year of professional employment.

Interview Question 5. The fifth interview question posed to the participants was "Do you feel you were adequately- educationally and clinically- prepared to perform the job duties on the first day of employment as an entry-level radiologic technologist?" All participants reported they were more than adequately prepared, both didactically and clinically, to perform the tasks of an entry-level radiologic technologist and to successfully pass the ARRT credentialing examination upon graduation.

Interview Question 6. The sixth interview question posed to the participants was "Can you identify any skills or knowledge that you did not have but was required for employment in your entry-level position?" The first sub-question to the sixth interview question posed to the participants was "Can you describe these skills deficits?" The second sub-question to the sixth research question posed to the participants was "Where do you think these deficits were missed?" The respondents to this study were all employed at a pediatric hospital in the southeastern region of the United States. As such, several participants reported that "being knowledgeable and comfortable with performing radiographic procedures on pediatric patients" as a deficit in their educational preparation for employment as an entry-level technologist. The respondents identified that their educational programs had adequately prepared them for patient interactions with adult patients as the standard. However, in a pediatric facility, there was a need for technologists to communicate on an age specific basis with the patients and with the parents also. Additionally, interviewees one and three reported their "fluoroscopic skills and knowledge of pediatric patients was limited". When imaging pediatric patients, the technologist must consciously exercise extreme care when both performing radiographic procedures and establishing protocols. By doing so, the technologist will reduce radiation exposures to the pediatric patient while safely and effectively produce diagnostic quality images.

Interview Question 7. The seventh interview question posed to the participants was "What is an experience where things went great or poorly in your duties as an entry-level technologist?" The first sub-question to research question seven was "Why do you think things went well or poorly?" The second sub-question to question seven was "Did you have a mentor to speak with about this incident during or after the procedure was completed?" All respondents identified that upon employment as an entry-level radiologic technologist, a mentor was assigned to work with them for the first 90 days of employment, the probation period was a great experience. During this time, the mentor was responsible for training the new technologist to operate the various equipment throughout the department. Additionally, the mentor was responsible for assessing the new employees' competency in performing diagnostic, fluoroscopic, emergency and trauma, surgical, and portable procedures. These competencies included age-specific communication, providing pre- and post-procedure care instructions to the patient and family, demonstration of proper customer service etiquette, proper operation of radiographic equipment, and the proper selection of technical factors to produce a diagnostic quality radiograph based on patient size and pathology. A good experience identified by participant 10 was when he took the time to properly communicate with a patient, and the parents, the patient was thankful for his attentiveness when the procedure was completed. An example of a poor experience identified was when the new, entry-level technologists had to produce a quality radiograph while under intense pressure in the operating room. Participant 11 suggested the "…fast-pace, life or death urgency of the operating room and emergency room was often overwhelming for a new, entry-level technologist".

Interview Question 8. The eighth interview question posed to the participants was "What is an experience where you were complimented on how you performed a procedure?" The sub-question was "How do you describe the success of what you've been doing?" All participants reported experiences when they were often complimented by the patient and/or the patient's parents when a difficult case was performed well because the technologist was focused on the needs of the patient. The success of performing procedures well was unanimously attributed to "experience and patience" by the participants.

Interview Question 9. The ninth interview question posed to the participants was "What is an experience when you were given guidance by a senior technologist or manager while performing a radiographic procedure?" The first sub-question was "Had you seen this before in your training?" Because of the mentoring program developed for all new employees, all entry-level technologists were assigned to a senior technologist as a mentor during their probationary period, the first 90 days of employment. Therefore, all participants were given explicit guidance during this probationary period. This practice was very similar to the competency-based clinical education component of their educational program where students were assigned to a clinical instructor to oversee their training (Bloom, 2014). Additionally, all participants responded there were no new procedures. That all the procedures they have encountered as a new technologist were taught didactically and clinically while matriculating in the radiography program. But as a student in the clinical role, students are assigned a preceptor but in the role of a technologist the decisions are solely theirs.

