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American Registry Of Radiologic Technologists Exam Preparation: A Case Study

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AMERICAN REGISTRY OF RADIOLOGIC TECHNOLOGISTS

EXAM PREPARATION: A CASE STUDY

By

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ABSTRACT

The purpose of this case study was to investigate the students' perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) certification exam after the completion of a last semester registry preparation course at a small health profession college located in the northeast. In addition to perceptions of preparedness this study explored the effectiveness of the HESI Radiography Exit Exam preparation tool and the relationship between perceptions of preparedness and ARRT exam scores and 1st time pass rates. The problem that initiated this case study was the ARRT exam scores and 1st time pass rates at Radiography Program X were below the state and national averages from 2013-2018. Three research questions and various sub questions guided this case study. The research questions were answered by collecting and analyzing a variety of qualitative and quantitative datasets. The qualitative datasets were retrospective end of semester course surveys from the last semester registry preparation course and a post-graduation follow-up survey that was created for this study. The quantitative data included ARRT exam scores and 1st time pass rates and HESI Radiography Exit Exam scores.

The findings revealed that various elements within the last semester registry preparation course were beneficial in students' preparation to take the ARRT exam. Twelve course element codes were extrapolated from the open-ended comments from the qualitative surveys, which

were then categorized into three emergent themes. The three emergent themes regarding the perceptions of preparedness were 1) knowledge mastery, 2) exam familiarity, and 3) skill strategies. Knowledge mastery was the emergent theme when answering the research questions. The recommendations based on the results of this study include providing radiography students with a multifaceted registry preparation course. Major elements of the course design include: mock exams, reviews, exam question type and format, exam format, study strategies, and preparation textbook. In addition to a registry preparation course, conducting a learning style questionnaire may also assist in the success of radiography students on the ARRT exam and guide program improvements.

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CHAPTER ONE

INTRODUCTION

According to the U.S. Bureau of Labor Statistics (2019), the "Employment of radiologic technologists is projected to grow 9 percent from 2018 to 2028, faster than the average for all occupations" (para. 7). The radiography profession is the third largest health profession only to be exceeded by nurses and doctors (American Registry of Radiologic Technologists [ARRT], n.d.c). Radiologic technologists are an integral part of the healthcare team that provides care and services to patients and performs diagnostic imaging exams on patients in a variety of settings. With this estimated increase in job growth, it is important to understand the education and certification requirements of the profession when choosing a career path such as radiologic technology.

Forty-three states within the United States have specific requirements for radiologic technologists (American Society of Radiologic Technologists [ASRT], 2019). The specifications of the American Registry of Radiologic Technologists (ARRT) include a certification examination. The ARRT is the national organization that offers certification examinations and maintains registration of radiologic technologists. The purpose of the certification examination "is to assess the knowledge and cognitive skill underlying the intelligent performance of the tasks typically required of radiographers" (ARRT, 2018a, para.1). The ARRT certification exam can only be taken three times at a cost of $200 for each attempt (ARRT, 2018c). The completion of an approved educational program that incorporates didactic and clinical components is required to be eligible to take the certification exam (ARRT, 2018c). The radiography program must be accredited by a recognized organization, such as the Joint Review Committee on Education in Radiologic Technology (JRCERT). The JRCERT provides programs with standards

to promote high-quality education and patient safety (Joint Review Committee on Education in Radiologic Technology [JRCERT], 2019a).

The promising career outlook for the health profession of radiologic technology indicated by the U.S. Bureau of Statistics (2019) may lead to an increased demand for education in the radiologic technology field. This increased demand may encourage radiologic technology programs to identify what sets them apart from others to be the program of choice. Radiography program accreditation such as the Joint Review Committee on Education in Radiologic Technology (JRCERT) requires programs to make publicly available specific program outcomes (JRCERT, 2018). This provides prospective students with transparency when exploring radiography programs. When researching radiography programs, students may research program statistics that include retention rate, graduation rate, job placement rate, and certification exam first-time pass rate. This information provides students with insight into the quality of the program to make an informed decision when choosing radiography.

American Registry of Radiologic Technologists (ARRT) certification exam scores may be a statistic that radiography programs track to determine student success and the effectiveness of the program. The ARRT exam evaluates the knowledge required of entry level radiologic technologists (ARRT, 2018c). In order to prepare students to take the certification exam and execute professional practice, radiography program curricula are designed around the ARRT exam content. Individual programs often compare their ARRT certification exam average scores and pass rates to state and national averages to see where their program falls among other radiography programs. From 2013 to 2018, Radiography Program X student's American Registry of Radiologic Technologists (ARRT) certification exam scores were below the state's average rate by an average of 1.5 points and national by an average of 6 points, as well as a lower first-time pass rate by an average of 2% compared to the state and 3% nationally (ARRT,

2013, 2014, 2015, 2016, 2017, 2018a). Successful exam rates are important, yet, understanding the student perception of preparedness may provide insight for radiography programs to increase student preparation to increase ARRT exam scores and pass rates. This case study specifically explored Radiography Programs X's students' perceptions of ARRT certification exam preparedness. The results can inform Radiography Program X in future decisions regarding exam preparation to prepare students to enter the field as radiologic technologists.

As required by the American Registry of Radiologic Technologists (ARRT) and the Joint Review Committee on Education in Radiologic Technology (JRCERT), radiography programs must have both didactic and clinical components (ARRT, 2018c; JRCERT, 2018). Radiography students learn concepts in the classroom (didactic) and apply them in the clinical setting (practice). Students work alongside registered radiologic technologists performing imaging exams on patients as part of the clinical program requirements. The clinical environment provides students the opportunity to practice and perfect skills, concepts, and best practices taught in the classroom. The classroom instruction of performing imaging exams is based on certification exam content specifications presented by the ARRT (ARRT, 2018c).

Prior research indicates that there is a disconnect between didactic and clinical education, which can be referred to as a theory-practice gap (Allen, 2014; Botwe, Arthur, Tenkorang, & Anim-Sampong, 2017; Falk, K., Falk, H., & Ung, 2016; Hanberg & Brown, 2006; Mgbekem, Ojong, Lukpata, Armon, & Kalu, 2016; Scully, 2011; Wilkinson, Smallidge, Boyd, & Giblin, 2015; Wright & Homer, 2017). This disconnect refers to content that students are learning in the classroom may not be what they are exposed to or need to demonstrate in the clinical environment; this divide may possibly interfere with students' retention of concepts covered on the certification exam. The difference between what is taught and what is practiced is not new. Roth, Mavin, and Dekker (2014) attributed the theory-practice gap as dating back to Aristotle

and that "knowing-in-practice . . . requires not only knowing-that and knowing-how but also knowing-what-for and knowing-in-order-to" (p. 522). When evaluating ways to narrow the theory-practice gap, focus can be placed on the classroom, clinical environment, and or both. For example, incorporating evidence-based practice in the clinical environment promotes awareness of the theory that guides best practice standards (Billings & Kowalski, 2006).

This case study explored student perceptions of their preparedness after completing the last semester registry preparation course at Radiography Program X. The purpose of the registry preparation course is to better prepare radiography students to take the American Registry of Radiologic Technologists (ARRT) national certification exam. In 2016, the Radiography Program X implemented a new ARRT certification exam preparation tool, which included the Health Education Systems, Inc. (HESI) Radiography Exit Exam. This case study reviewed data sets that pertain to the last semester registry preparation course including end of the semester course student surveys, HESI Radiography Exit Exam scores, ARRT exam scores and pass rates. To specifically explore students' perceptions of how the last semester preparation course prepared students to take the ARRT exam a post-graduation follow-up survey was used. The purpose of this case study was to examine the Radiography Program X's students' perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) certification exam as it related to an exam preparation tool and ARRT exam scores and pass rates.