Interview Question 10. The tenth interview question posed to the participants was "During your first year of employment, have you ever experienced or personally been involved where a medical error occurred?" The first sub-question was "If so, describe the medical error that you witnessed." The second sub-question was "What did you do when you identified a medical error?" The third sub-question to the tenth research question "What was the outcome of the event?" Overwhelmingly, all participants stated that during their first-year of employment they had either witnessed or were personally involved when a medical error had occurred. Their experiences were varied. Several participants identified medical errors as occasions when images (x-rays) were performed with the wrong patient identification. Also, the wrong side was x-rayed. In both situations, a patient could have been medically treated incorrectly resulting in malpractice. Other participants identified medical errors when patients were administered the incorrect intravenous contrast material based on their diagnosis. This type of error could in many cases be a life-threatening event, which could have also led to malpractice. Finally, one participant discussed an incident when a patient fell off of the imaging table and later expired because of the injury sustained. Again, this is an incident of medical malpractice. In all events, the participants described the process of reporting medical errors as: reporting the incident to the manager or supervisor, contacting the radiologist on duty, and finally submitting a patient safety (PSR) or incident report specifically detailing the incident. The PSR was then reviewed by the director and manager then forwarded to the hospital's risk management department to mitigate potential legal actions later.

Interview Question 11. The eleventh interview question posed to the participants was "In your experiences as an entry-level technologist, do you feel you were prepared and knowledgeable adequately to address medical errors?" The response to this question was yes. All participants reported that they were provided with the knowledge to address medical errors in their didactic instruction and during new employee orientation at the institution of employment.

Interview Question 12. The twelfth interview question posed to the participants was "Upon accepting this entry-level position, did your supervisor (or his/her designee) provide you additional training for this job?" The sub-question was "What did the additional training include?" Interviewees two, five, and eight spoke positively about the mentoring program for new employees. Interviewee twelve compared his experience as a server prior to becoming a technologist. He said, "in any new position you must learn the ropes of that place and that having additional training upon starting a new position is essential to understanding what to do, how to do it, and what is expected of employees". All participants reported their supervisor provided them with additional training upon accepting the job. The additional training the participants were provided included training on: all radiographic equipment, hospital-wide and departmental computer systems (hardware and software), and procedure protocols.

Table 6. Interview Questions and Identified Themes from Data

Interview Question	Themes from Data
Why did you choose radiologic technology as your career choice?	• Helping others, medical career
What do you like about the profession?	• Helping others
What are some of the experiences you had as a radiologic technologist during your first-year of employment?	• Interactions with patients and co-workers, teamwork
What are the special challenges you faced in your first year of employment?	• Learning how to operate various equipment, effective communication
Do you feel you were adequately, educationally, and clinically, prepared to perform the job duties on the first day of employment as an entry-level radiologic technologist?	• Yes, adequately prepared educationally and clinically
Can you identify any skills or knowledge that you did not have but was required for employment in your entry-level position?	• Limited knowledge of pediatrics, age-specific communication, and didactic instruction

Sub question: Can you describe what ere these skills deficits? Sub question: Where do you think these deficits were missed?	
What is an experience where things went great or poorly in your duties as an entry-level technologist? Sub question: Why do you think things went well or poorly? Sub question: Did you have a mentor to speak with about this incident during or after the procedure was completed?	• All new employees are assigned a mentor during their probationary period to become acclimated with the department and the hospital
What is an experience where you were complimented on how you performed a procedure? Sub question: How do you describe the success of what you've been doing?	• Experience and confidence
What is an experience when you were given guidance by a senior technologist or manager while performing a radiographic procedure? Sub questions: Had you seen this before in your training?	• Mentoring
During your first year of employment, have you ever experienced or personally been involved where a medical error occurred?	• Wrong patient, wrong procedure • Contrast (x-ray dye) reaction

Summary

Chapter 4 provided a description of the participants, a review of the data collection process, and a comprehensive analysis of the data. All participants met the study's eligibility criteria and purpose. Participants were graduates of either a baccalaureate or associate degree program and were employed in their first entry-level, professional position since completing their training and successfully passing the ARRT certification examination. Because participants were diverse in their age, gender, and race, they were representative of the profession as a whole. Each participant was interviewed individually, and the interview was audio taped.

The participants provided responses to the twelve semi-structured questions and sub-questions. All data collected were coded to form themes. This chapter included a narrative and table summary (see Table 5) demonstrating the data collected and analyzed.

CHAPTER 5. DISCUSSION, IMPLICATIONS, RECOMMENDATIONS

The intent of this chapter is multifaceted. First, there will be a discussion and interpretation of the researcher's study results. Secondly, there will be insights into the implications of the study's results. Finally, the researcher will provide recommendations for further research.

Summary of the Results

The purpose of the basic qualitative study was to explore the first-year employment experiences of entry-level radiologic technologists. Twelve newly hired, radiologic technologists, employed in their first entry-level professional position since graduation, were interviewed. Although there is literature to document the first-year employment of several health professions, there was none specifically in the discipline of radiologic technology. Understanding the first-year employment experiences of entry-level radiologic technologists provided insight into the educational process as well as the employment expectations of administrators.

The primary research question was, "What are the first-year employment experiences of entry-level, radiologic technologists?" The participants described their first-year employment experiences as an entry-level radiologic technologist as positive. Specifically, all participants cited working collaboratively with colleagues and students as a significant part of their rewarding first year experience. Also, helping the sick was rewarding. However, the entry-level technologists repeatedly commented that working with various types of equipment (fluoroscopic, portable, c-arms, etc.) and brands (manufacturers like Siemen's, Philips, GE, etc.) as being one of the greatest challenges.

Sub question one was, “What are the special challenges that radiologic technologists experience in their first-year of employment?” Again, one of biggest challenges reported was “…working with a variety of equipment and learning the appropriate technical factors necessary to produce diagnostic quality images”. Additionally, two respondents identified learning how to effectively communicate with physicians, nurses, co-workers, the patients, and families were special challenges for them.

Sub question two was, “What meaning do radiologic technologists ascribe to their work experiences?” All respondents identified the profession of radiologic technologists fulfills their desire to “help other people” and “working in the medical profession that is not nursing”.

Sub question three was, “How are these experiences related to optimal or sub-optimal outcomes in diagnostic medical imaging?” All the participants for this study were employed at a pediatric hospital in a southern state. Therefore, many of the responses were similar. All respondents reported that with employment at the study site that a mentor was assigned to work with him or her during their 90-day probationary period. Additionally, all respondents reported that having a mentor was a positive experience. The mentor was responsible for teaching the new technologists how to operate all the equipment. Additionally, the mentor was responsible for assessing the new employees’ competencies in performing diagnostic, fluoroscopic, emergency and trauma, surgical, and portable procedures. Also, the mentor must assess the entry-level employees’ competencies with age-specific communication, providing pre- and post-procedure care instructions to the patient and family, demonstration of proper customer service etiquette, proper operation of radiographic equipment, and the proper selection of technical factors to produce a diagnostic quality radiograph based on the patient’s size and pathology. All participants stated that during their first-year of employment they had either witnessed or were personally involved when a medical error had occurred which could potentially lead to malpractice. Some examples of medical errors reported by the respondents included: images (x-rays) were performed with the wrong patient identification, performing an x-ray on the wrong side (right vs. left), and administering the incorrect type or amount of intravenous contrast material (x-ray dye) based on their diagnosis. The most significant medical error reported was a patient that was left unattended that fell off the imaging table and later expired because of the head injury sustained. All participants knew the process for reporting medical errors from their didactic training and new hire mentoring.

Sub question four was, "What role did educational preparation play during the first year as a radiologic technologist?" All participants reported they felt they were more than adequately prepared, both didactically and clinically, to perform the tasks of an entry-level radiologic technologist upon graduation. Also, all participants reported they were educationally prepared because they successfully passed the American Registry of Radiologic Technologists (ARRT) credentialing examination on the first attempt upon graduation from their educational program. All participants responded they did not encounter any new procedures during their first year of professional employment different from those taught didactically and clinically while matriculating in the radiography program. The respondents reported the following as positive aspects of their educational programs in preparation for their employment as an entry-level radiologic technologist: a) being knowledgeable and comfortable with performing radiographic procedures on pediatric patients, and b) being knowledgeable about good age-specific communication skills. Conversely, the participants reported the following as negative or limiting factors in their educational programs: a) having more preparation in fluoroscopic skills and knowledge of pediatric patients was limited, and b) having additional preparation for pediatric patient interactions because adult patients were utilized as the standard for their education.