Radiography Program X's American Registry of Radiologic Technologists (ARRT) certification exam scores and pass rates have been below state and national averages from 2013 to 2018. In addition to the differences between didactic instruction and clinical education that may influence the ARRT certification exam scores and pass rates, another factor may be the increase in the exam cut score or the standard of passing the exam. In 2012, the ARRT announced that starting in 2013, the "Radiography certification exam will be measured against a

slightly higher cut score, distinguishing those who pass from those who do not" (ARRT, 2012, para. 1). The increase in the exam cut score means that candidates must answer six more questions correctly than before, while still receiving a passing score of at least 75% (ARRT, 2012b). Due to the change in the passing standard, radiography programs need to ensure students are adequately prepared to take the ARRT certification exam. Radiography programs may implement exam preparation tools from companies such as Health Education Systems, Inc. (HESI), to support their students to succeed on the ARRT certification exam. HESI products have been used within nursing education for years and have branched out to other health professions such as radiography (Evolve, 2019).

In 2016, as part of the registry preparation course, Radiography Program X started using the HESI Radiography Exit Exam as a preparation tool with the intention to increase students' preparedness and to see an increase in American Registry of Radiologic Technologists (ARRT) exam scores and pass rates. The HESI Radiography Exit Exam proctored by faculty and completed by students on the last day of the final semester and offers a similar experience to the American Registry of Radiologic Technologists (ARRT) certification exam. This product is defined as a tool, due to the provided results and recourses that the student can access that supports their success on the ARRT certification exam. The HESI Radiography Exit Exam is promoted to be a potential predictor of success on the ARRT exam by applying the HESI Predictability Model (HPM) to the scores (Elsevier, 2018). The acceptable score of the HESI Radiography Exit Exam is 700, however, the recommended score is 750 as a predictor of passing the ARRT exam (Elsevier, 2018). A brief explanation of performance levels is included with the results after students complete the HESI Radiography Exit Exam. The HESI Radiography Exit Exam is accessed by a secure code to maintain exam security and integrity (Evolve, 2019). HESI was chosen due to its extensive history with nursing National Council Licensure Examination

(NCLEX) preparation. Evolve, the educational website housing HESI products presents a research summary of ten journal articles showing reliability of the nursing HESI Exit Exam (Evolve, n.d.a). The HESI assessment results provide students with remediation in areas of weakness. The remediation and resources align with the specific ARRT exam content areas and are individualized for each student as determined by the assessment (Evolve, 2019). Evolve (2019) promotes their product stating "HESI's Review & Testing for Radiography is a comprehensive suite of products that combines proven HESI preparation and testing products with trusted Elsevier remediation content from market-leading Elsevier Radiography textbooks" (para. 2). With the importance of passing the certification exam and maintaining competence within the field of radiologic technology, evaluating student perceptions of ARRT exam preparedness could be a crucial component of a radiography program, not only for Radiography Program X but to offer a guide when choosing exam preparation methods to comparative programs facing similar issues.

Problem Statement

The American Registry of Radiologic Technologists (ARRT) certification exam scores from Radiography Program X students have remained below the state and national average since 2013; below the state by an average of 1.5 points and national by 6 points, along with lower first-time pass rates by an average of 2% compared to the state and 3% nationally (ARRT, 2013, 2014, 2015, 2016, 2017, 2018a). The decrease in ARRT exam scores and pass rates may affect a program's accreditation and federal funding. Student exam preparation may influence initial ARRT certification exam scores and first-time pass rates as well as their overall understanding of the knowledge required of registered radiologic technologists.

Purpose of the Study

The purpose of this study was to evaluate Radiography Program X's student perceptions of American Registry of Radiologic Technologists (ARRT) certification exam preparedness after completion of the last semester registry preparation course. The focus of this research study was to examine student perceptions of how well the registry preparation course prepared them for successfully passing the ARRT certification exam. In addition to exploring student perceptions, this study considered whether there is a relationship between components of the last semester registry preparation course and student's ARRT exam scores and pass rates. The information gained from this case study can provide information and resources for this radiography program, and potentially others, to increase student success on the ARRT certification exam.

This case study included an examination of six years (2013 – 2018) of approximately 115 sets of student data. The data consisted of

- end of the semester course surveys (open-ended comments),

- post-graduation follow-up surveys (open-ended comments),

- HESI Radiography Exit Exam scores (assessment data), and

- American Registry of Radiologic Technologists' (ARRT) certification exam
  scores and pass rates (assessment data).

The student perception data were gained by examining two different surveys using the same set of participants. The open-ended questions from end of semester course surveys and post-graduation follow-up surveys were used. The end of the semester course surveys were delivered by the institution, whereas I, the researcher, developed the post-graduation follow-up survey and was distributed after University of New England Institutional Review Board (UNE IRB). IRB approval was not required at the site due to the institution not having their own institutional review board. Permission to conduct the study was granted in the form of writing

from the president of the institution. The two surveys provided student perceptions before (end of semester survey) and after (post-graduation follow-up survey) taking the ARRT certification exam. The assessment scores assisted with triangulation to increase the validity of the research and the results (Creswell, 2015). The six years of data provided me, the researcher, the opportunity to examine the last semester registry preparation course three years before Radiography Program X began using the HESI preparation tool and three years of students using the tool to assist in determining correlation to the students' perceptions of preparedness and ARRT certification exam scores and first-time pass rates. This case study can provide the radiography program information and insight for future decisions regarding student ARRT exam preparation tools.

Research Questions

This study strived to answer the following research questions:

RQ1: What are the students' perceptions of their ARRT certification exam preparedness after completing the last semester registry preparation course?

SQ1: How did the use of the HESI Radiography Exit Exam preparation tool affect students' perception(s)?

SQ2: What is the relationship between students' perceptions of preparedness and their HESI Radiography Exit Exam scores?

RQ2: What is the relationship between students' perceptions of exam preparedness and ARRT certification exam scores and pass rates?

SQ1: What is the difference between students' perceptions that used the HESI Radiography Exit Exam preparation tool and those who did not?

RQ3: What is the relationship between students' perceptions of preparedness before and after taking the ARRT exam?

SQ1: How did the use of the HESI Radiography Exit Exam preparation tool affect students' perception(s)?

Conceptual Framework

Ravitch and Riggan (2016) describe the elements of a conceptual framework to be personal interests, topical research, and theoretical frameworks. These elements give researchers steppingstones for the direction and creation of one's research study. The conceptual framework presented in this chapter includes a brief overview of these three elements. The conceptual framework of this study is developed more fully within Chapter 2, Literature Review.

Personal Interest

When students enter a radiography program, they are admitted with the expectation of graduating as successful health professionals, which includes passing the American Registry of Radiologic Technologists (ARRT) national certification exam. As the researcher of this study and a faculty member of a radiography program, it is tough not to feel partially responsible for the certification exam scores achieved by graduates. In general, educators want their students to succeed and strive to provide a learning environment in which they can do so. Examining student perceptions of preparedness after completing the last semester registry preparation course may provide me, the researcher, and Radiography Program X assistance with future decisions regarding best methods in promoting student success and narrowing the theory-practice gap.

Topical Research

In the search for supporting literature for this research study, I, the researcher, discovered there is a limited amount of literature focusing on radiography education and the American Registry of Radiologic Technologists (ARRT) certification examination and preparation methods. The literature pertaining specifically to registry preparation courses, tools, and students' perceptions of preparedness as it relates to ARRT exam scores and pass rates is limited.

Vealé, Clark, Killion, and Sharma (2017) and Schmuck and Cook (2018) presented studies on different preparation methods, however, did not evaluate the student perception or both components of ARRT exam scores and pass rates. Due to the lack of research pertaining to ARRT exam preparation, exam scores, and pass rates, this study assists in adding to the literature relating to the radiologic technology field. I, the researcher, found studies pertaining to radiography student perceptions (Chamberlain, 2015; Gqweta, 2012; West, 2016) nonetheless, the studies did not directly relate student perceptions to ARRT exam scores and pass rates received. The lack of literature pertaining to the investigation of student perceptions of preparedness as it relates to the American Registry of Radiologic Technologists (ARRT) certification exam scores and pass rates provided validation for this case study.

During the search for literature focusing on radiography exam preparation, the existence of the theory-practice gap within the profession of radiologic technology became evident (Allen, 2014; Botwe et al., 2017; Falk et al., 2016; Hanberg & Brown, 2006; Mgbekem et al., 2016). I found theory-practice gap literature focused on methods for narrowing the gap within the clinical environment. This case study concentrated on the didactic (theory) element, the use of a registry preparation course, and a tool to assist in narrowing the theory-practice gap and how that relates to radiography students' perceptions of their preparation for their certification exam and professional practice.

Theoretical Research

Literature reviewed indicated that there may be a disconnect between didactic and clinical education (Allen, 2014; Botwe et al., 2017; Falk et al., 2016; Hanberg & Brown, 2006; Mgbekem et al., 2016; Scully, 2011; Wilkinson et al., 2015; Wright & Homer, 2017). What radiography students learn in the classroom may be different than how the radiologic technologist and student perform in the clinical environment, which may affect students'

perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) certification exam and the scores received. This difference is called the theory-practice gap (Allen, 2014; Botwe et al., 2017; Falk et al., 2016; Hanberg & Brown, 2006; Mgbekem et al., 2016; Roth, Mavin, & Dekker, 2014; Scully, 2011; Wilkinson et al., 2015; Wright & Homer, 2017). The difference between theory and practice as a theoretical explanation that dates back to Aristotle (Roth, Mavin, & Dekker, 2014). Botwe et al. (2017) noted that,

> Theory–practice gap is the discrepancy between what is taught (theory) in the classroom and what is actually practiced clinically. It is considered detrimental to radiography education and effective practice and has profound implications for the future of the profession. (p. 147)

Bowte et al. (2017) bring attention to the theory-practice gap within the field of radiography, however, this is not the only healthcare discipline affected by this gap. Medicine (Wright & Homer, 2017), dental hygiene (Falk et al., 2016; Wilkinson et al., 2015), and nursing (Hanberg & Brown, 2006; Mortell, 2019; Scully, 2011) are all affected by this gap and researchers have been attempting to determine methods for narrowing that gap.

The theory-practice gap provided a theoretical framework for this research study because the theory-practice gap offers a deeper understanding of the disconnect between didactic and clinical education, which may have a direct effect on how students perceive their readiness to take the certification exam and their received scores. Increasing student preparedness for the American Registry of Radiologic Technologists (ARRT) certification exam is a potential method of narrowing that gap. Botwe et al. (2017) conducted a study specific to the performance of chest x-rays. The results of this study indicated the presence of a theory-practice gap and stated, "Lack of congruence between theory and practice presents serious problems to students" (Botwe et al., 2017, p. 146). The study (Botwe et al, 2017) also identified causes of this gap to be the level of

competence and experience of technologists and supervisors. This case study investigated the relationship between student perceptions of exam preparedness and ARRT certification exam scores and pass rates. An increase in ARRT certification exam scores may demonstrate a narrowing of the theory-practice gap as new radiologic technologists enter the field with a deeper knowledge and understanding of current best practices and standards.

Assumptions, Limitations, and Scope

Identifying the assumptions, limitations, and the scope of a study offers the reader background information to have a clear understanding of the study and the perspective of the researcher. As the researcher, I assume that the Radiography Program X provided an equal and adequate testing environment for all cohorts. A limitation of this case study was that it does not provide information on causation; it was intended to only be used as a resource when investigating student perceptions of exam preparedness and considering the use of radiography certification exam preparation tools. This limitation was due to this study only evaluating one radiography program, Radiography Program X from 2013 – 2018. The population of this case study may also be considered a limitation due to the study's focus on one specific radiography program, making it potentially difficult to generalize to other radiography programs; however, the transferability of this study could be used when evaluating students' perceptions of preparation, ARRT exam preparation courses and tools (Patton, 2015).

The scope of this study was limited to associate degree level radiography students over a six-year time period, analyzing data from approximately 115 students. Radiography Program X is part of a small health professions college located in the Northeast of the United States. This case study explored student perceptions after the completion of a last semester registry preparation course. This study also investigated the relationship between student perceptions of

preparedness, their HESI Radiography Exit Exam scores, American Registry of Radiologic

Technologists (ARRT) certification exam scores and pass rates.

Significance

The significance of this case study was the examination of student perceptions of their

preparedness to take the American Registry of Radiologic Technologists (ARRT) certification

exam. Gaining the student perception may provide insight into ARRT exam preparation tools

and registry preparation courses to better prepared students for certification. Better preparation of

radiologic technology students to take the ARRT exam has the possibility of improving the

quality of imaging services and patient care due to the increased understanding and overall

knowledge of the tasks of a radiologic technologist. This case study provides Radiography

Program X evidence specific to the HESI preparation tool as an effective ARRT certification

exam preparation tool and the students' perceptions of the last semester registry preparation

course.

Definition of Terms

The following is a list of defined terms that will help clarify their meaning and how they

relate to the study.

American Registry of Radiologic Technologists (ARRT): The largest organization that

provides initial certification and continued registration for Radiologic Technologists in the

United States (ARRT, n.d.a).

American Society of Radiologic Technologists (ASRT): Organization that promotes high

-quality patient care and standards for the radiologic technology profession (ASRT, n.d.a).

American Registry of Radiologic Technologists Certification: The passing of an ARRT

examination after meeting all ethical, education, and clinical requirements (ARRT, n.d.b).

Continuing Qualifications Requirements (CQR): Requirements of registration for radiologic technologists who gained certification starting in 2011, which includes completing a profile and self-assessment every ten years. The results of the self-assessment may require prescribed topics for continuing education credits (ARRT, 2017b).

ARRT Exam Cut Score: the standard of passing the ARRT certification exam (ARRT, 2012b).

Health Education Systems, Inc. (HESI): exam preparation tool created by the publishing company Elsevier (Elsevier, 2019).

Joint Review Commission on Education in Radiologic Technology (JRCERT): Accrediting agency for radiologic technology programs (JRCERT, 2019a).

New England Commission of Higher Education (NECHE): Accrediting agency for colleges and universities in New England (NECHE, n.d.).

Radiologic Technologist: A person who meets all educational and clinical requirements and maintains certification and registration from the ARRT. "Radiologic technologists are the medical personnel who perform diagnostic imaging examinations and administer radiation therapy treatments. They are educated in anatomy, patient positioning, examination techniques, equipment protocols, radiation safety, radiation protection and basic patient care" (ASRT, n.d.b, para. 1).

Registration: To maintain certification as a registered radiologic technologist must meet all ethical and continuing education credit requirements (ARRT, n.d.b).

Conclusion

The intention of this case study was to assess student perceptions of American Registry of Radiologic Technologists (ARRT) certification exam preparedness after completion of a last semester registry preparation course. This case study also aimed to evaluate the relationship

between student perceptions, the HESI Radiography Exit Exam scores, and the ARRT certification exam scores of students who used the HESI preparation tool compared to those who did not. The results of this research study have the potential to impact the future of radiography education and assist in narrowing the theory-practice gap. In 2019, the Joint Review Commission on Education in Radiologic Technology identified 584 accredited radiography programs in the United States (JRCERT, 2019c). This case study examined student perceptions of preparedness after the completion of a last semester registry preparation course which provides Radiography Program X with information for determining future decisions regarding student certification exam preparation. This study may also be beneficial to other radiography programs in the United States that use similar methods of preparation. Adequately preparing students to take the American Registry of Radiologic Technologists (ARRT) certification exam may also increase certification exam scores and promote the performance of best practices as described by the profession (ARRT, 2018c). The information gained from this case study could support the development of an exam preparation model or design. The objective of the model or design would be to increase ARRT exam scores and pass rates to promote radiography students and graduates to perform (practice) the concepts, skills, and best practice standards set forth by the ARRT (theory), and possibly narrow the theory-practice gap.