Sub question five was, "What are the day-to-day experiences of radiologic technologists in a typical imaging department?" As all respondents were employed at a pediatric hospital, all participants reported that working with and helping children, and working in a collegial environment with colleagues and students as their day-to-day experiences. Additionally, all participants were appreciative of the mentoring program at their facility. The mentoring program allowed them the freedom to learn how to properly operate all radiographic equipment throughout the radiology department without judgment or penalty during their first 90 days of employment as well as to learn how to operate hospital-wide and departmental computer systems (hardware and software) necessary to be an effective radiologic technologist. According to participant 12, the mentoring program allowed the entry-level technologist to learn the ropes.

Discussion of the Results

Each of the semi-structured interview questions were designed to elicit an answer to the following research question: what are the first-year employment experiences of radiologic technologists? Radiologic technologists are responsible for organizing their work, planning their work, and evaluating images for diagnostic quality. This careful planning ensures the production of images of diagnostic quality and ensures the safety of the patients during the procedures (Castillo, Caruana, & Wainwright, 2011). However, during the past several decades, there have been many technological advancements in the form of new imaging modalities. These new technologies come with increasing complexity of operation and the production of diagnostic imaging. These expansions, in turn, will require the expansion in education and training for the radiologic technologists. As a result, radiologic technologists are spending more time with imaging informatics and advanced patient care skills. Radiologic technologists are responsible for the well-being of patients during all imaging procedures. This means that the technologist must pay attention to the physical, emotional, and social well-being of each patient with each interaction.

All participants agreed that they selected radiologic technology as their career choice and the reason they liked the profession is because they wanted a career in medicine to help others. When assessing special challenges, which the participants encountered during their first-employment year experiences, their responses aligned with one or more of the following themes: interactions with patients, interactions with co-workers or students, technology, and teamwork.

Similarly, the participants also ascribed meaning to their work experiences by working directly with patients and their families, professionals in other health-related disciplines, and especially their colleagues. Additionally, the participants all identified that having a mentorship program and working as a team in the radiology department contributed to the development of a positive work environment. Finally, the participants suggested that their confidence in performing radiographic procedures on a day-to-day basis was directly attributed to experience.

The participants correlated optimal and sub-optimal outcomes in their work with having less experience and confidence. Therefore, more experience and confidence equated to optimal outcomes. Similarly, the lack of experience and confidence can be directly attributed to sub-optimal outcomes. Examples cited of sub-optimal outcomes included:

- Performing a radiographic procedure on the wrong patient;
- Performing the wrong procedure on a patient;
- Carelessness in reviewing patient history prior to performing procedures that could potentially result in a patient injury or death.

The participants were very knowledgeable about how to address medical errors from orientation with the employer, but they suggested that there was a lack of adequate didactic instruction in their education programs.

All the participants reported they were adequately educationally prepared to practice the daily responsibilities of a radiologic technologist in their first jobs on their first day of professional employment. However, all participants reported that the instruction in their educational programs did not provide adequate didactic instruction on pediatrics. The participants stated the curriculum and instruction was primarily geared towards the average, adult patient. Additionally, the participants strongly suggested the educational programs were deficient in providing adequate didactic instruction on age-specific communication.

The participants described the day-to-day experiences as an entry-level radiologic technologist as challenging but rewarding. The technical aspects of the job could be challenging. However, the interactions with patients, families, other health care professionals, and colleagues were very rewarding.