Chapter 2 of this study will discuss the investigation of the literature regarding the didactic and clinical success of radiography students and inform the reader of the study's conceptual and theoretical frameworks. Chapter 3 will examine the methodology for this research study with details of the site, population, collection, and analyzation methods. Chapter 4 will discuss the results of the data collected and analyzed and answers the research questions. Chapter 5 will finalize the study by interpreting the results depicted in Chapter 4. Chapter 5 will

also present a conclusion, and future recommendations regarding the Radiography Program X 's

last semester registry preparation course.

CHAPTER 2

LITERATURE REVIEW

The average American Registry of Radiologic Technologists (ARRT) certification exam

scores and first-time pass rates for Radiography Program X students have been below the state

and national average from 2013 to 2018. Scores are below the state average of 1.5 points and the

national average by 6 points, as well as reflecting a lower first-time pass rate by an average of

2% compared to the state and 3% nationally (ARRT, 2013, 2014, 2015, 2016, 2017, 2018b). The

purpose of this case study was to explore the program's student perceptions of exam

preparedness after the completion of their last semester registry preparation course. The purpose

of the certification examination "is to assess the knowledge and cognitive skill underlying the

intelligent performance of the tasks typically required of radiographers" (ARRT, 2018c, para.1).

The content categories of the exam are taught in the classroom then applied and reinforced in the

radiography student's clinical setting (ARRT, 2018c). The clinical component offers students the

opportunity to observe, practice, and demonstrate competency of exams and skills taught in the

classroom.

There is limited literature regarding the scores of the American Registry of Radiologic

Technologists certification exam (Babcock, 2016; Chamberlain, 2015; Schmuck & Cook, 2018;

Vealé et al., 2017). The lack of literature pertaining to decreased certification exam scores brings

about many questions. What is the cause of this score decline? Is it due to changes in exam

content or a programmatic curriculum? Are the students adequately prepared to take the exam? Is

it caused by differences in didactic and clinical practice? Based on my experience and

observations within the radiography field, all these factors may affect exam scores; however,

students' perceptions of American Registry of Radiologic Technologists (ARRT) exam

preparation was the focus of this research study. This literature review includes a conceptual

framework which comprises personal interest, topical research, and theoretical research to provide direction and background for this case study. This literature review will focus on key deterrents of student's clinical and didactic success along with predictors of student success that may relate to the ARRT certification exam and provide insight into the theory-practice gap.

Conceptual Framework

Several components contribute to a conceptual framework. Ravitch and Riggan (2016) discuss the elements of a conceptual framework; personal interests, topical research, and theoretical frameworks or the literature review. These elements give researchers steppingstones to the direction and creation of one's research study. Conceptual frameworks provide readers with the information necessary to have a deeper understanding and background of the approach taken by the researcher and the study.

Personal Interest

When a student enters a radiography program, they are admitted with the expectation to graduate as a successful health professional, which includes passing the American Registry of Radiologic Technologists (ARRT) national certification exam. As the researcher of this study and a faculty member of a radiography program, I feel partially responsible for the success of graduates as it relates to the education provided. Providing adequate exam preparation is an essential part of increasing student success (Chamberlain, 2015; Schmuck & Cook, 2018; West, 2016). Examining student perceptions of preparedness after the completion of the last semester registry preparation course can inform Radiography Program X in future decisions regarding best methods in preparing for student success and assist in narrowing the theory-practice gap.

As the researcher and a didactic faculty member, I continuously strive to adequately prepare radiography students for successful completion of the certification exam; identifying solutions within the classroom may impact the ARRT exam scores and future technologists. This

case study intended to determine if there was a correlation between students' perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) certification examination and assessment scores within the last semester registry preparation course. The radiography students in this case study were from a small health professions college located in the Northeast of the United States that graduated from 2013 to 2018, making the sample approximately 115 students.

Topical Research

In the literature search pertaining to the success and perceptions of radiography students, I used a variety of databases which identified ProQuest and ScienceDirect to be seen frequently. I found that literature specifically focusing on radiography education and certification examinations was limited (Babcock, 2016; Chamberlain, 2015; Schmuck & Cook, 2018; Vealé et al., 2017; West, 2016). I expanded the search of literature to include other health professions including medicine, dental hygiene, and nursing in order to increase the depth and breadth of support of this study. The inclusion of other health professions within this study provided insight and support due to the similarities among the professions; including the presence of the theory-practice gap (Falk et al., 2016; Hanberg & Brown, 2006; Mortell, 2019; Scully, 2011; Wilkinson et al., 2015; Wright & Homer, 2017). The majority of health professions' education literature pertains to the field of nursing (Falk et al., 2016; Hanberg & Brown, 2006; Mangold, 2007; Scully, 2011).

Prior research studies examined success on the American Registry of Radiologic Technologists (ARRT) certification exam scores (Vealé et al., 2017; Schmuck & Cook, 2018), however, the Health Education Systems, Inc. (HESI) Radiography preparation tool as it relates to both ARRT exam scores and pass rates was not investigated, nor students' perceptions. Vealé et al.'s (2017) quantitative study investigated two radiography student cohorts comparing HESI

Exit Exam and ARRT exam assessment scores discovering that cohort one had a strong correlation and cohort two had a weak correlation. Schmuck and Cook's (2018) quantitative research study was conducted to determine a cutoff score of a mock exam score that would predict passing the ARRT exam; the mock exam used was from the *Lange Q&A: Radiography Examination*. The results showed that "there is no evidence that the mock certification cutoff scores affect whether or not a student passes the ARRT examination" (p. 22). These two studies (Vealé et al., 2017; Schmuck & Cook, 2018) provided me, the researcher with validation to conduct this study due to the differences in variables used; this case study examined student perceptions of preparedness and how it may related to the last semester registry preparation course assessments and ARRT scores and pass rates.

Theoretical Research

Researchers have discovered that there may be differences between didactic and clinical education (Allen, 2014; Botwe et al., 2017; Falk et al., 2016; Hanberg & Brown, 2006; Mgbekem et al., 2016; Scully, 2011; Wilkinson et al., 2015; Wright & Homer, 2017). What radiography students learn in the classroom may be different from how radiologic technologists and students perform in the clinical environment. This difference is called theory-practice gap. The theory-practice gap and American Registry of Radiologic Technologists (ARRT) certification exam preparation and scores may be related. Botwe et al. (2017) noted that,

> Theory–practice gap is the discrepancy between what is taught (theory) in the classroom
> and what is actually practiced clinically. It is considered detrimental to radiography
> education and effective practice and has profound implications for the future of the
> profession. (p. 147)

This gap between theory and practice may have a significant impact on the perception of how prepared radiography students when taking the ARRT exam and on the scores received. If

students are not performing procedures based on best practices, they are not emphasizing the concepts presented on the exam which may be contributing to this gap.

Using the theory-practice gap as a theoretical lens for this study provided background to the necessity of this study and possible contributing factors in the decrease of the national certification exam scores of radiography students. Allen (2014) performed a study observing and interviewing radiologic technologists that resulted in the evidence of a theory-practice gap. Within Allen's (2014) study, there is mention of the potential effect a theory-practice gap may have on the education of radiography students. Botwe, Arthur, Tenkorgan, and Anim-Sampong (2017) conducted a similar study specific to the performance of chest x-rays. The results of this study also indicated a theory-practice gap and stated, "Lack of congruence between theory and practice presents serious problems to students" (Botwe et al., 2017, p. 146). Knowing that the theory-practice gap exists between the clinical and classroom settings, this study focused on the students' perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) exam with the focus on the classroom or theory aspect.

Radiography students learn concepts in the classroom and practically apply them in the clinical setting on patients. Part of the requirements to take the American Registry of Radiologic Technologists (ARRT) certification examination is the completion of specific x-ray exam competencies (ARRT, 2018c). The radiologic technologists within the clinical sites assess students while performing x-ray examinations to determine if they are competent. The validity of the methods of assessment may also play a role within the theory-practice gap (Wright & Homer, 2017; Wyatt, 2015); meaning, the assessments are subjective based on what the technologist believes is considered competent. The Radiography Program X faculty and administration has the expectation that technologists are assessing students based on best practices that are defined in the classroom and the ARRT certification exam. Students' perceptions of following best

practices based on ARRT exam content may be impacted if the technologists within the clinical setting are not assessing them based on those standards, in turn, potentially providing a misleading perception of exam preparedness.

Literature and prior studies not only indicate the potential causes and the presence of the theory-practice gap; solutions are also identified (Drotar, 2016; Falk et al., 2016; Hanberg & Brown, 2016; Mgbekem et al., 2016; Scully, 2011; Wilkinson et al., 2015). Hanberg and Brown (2006) discussed incorporating evidence-based practice as a potential method to close the theory-practice gap. Another solution to narrow the gap was using teaching methods that included critical thinking and problem solving (Drotar, 2016; Scully, 2011; Wilkinson et al., 2015). Increasing methods of critical thinking and problem solving for health profession students offers them opportunities to apply concepts in a variety of settings; this may include exam preparation tools used within the classroom.

Incorporating reflective practice within radiography education may be an additional solution to narrowing the theory-practice gap (Falk et al., 2016; Mgbekem et al., 2016). Reflective practice can be applied in both the clinical and didactic setting (Falk et al., 2016; Baird, 2008; Mgbekem et al., 2016; Roth, Mavin, & Dekker, 2014; Scully, 2011); students indicate what they have done, learned, and then reflect on how to do things differently next time or identify gaps in knowledge. These studies (Falk et al., 2016; Mgbekem et al., 2016) provide awareness into methods being used in the classroom specific to the comprehensive preparation with a sample group to increase the appropriate use of the preparation tool.

Knowing that the theory-practice gap exists, understanding potential causes and solutions gives background to the decisions made in this case study that examined students' perceptions of a preparation course and tools used within the classroom. Building confidence within the realm of theory/classroom has the potential to increase student's preparedness of passing the ARRT

certification exam. Passing the ARRT exam and doing well may also improve the practical application of theory, elevating the quality of new technologists working with radiography students in the future.

Literature Review

In order to understand the complexity of the theory-practice gap, the presented literature focuses on both the clinical and didactic setting. This literature review includes studies examining the perceptions of radiography students (Chamberlain, 2015; Gqweta, 2012; West, 2016), along with studies that present assessment scores throughout a radiography student's program (Chamberlain, 2015; Davis, Groom, & Friesner, 2018; Finnel, 2018; Ferenchak, 2009; Gqweta, 2012; Kridiotis, Bezuidenhout, & Raubenheimer, 2016; Levy, 2018; Michael, 2018; Siemens, 2011; Vealé, Clark, Killion, & Sharma, 2017). In addition, factors that contribute to a radiography student being successful and or unsuccessful in the clinical and didactic environment are included. This literature review provides the reader with background into the necessity of this study and information that may assist in the interpretation of this study's results and recommendations.

Clinical Setting

There are many dimensions to a clinical setting for radiography students, especially when it comes to ensuring the success of students. Radiography clinical education is different from many other health professions education. Radiography clinical requirements are based on accreditation standards set forth by the Joint Review Commission on Education in Radiologic Technology (JRCERT) the program must maintain a one-to-one student to technologist ratio (JRCERT, 2018). Awareness of the relationship between radiography students and radiologic technologists can provide a greater understanding of how the relationship may play a role in the theory-practice gap and student perceptions of American Registry of Radiologic Technologists

(ARRT) exam preparation. A significant factor found in the literature specific to the clinical setting was the professionalism of the radiologic technologists working with the students, which helps describe how the healthcare environment affects student success (Challen et al., 2017; Conway et al., 2008; Nortje & Hoffman, 2018; Sim & Radloff, 2009).

Professionalism of practitioners. Radiologic technologists are not immune to the stress and burnout faced by nurses and other healthcare professionals (Dunlop, 2015; Reingold, 2015). Many factors play a role in the overall satisfaction of employees (Dunlop, 2015; Reingold, 2015). Changes in the medical imaging environment and the potential dissatisfaction of healthcare employees may play a role in students having difficulty learning and gaining competency in the field (Dunlap, 2015; Reingold, 2015; Seeram, et al., 2015). When evaluating the clinical setting for radiography students, understanding the healthcare environment is a must. Before radiography students enter a radiology department, they have created certain expectations and ideas of what the clinical experience will entail (Brown et al., 2011; Fowler & Wilford, 2016; Hyde, 2015; Mason, 2006). However, studies demonstrated that there is a difference in students' perceptions of what a clinical should be compared to what it is (Brown et al., 2011; Fowler & Wilford, 2016; Hyde, 2015; Mason, 2006; Thompson, Smythe, & Jones, 2016). Studies (Brown et al., 2011; Fowler & Wilford, 2016; Hyde, 2015; Mason, 2006; Thompson, et al., 2016) identified key reasons that may contribute to the difference in students' perceptions of clinical and the reality; personality differences, ineffective communication, and too much or too little supervision.

In addition to students' perceptions and expectations of the clinical setting, the overall healthcare environment has changed. Common themes identified in studies and research are staff cutbacks, financial restraints, advancement in technology, and staff taking on multiple roles (Reingold, 2015; Seeram et al., 2015; Sim & Radloff, 2009; Yielder et al., 2009). This type of

working environment causes stress, burnout, ineffective communication skills, and low self-esteem (Dunlap, 2015; Reingold, 2015; Seeram et al., 2015; Yielder, 2009), which may affect staff interactions with radiography students.

A study presented by Reingold (2015), a radiologic technologist, examined the stressors and stress reduction of radiologic technologists using qualitative analysis of open-ended survey questions. The analysis used the Perceived Stress Scale and American Institute of Stress Workplace Stress Survey. The participants were 42 radiologic technologists with a variety of demographic backgrounds from six hospitals within a healthcare system located in four states. The results described stressors to be money, limited time to complete work, feeling rushed, frustration working with students, feeling underappreciated, and experiencing a negative work environment. Reingold's (2015) study was specifically designed to evaluate the intervention of a stress reduction program; however, the pre-intervention results hold relevance to the work environment and background of radiologic technologists. Working in this type of environment may change the perceptions of professionalism for radiologic technologists, which directly affects the clinical environment for students (Brown et al., 2011; Challen et al., 2017; Conway et al., 2008; Cox et al., 2013; Dunlap, 2015; Seeram et al., 2015; Sim & Radloff, 2009).