Conclusions Based on the Results

The field of radiologic technology is very dynamic. Manufacturers are building better, faster, and more efficient radiographic equipment each year. The work in this discipline involves interactions with a variety of people and direct patient care daily. Effective and age-specific communication is essential. Additionally, the variety of modalities within the discipline allows for continued career growth and advancement. The work itself is quite technical. Learning how to use various equipment is a necessity. Therefore, technologists must be willing to grow and learn to become a productive and integral part of the imaging team. The radiologic technologist must be able to adapt to situations and challenges as they are presented. The work can be unpredictable, high paced, complex, highly stressful, yet rewarding. An essential skill one must possess is the ability to problem solve. Finally, mentoring and teamwork are essential attributes for a radiology department to develop so that the personnel experience a positive, cohesive work atmosphere.

Comparison of Findings with Theoretical Framework and Previous Literature

Critical thinking is applicable to both the didactic and clinical components of radiologic sciences education (Kowalczyk & Leggett, 2005). Although didactic instruction in the radiologic sciences is primarily geared to the "normal" adult patient, students, and later the entry-level technologists, must learn how to adapt to all patients. Several areas where critical thinking is applicable include variations in: age, weight, body habitus, and the type of radiographic equipment being used (Bushong, 2013; Adler & Carlton, 2016). From interview question three, "What are some of the experiences you had as a radiologic technologist during your first year of employment", many of the respondents identified they had many technical problems with operating different types of radiographic equipment. In order to overcome this issue, the entry-level radiologic technologists would need to apply critical thinking skills to be able to seamlessly maneuver between equipment made by different vendors. Additionally, interview question six, "Can you identify any skills or knowledge that you did not have but was required for employment in your entry-level position?" and the sub-question "Can you describe these skill deficits?", the respondents answered they were adequately prepared educationally for adult patients but lacked in their ability to communicate effectively with pediatric patients and their parents. To effectively communicate with the pediatric patient required the technologist to critically think of how they have communicated with adult patients and adapt that knowledge to a much younger audience.

In addition to thinking critically, the entry-level technologist becomes more effective and efficient with performing radiographic procedures through experience. Experiential is learning through experience (Dickman, Milligan, & Kodadek, 2013). Experiential learning is incorporated into radiologic sciences education in the competency-based clinical education component. Prior to their enrollment in competency-based clinical courses, radiologic technology students are required to have laboratory experiences in:

1. Patient care to teach body mechanics and basic patient care skills;
2. Radiographic procedures where the student learns how to adapt “normal” techniques to address the patient’s body habitus, pathology, ambulatory versus non-ambulatory patients; and to a limited degree the pediatric versus adult patient; and
3. Radiographic imaging where the student is taught how the equipment works and what happens when techniques are changed to accommodate the patient condition (Bushong, 2013).

The radiologic technology student, and later practitioner, moves through Kolb’s experiential learning cycle from the patient encounters, to reflection, to conceptualization, to experimentation with the performance of radiographic procedures (Kolb, 1984). Upon graduation, the entry-level and experienced technologist continues to utilize the knowledge and skills gained in their educational program with each patient encountered throughout their career. The respondents identified in interview question four, “What are the special challenges you faced in your first-year employment?”, that working with different equipment types aid them in learning how to adjust techniques for each patient. Additionally, sub-question two to interview question seven asked “did you have a mentor to speak with about this incident (where things went great or poorly) during or after the procedure was completed?”, identified there was a mentoring program developed at this institution for new, entry-level technologist where the mentor was responsible for educating the employee for the first 90 days of employment. Therefore, the new technologist was provided one-on-one, explicit instruction from a more seasoned, senior technologist and shown how to operate new equipment and the correct images to perform for each radiographic procedure. Again, learning was gained through experience.

Additionally, the apprenticeship theory provided the conceptual framework for this study. The apprenticeship theory blends formal and informal education preparation so that it represents one's understanding of reality (Austin, 2009; Bouta & Paraskeva, 2013; Stewart & Lagowski, 2003). The apprenticeship theory illustrates how the parts of a discipline are interconnected to bring understanding within the discipline. This theory of learning addresses the educational preparedness of the student and is directly correlated with the performance of the professional. The learner constructs mental formation of the environment, thereby allowing the learner to perform similarly to their peers.

Preliminary findings from this limited qualitative study suggest there is no disconnect between the educational preparedness of the entry-level radiologic technologist and their skills, knowledge, and abilities to perform the day-to-day tasks required of them. These findings concur with the study by Harris (1996) that there are not significant differences in the educational preparedness of graduates and their abilities. Therefore, there does not appear to be a gap between training and practice except in the areas of pediatrics and age-specific communication.

Educational research is conducted for a wide variety of purposes. Like research in other disciplines, educational researchers must be proficient in conducting research using various methods. In investigating the topic of first year employment experiences of entry-level radiologic technologists, the researcher determined that basic qualitative research would be best. Carr (1994) stated that qualitative research is a non-numerical method of scientific inquiry that aims to explain an in-depth understanding of human nature. Qualitative research typically investigates the how's and why's of decision making. Further, qualitative research produces information about the specific case(s) being studied and can only speculate on more general conclusions.

Qualitative research method of scientific inquiry is particularly appropriate in the social sciences. According to Carr (1994), strengths of utilizing a qualitative research approach would include:

1. The ability to gather and analyze in depth data on a specific and often complex topic.
2. Qualitative research especially and closely investigates real-life situations in their natural setting or environment.
3. Researchers actively respond to change that take place in the duration of the study.
4. Qualitative research can be carried out with a relatively small budget and in a short amount of time.

This researcher determined, therefore, that basic qualitative research was the most effective research design to evaluate the first-year employment experiences of entry-level technologists that were graduates of a competency-based education program.

Interpretation of the Findings

Most educational programs in radiologic technology are accredited through the Joint Review Committee on Education in Radiologic Technology (JRCERT) or through the regional accreditor of the sponsoring institution. The JRCERT does not endorse a particular curriculum guide for educational programs but requires a well-organized curriculum that builds mastery, so students are prepared to practice in their professional field along with educationally qualified and experienced faculty for delivery. However, as the professional organization for the profession, the American Society of Radiologic Technologists (ASRT) has developed a curriculum guide for educational programs to structure their curriculum for each modality. Each curriculum guide is devised from the content specification of the American Registry of Radiologic Technologists (ARRT) certification examination. According to the JRCERT (2017) annual primary examination report, in the discipline of radiography 87.2 examinees passed the ARRT certification examination on their first attempt. Therefore, it can be concluded that graduates of educational programs in radiologic sciences are well prepared to sit for the ARRT national certification examination and to assume the role of the entry-level radiologic technologist, on-the-job mentoring is also essential.

Limitations

Limitations potentially impacting this study included the small sample size of the study. Additionally, the participants of this study were all from a pediatric facility. In addition, the results of this study were limited to the southeastern region of the United States. Finally, the participants of this study were all from the discipline of radiography and did not include other modalities in the discipline such as nuclear medicine, ultrasound, CT, MRI, interventional radiography, or radiation therapy.

Implication for Practice

The results of this study indicated that there is a greater need for emphasis on pediatrics in the professional radiologic sciences curriculum. According to the Image Gently Alliance and Campaign (2017), there should be awareness on ways to improve safety for pediatric patients while performing diagnostic medical imaging studies worldwide. Additionally, the results of this study implied that there should be a greater emphasis on addressing and identifying medical errors in the professional radiologic sciences curriculum. Currently, the ASRT curriculum guide is on a five-year review cycle. Perhaps the cycle of review should be more frequent, so that the professional curriculum reflects the current practice in the discipline.

Recommendations for Further Research

As discussed in previous sections of Chapter 5, there are several opportunities for future research. First, this study should be conducted in other regions of the U.S. or across the U.S. Additionally, a quantitative study may provide regional results. Also, this study was limited to diagnostic radiology (x-ray). The study could be extended to include other imaging modalities to assess the first-year employment experiences of technologists in CT, MRI, ultrasound, nuclear medicine, and radiation therapy. The participants of this study were from associate-degree and baccalaureate-level programs. A quantitative study comparing the first-year employment experience of associate-degree and baccalaureate-degree graduates may yield further information.