Professionalism is defined as "the conduct, aims, or qualities that characterize or mark a profession or a professional person" (Professionalism, 2018, para. 1). To drill down deeper for what professionalism entails for a radiologic technologist, it is common to look towards the American Registry of Radiologic Technologists (ARRT) for guidance. The ARRT certifies individuals by an examination and after maintains registration for radiologic technologists. The ARRT developed the Standards of Ethics, which includes the Code of Ethics and the Rules of Ethics (ARRT, 2018a). The Code of Ethics defines the behaviors of those certified to aspire to hold, and the Rules of Ethics are the minimum standards that must be followed as a registered

radiologic technologist. These rules are enforceable, and violations may be reported at the federal and state levels and perhaps result in the potential loss of certification (ARRT, 2018a).

Key components of the Rules of Ethics (ARRT, 2018a) are specific to what radiologic technologists should not do in practice. These are defined as: fraud or deceptive practices, subversion of any ARRT examination or continuing qualifications requirement information, unprofessional conduct, breach in scope of practice, question of fitness to practice, improper management of patient records, violation of state and federal law and duty to report (ARRT, 2018a). The aspirations included in the Code of Ethics are: respond to the needs of patients and co-workers, perform all duties without bias, have respect and dignity for mankind, use equipment based on knowledge and founded concepts, act in the best interest of the patient, provide detailed clinical history for the radiologist, maintain radiation safety principles, make ethical decisions, provide quality care, protect patient privacy, continue professional development, and do not use illegal drugs that impair responsibilities as a radiologic technologist (ARRT, 2018a). Technologists should always consider these standards and model these behaviors for radiography students.

Mortell (2018) added the component of ethics to the concept of the theory practice gap; theory – practice – ethics gap. The unprofessional behavior of technologists not following best practices may be considered a violation of the Standards of Ethics defined by the American Registry of Radiologic Technologists (ARRT, 2018a). Mortell's (2018) case study contributed to a deeper understanding of the theory practice gap by evaluating unethical practices of healthcare providers not following standards of practice. Mortell (2018) states "This paradigm [theory – practice – ethics gap], acknowledges that all healthcare professionals are provided with theoretical knowledge and practical skills to practice competently and safely, yet continue to be ethically non-compliant for correct procedure" (p. 41). The unethical and unprofessional

behavior of technologists may play a role in the increase of the theory practice gap and the decrease in ARRT certification exam scores due to the lack of following standards of practice.

Studies (Challen et al., 2017; Nortje & Hoffman, 2018) have examined the perceptions of professionalism within healthcare settings. Nortje and Hoffman (2018) used the Interpretative Phenomenological Analysis (IPA) to evaluate 31 radiography students. The results are broken down into three sections: understanding of professionalism, attributes of a professional, and factors in developing professionalism. Students' perceptions of professionalism stated by Nortje and Hoffman (2018) suggests it:

> is seen as the ability to gain particular qualification and/or certification to do specific tasks within the said profession, to abide by the rules of the profession, as well as to meet the profession-specific expectations of peers and the public at large. (p. 112)

When students were asked to rank attributes: respect, ethical behavior, altruism, accountability, and interpersonal skills were listed as the top five. Students indicated that the factors influencing the development of professionalism were the understanding of academic content, positive patient interactions, prior experience, good role model behavior, and of following expectations of society (Nortje & Hoffman, 2018).

Challen, Laanelaid, and Kukkes (2017) evaluated the perceptions of professionalism using focus groups of 1st and 3rd year radiography students. Challen, Laanelaid, and Kukkes's qualitative study used semi-structured interviews, asking open-ended questions. The interviews were transcribed and analyzed for themes. Significant themes of professionalism were noted to be good technical skills, ethical conduct, effective communication, teamwork, and problem-solving. The results and themes are similar to the Nortje and Hoffman (2018) study, showing the importance of technologists' knowledge of the field and how they communicate. The students described unprofessional aspects as excuses for repeating an image or poor image quality, and

not adhering to radiation safety principles. In their development of professionalism, students believe in the importance of theoretical knowledge, understanding the complexity of the radiographer's role, and being a role model (Challen et al., 2017).

As noted previously, students' perceptions and expectations of professionalism within the clinical setting (Brown et al., 2011; Fowler & Wilford, 2016; Hyde, 2015; Mason, 2006; Thompson, Smythe, & Jones, 2016) are in line with the standards set forth by the American Registry of Radiologic Technologists (ARRT, 2018a). The clinical environment for radiography students is usually the largest component of a radiography program. Students are first introduced to standards and best practices within the classroom setting. Radiography program faculty use textbooks as resources in introductory courses to give students a look into the clinical setting, which introduces them to the practice standards and professionalism of radiologic technologists (Adler & Carlton, 2016). Dr. Cheryl Whitting (2010), a principal lecturer in diagnostic radiography and clinical practice, stated in an article discussing professionalism that "several studies show how clinically-based learning experiences often bring about a decline in students' professional standards" (p. 18). Understanding the professional standards set by the ARRT and appreciating the perceptions of radiography students, can have a significant impact on the healthcare environment within the medical imaging department. Reminding technologists of the ARRT standards may inspire them to uphold and model professional behaviors for the students they work alongside, and positively affect the radiologic technologists of the future (ARRT, 2018a). This has the potential to increase students' perceptions of preparedness to take the ARRT exam and scores due to the performance of best practices and concepts that are taught in the classroom and found on the exam.

Didactic Setting

The didactic component of a radiography program provides students with the foundation for use within the clinical environment. Studies (Davis et al., 2018; Finnel, 2018; Siemens, 2011; Vealé, Clark, Killion, & Sharma, 2017) pertaining to the success of radiography students within the didactic aspect of their radiography program have different areas of emphasis. These studies (Davis et al., 2018; Finnel, 2018; Siemens, 2011; and Vealé, Clark, Killion, & Sharma, 2017) focus on areas that include pre-admissions requirements, course assessments, exam certification preparation, exit examination scores, and passing the certification examination. This case study examined students' perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) certification exam and several assessment scores after the completion of a last semester registry preparation course.

Didactic assessments. When students are admitted into an educational program, it is important that these individuals are qualified. Ensuring students are qualified increases the success and retention of the students. Based on accreditation standards determined by the Joint Review on Education in Radiology Technology (JRCERT), program assessments and outcomes need to be determined, measured, and maintained (JRCERT, 2018). Many of the assessments included within this case study are already tracked at the program and college level. These assessments are beneficial to determining a student's comprehensive knowledge but are also a necessity for accreditation.

Prior studies have evaluated different aspects of admissions requirements and the correlation to other facets of the program (Davis et al., 2018; Finnel, 2018; Siemens, 2011; Vealé et al., 2017). Davis, Groom, and Friesner (2018) conducted a study that focused on predictors of success within five health professions programs. The results indicated that the more college-prepared is a student, the greater their chance of being accepted into their declared program.

Davis, Groom, and Friesner (2018) also discussed the importance of passing the certification exam in the student's chosen field; they stated "passing the exam not only requires that students adequately learn the majority of the content in the profession program, but also have the test-taking skill necessary to pass a high-stakes, standardized exam" (Davis et al, 2018, p. 23). Evaluating student's prior scores on standardized tests suggests preparedness for the certification exam, which may affect student's perceptions of preparedness.

Vealé, Clark, Killion, and Sharma (2017) conducted a study that provided evaluation of multiple factors of the progression from admissions to the certification exam of radiography students. The factors evaluated were the Health Education Systems, Inc. (HESI) admissions assessment exam and two different exit exams. One of the exit exams completed by students was the HESI Radiography Exit Exam, and the other was the program's exit exam. The study's sample incorporated two cohorts of radiography students, which determined "students who passed the HESI radiography exit examination and the RADS program's exit examination also passed the ARRT certification examination" (Vealé et al., 2017, p. 94). When evaluating the HESI Radiography Exit Exam independent from the program's exit exam and the American Registry of Radiologic Technologist (ARRT) exam, only one of the two cohorts of students showed a strong correlation. Limitations were discussed within the study; all of the exams were voluntary and did not affect the student's admission or completion of the program. Vealé et al (2017) also noted that one cohort of students took both exit exams on the same day, potentially causing testing fatigue.

The focus of this case study pertained to the student perception of preparedness and assessment performance within of the last semester registry preparation course of students at Radiography Program X. In addition to the Radiography Exit Exam scores, this study examined perceptions of preparedness as related to the ARRT exam scores and 1st time pass rates. The

examination of student perceptions and the relationship with assessment scores provided triangulation and validity to the study and results (Creswell, 2015).

Certification exam preparation tool. The certification preparation tool used with the radiography program at the Radiography Program X was provided by the Elsevier publishing company called Health Education Systems, Inc. (HESI) Radiography preparation tool, and includes the HESI Radiography Exit Exam. The HESI Radiography tool provided students and faculty with a variety of testing and remediation options. The HESI Radiography Exit Exam results include a description of recommended performance levels that predict success of the American Registry of Radiologic Technologists (ARRT) certification exam (Elsevier, 2018). The recommended score is 750 and higher, the acceptable score between 700 and 750, whereas below 700 indicates students need to continue remediation before taking the ARRT exam (Elsevier, 2018). The HESI tool is maintained through Evolve, an online division of Elsevier (Elsevier, 2019). HESI has been used within nursing education to prepare graduates to take the NCLEX-RN exam for many years with success (Nibert & Morrison, 2013). Elsevier provides two customer success stories of radiography programs that have been using the HESI Radiography Exit Exam preparation tool. These narratives give me, the researcher insight into other programs' use of this ARRT exam preparation tool.

Evolve shares customer success stories regarding radiography programs using the HESI Radiography Exit Exam preparation tool. In one success story, Lisa Aberle, assistant professor of radiography and program director at Heartland Community College in Illinois, discussed her program's drop in ARRT 1st time pass rate from 100 to 89% (Evolve, n.d.b). At that time, in 2009, the HESI Radiography Exit Exam was implemented, and the exam was given at the beginning of the radiography students' final semester. This gave the students and faculty the

opportunity to address areas of concern. In 2012, it was reported that the 1ˢᵗ time pass rate, after using the HESI tool, returned to 100% (Evolve, n.d.b).

Another customer success story presented by Evolve described West Kentucky Community and Technical College and their participation in a pilot study to determine the effectiveness of using the HESI Radiography Exit Exam and its correlation to the American Registry of Radiologic Technologists certification exam (Evolve, n.d.c). Faculty worked individually with students in areas of weakness as determined by the HESI Radiography Exit Exam results. The students' ARRT exam scores were tracked and compared to the HESI Radiography Exit Exam. The article stated, "Faculty in the Radiography Program at West Kentucky Community & Technical College believe that HESI testing helped prepare students for the exam" (Evolve, n.d.c, para. 4). When comparing the HESI Exit Exam and the ARRT exam results, there a positive correlation between the two exam scores (Evolve, n.d.c).

Heartland Community College (Evolve, n.d.b) and West Kentucky Community & Technical College (Evolve, n.d.c) reported success with the use of the HESI Radiography Exit Exam preparation tool. These reports provide insight into two radiography programs' use of HESI as an American Registry of Radiologic Technologist preparation tool as part of the last semester registry preparation course. The documented experiences from Heartland Community College and West Kentucky Community & Technical College provide me, the researcher with background information on the preparation tool's use and success that is used within the conclusion and recommendations of this study (Evolve, n.d.b; Evolve, n.d.c).

Radiography student perspectives. The key focus of this study was the student perception of preparedness to take the American Registry of Radiologic Technologists (ARRT) national certification exam. I, the researcher, found literature regarding a variety of student perceptions relating to radiography didactic preparation (Chamberlain, 2015; Gqweta, 2012;

West, 2016). These studies (Chamberlain, 2015; Gqweta, 2012; West, 2016) did not specifically examine radiography student perceptions of ARRT exam preparedness. However, the information gathered from these prior studies contributes to this study by validating the necessity for the research and that it could add to future recommendations.

Chamberlain (2015) conducted a study that asked radiography students questions pertaining to study skills helpful in passing the American Registry of Radiologic Technologists (ARRT) exam and what experiences did they feel were most beneficial. Nine radiography students from one graduating class that passed the ARRT exam were interviewed. The major theme identified was self-motivation and self-monitoring (Chamberlain, 2015). Chamberlain's (2015) study provided insight into the perspective of radiography students that passed the certification exam, moreover, this study investigated the perceptions of students that passed the ARRT and those who did not.

Gqweta's (2012) study explored responses from 21 radiography students using interview questions to gain insight into poor academic performance and strategies for improvement. The radiography students in Gqweta's (2012) study were in their final year of the program. The results indicated that their poor academic performance was due to difficulty with understanding content, inadequate preparation, absence of independent study, confusion with assessment questions, and ineffective studying techniques (Gqweta, 2012). Gqweta's (2012) study relative to poor academic performance, though, does not provide information regarding the preparedness relating to the American Registry of Radiologic Technologists (ARRT) exam.

West (2016) focused on the student perspective relating to the American Registry of Radiologic Technologists (ARRT) exam preparation methods and tools; specifically, blended learning. Nine radiography students were given a 19-item questionnaire to gain their perspective pertaining to different learning techniques, methods, and tools used within a last semester review

course. The results suggested that students believed that the digital component enhanced learning and knowledge, students equally found lectures with engagement and lectures with electronic resources beneficial, and that blended learning methods were helpful in the review course (West, 2016). West's (2016) study presents similarities to Radiography Program X's last semester registry preparation course due to using a blended learning method. West (2016) only focused on students' perspectives before taking the ARRT exam, whereas this research study examined student perceptions before and after the ARRT exam and investigated the relationship of their perceptions to their cohort's ARRT scores and pass rates.

Differences in Student Learning

Another factor that may contribute to students' perceptions of preparedness and the decline in exam scores is the differences in student learning (Cox, Clutter, Sergakis, & Harris, 2013; Dungey & Yielder, 2017; Ward & Makela, 2010). The majority of students pursuing higher education have grown up with technology. The differences that accompany what many call a generation gap may have a significant influence on the communication and interactions between students, faculty, and technologists (Bahadure, Thsar, & Vagha, 2016; Hills & Levett-Jones, 2017; Lourenco & Cronan, 2017; Mangold, 2007; Skiba & Barton, 2006; Williams, Medina, & Clifton, 2017). Along with the generation gap, differences in learning styles may play a role in student success and satisfaction in the clinical environment, as well as in the classroom (Cox, et al., 2013: Dungey & Yielder, 2017; Ward & Makela, 2010).

Generation gap. When outlining the differences between students, it is essential to look at the generation gap. Individuals entering college that are within the Millennial Generation were born between the years 1982-2000 (Williams et al., 2017). Other names for this age group are Generation Y, Internet Generation, Generation Next, and Nexters (Williams et al., 2017).

Hills and Levett-Jones (2017) conducted a 3-step research study to determine learning strategies of health professions students that were considered part of Generation Y, those born between 1982 and 2002. The results of interest in Hills and Levett-Jones's study were the comparison of the Y Generation with Generation X, which is defined as those born between 1961-1981; "Generation Y placed a higher level of importance on group assignments with peers" (Hills & Levett-Jones, 2017, p. 9). Hills and Levett-Jones (2017) also determined that Generation Y showed interest in "authentic learning experiences based on real clinical events that are relevant to practice" (Hills & Levett-Jones, 2017, p. 11). The differences in learning preferences between generations may have a direct impact on radiography student's intake and practical application of information within clinical placements and in the classroom.