Conclusion

The purpose of the basic qualitative study was to identify the first-year employment experiences of entry-level radiologic technologists and the meanings they ascribe to their experiences. Through using semi-structured interview questions when interviewing the 12 participants, the researcher was able to identify satisfaction with the overall educational preparation of entry-level radiologic technologists. However, the participants suggested there should be a greater emphasis on pediatric imaging and medical errors in the professional curriculum. Radiologic technology is an exciting and dynamic field with a variety of modalities to consider for career growth. However, the professional curriculum offerings and the actual day-to-day experiences of an entry-level technologist may not coincide.

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STATEMENT OF ORIGINAL WORK

Academic Honesty Policy

Capella University's Academic Honesty Policy (3.01.01) holds learners accountable for the integrity of work they submit, which includes but is not limited to discussion posting, assignments, comprehensive exams, and the dissertation or capstone project.

Established in the Policy are the expectations for original work, rationale for the policy, definition of terms that pertain to academic honesty and original work, and disciplinary consequences of academic dishonesty. Also stated in the Policy is the expectation that learners will follow APA rules for citing another person's ideas or works.

The following standards for original work and definition of *plagiarism* are discussed in the Policy:

> Learners are expected to be the sole authors of their work and to acknowledge the authorship of others' work through proper citation and reference. Use of another person's ideas, including another learner's, without proper reference or citation constitutes plagiarism and academic dishonesty and is prohibited conduct. (p. 1)
>
> Plagiarism is one example of academic dishonesty. Plagiarism is presenting someone else's ideas or work as your own. Plagiarism also includes copying verbatim or rephrasing ideas without properly acknowledging the source by author, date, and publication medium. (p. 2)

Capella University's Research Misconduct Policy (3.03.06) holds learners accountable for research integrity. What constitutes research misconduct is discussed in the Policy:

> Research misconduct includes but is not limited to falsification, fabrication, plagiarism, misappropriation, or other practices that seriously deviate from those that are commonly accepted within the academic community for proposing, conducting, or reviewing research, or in reporting research results. (p. 1)

Learners failing to abide by these policies are subject to consequences, including but not limited to dismissal or revocation of the degree.

Statement of Original Work and Signature

I have read, understood, and abided by Capella University's Academic Honesty Policy (3.01.01) and Research Misconduct Policy (3.03.06), including Policy Statements, Rationale, and Definitions.

I attest that this dissertation or capstone project is my own work. Where I have used the ideas or words of other, I have paraphrased, summarized, or used direct quotes following the guidelines set forth in the APA *Publication Manual.*

Learner name
and date ______Audrey Harris – February 3, 2018

Attachment A

Greetings:

My name is Audrey Harris. As a doctoral candidate in the School of Education at Capella University, I am engaging in a qualitative research to study the first-year employment experiences of entry-level radiologic technologists. As a recent graduate and new employee in the radiology department, I would like to invite you to be a participant.

The study will consist of a 60 to 90-minute interview. The interviews will be conducted in a secure, private conference room away from the main department. The researcher will schedule interviews with adequate time between interviews, so participants will not have any interaction with each other in order to ensure anonymity and participant privacy. Additionally, the interview session will be recorded only as a reference for the researcher. Your participation in this study and all information and statements you make will be held in the strictest of confidential and will only be used for this educational assignment. The results of this study will not be divulged to any other participant or employee at this institution or in this department.

Again, all responses and information divulged in this study will be kept strictly confidential. This means your interview responses will not be shared with anyone other than my mentor and doctoral committee members at Capella University. All information gathered for this study will not identify any participants individually. At any time during this study, as a participant you can withdraw from the study if you desire. Finally, you do not have to talk about anything you do not want to and you have the right to end this interview at any time.

If you have any questions, please do not hesitate to ask. If you are willing to participate in this research project, please print and sign the attached informed consent form and email it to me at aharris@capellauniversity.edu or mail it to me in the enclosed self-addressed stamped envelope.

Thank you in advance for your willingness to consider participating in my study.

Best wishes,

Audrey Harris

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