Lourenco and Cronan (2017) discussed the attributes of Millennial Generation individuals working in the field of radiology. The Millennial generation has shown that they value working in teams, mentoring, desire real-time feedback, and are looking for non-traditional job opportunities. The article described the importance of understanding generational differences and how it might affect the interactions and relationships with others. Developing an understanding of generational differences can provide health professions educational program leaders insight into areas to focus on, such as communication. The Millennial generation uses email and text messages to communicate, which is not the way one is expected to interact with patients (Lourenco & Cronan, 2017).

Mangold (2007) explored the relationship between the Baby Boomer, born between 1946 and 1964 and the Millennial generation, born from 1981 to 1999 (p. 21). For Millennials, the actual doing is higher in priority than knowing, trial and error and persistence is the norm; this may be due to playing video games with multiple lives and opportunities to complete the task (Mangold, 2017). Technology is an expectation in the learning environment, and Millennials, as

a generation, want activities that are interactive and fun. There is an appreciation of faculty and mentors who are approachable, supportive, understanding, good at communicating, professional, and motivating (Mangold, 2007). The practice of trial and error for Millennials may be difficult within the clinical setting due to performing procedures on patients. This type of learning may be utterly different from how the technologists learned themselves. Such difference has the potential to decrease effective communication between students and technologists (Lourenco & Cronan, 2017; Mangold, 2007).

Learning styles. Differences in learning styles of students are essential to understand in both the classroom and clinical setting and are an important tool for technologists when working with students in the clinical environment and with faculty in the classroom (Cox, et al., 2013; Ward & Makela, 2010). Identifying different methods of learning can help radiography students gain greater competence in the field. Understanding different learning styles contributed to this case study by providing future recommendations of different methods of teaching styles and tools to be within the last semester preparation course.

Ward and Makela's (2010) descriptive research study used the Learning Styles of the Clinical Practice Questionnaire (LSCPQ) to evaluate 349 radiography students from 38 programs. The cluster analysis method was applied, which identified the two most common learning styles to be purposeful (38.4%) and tentative (32.7%). The purposeful style was the highest among participants, and this style may be defined as one who asks questions before, during, and after, and uses theory and principals for decision making. The second highest style was tentative; this style veers towards planning rather than improvising, whereas the student relies on the technologists rather than themselves (Ward & Makela, 2010). Identifying student learning styles also allows faculty in the classroom and technologists in clinical environments to

adapt interactions based on how students learn best (Ward & Makela, 2010) and may even increase preparation for the certification exam.

Dungey and Yielder (2017) investigated the learning styles of 73 radiation therapy and imaging students over the course of three years. This evaluation was done using a validated tool derived from the Myers Briggs Personality Type Indicator (MBTI). The results showed that the two highest types or preferences were sensing (s) and judging (j). Sensing is the use of one's five senses to gain awareness, and judging prefers decision making and structure. When looking at the SJ combination, this preference is "characterized by responsibility, stability, security. . . by being concrete co-operators, speaking of duties and responsibilities, what to take good care of, and being careful to follow the rules and respect the rights of others" (Dungey & Yielder, 2017, p. 110). Knowing learning styles of radiography students is beneficial for the students themselves and those instructing them. This awareness allows for the flexibility of instruction methods to accommodate individual learning styles.

A third study evaluating learning styles of health professions students used Kolb's Learning Style Inventory, which included 56 students from four health professions programs. This study intended to compare learning style differences between classroom and clinical settings (Cox et al., 2013). The style that was the most prominent was the accommodator. The accommodator "excels in concrete experiences and active experimentation" (Cox et al., 2013, p. 224). The second most frequent style was identified as the diverger, which is "best with concrete experiences and reflective observation" (p. 224). Experience, experimentation, and reflection are common practices within the classroom and radiology clinical environments; however, acknowledgment of the differences among students can assist in the overall success of a student's education.

All of these studies (Cox et al., 2013, Dungey & Yielder, 2017, & Ward & Makela, 2010) indicated there are many ways students approach learning. When technologists and students have different approaches to learning, there could potentially be misperceptions of each other's actions and interactions. Insight into learning styles can better equip technologists working with a variety of students (Cox, et al., 2013; Ward & Makela, 2010). This background offers didactic faculty insight for instruction within the classroom.

Conclusion

Limited literature is available regarding the perceptions of radiography students' and American Registry of Radiologic Technologists (ARRT) certification exam scores. However, there are many aspects that affect the satisfaction of health professions students that may hinder the application of best practices in the clinical environment (Bowte et al., 2017; Falk et al., 2016; Hanberg & Brown, 2006; Roth et al., 2014; Thompson et al., 2016). The professionalism of technologists and the clinical environment are two key components of what contributes to the success of radiography students (Challen et al., 2017; Conway et al., 2008; Nortje & Hoffman, 2018; Sim & Radloff, 2009). Health professions students, including those studying radiography, have specific expectations of the clinical setting and the practitioners that work in it (Brown et al., 2011; Fowler et al., 2016; Hyde, 2015; Mason, 2006; Thompson et al., 2016). Several studies surveyed students to identify what the desired characteristics of technologists and found that being professional, respectful, effective communicator and competent in practice were most common (Conway et al., 2008; Ingrassia, 2011; Nortje, 2018; Perram et al., 2016).

When looking for reasons as to why technologists may be uncomfortable teaching students, the advancement of technology is identified as a challenge for some technologists to use and explain the equipment to students (Seeram et al., 2015). Students' expectations of technologists included being knowledgeable of procedures and equipment (Brown et al., 2011;

Hyde, 2015; Mason, 2006). Students learn best practices and standards in the classroom and should apply this knowledge alongside technologists working in the field. Radiologic technologists should feel the benefit of students maintaining currency with the newest standards and practices. Students want to learn from competent, high-quality radiologic technologists (Brown et al., 2011; Hyde, 2015; Mason, 2006); thus, increasing practice and retention of the concepts and preparation for the ARRT certification exam.

Another factor used to evaluate the theory-practice gap within the clinical and didactic settings was the understanding of learning styles, personalities, and other differences of students. This awareness sheds light on improving interactions and methods of instruction (Dungey & Yielder, 2017; Ward & Makela, 2010). Literature indicated that a generation gap may produce poor communication or conflicting expectations (Hills & Levett-Jones, 2017; Lourenco & Cronan, 2017; Skiba & Barton, 2006). Decreased communication between students and technologists may affect student's confidence in the clinical setting and performance of best practices (Challen et al., 2017; Nortje & Hoffman, 2018); in turn, affecting students' perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) certification exam.

This case study focused on the didactic aspect of the theory-practice gap; the student perception of preparedness, exam preparation assessments and American Registry of Radiologic Technologist (ARRT) certification exam scores and pass rates. Examination of student perceptions and their performance on assessments in the last semester registry preparation course can provide insight regarding the scores on the certification exam. The literature presented demonstrates a variety of information relevant to assessments of radiography students (Davis et al., 2018; Ferenchak, 2009; Finnel, 2018; Gqweta, 2012; Hicks, 2016; Ingrassia, 2011; Kridiotis

et al., 2016; Levy, 2018; Michael, 2018; Siemens, 2011), which provides support for this case study.

Literature reviewed did not address the concern of decreased scores of radiography students taking the American Registry of Radiologic Technologists (ARRT) certification exam. This case study focused on understanding student perceptions of preparation which may be vital to future preparation course recommendations. Increasing radiography student's preparedness and desire to not only pass the certification exam but to strive for excellence in comprehension and practical application of the requirements will help them to become high-quality radiologic technologists (ARRT, 2017). This increased quality and professionalism of newly certified technologists has the potential to affect the interactions with future radiography students.

CHAPTER 3

METHODOLOGY

A vital part of the associate's degree in radiography is to ensure adequate student preparation for the American Registry of Radiologic Technologists (ARRT) certification examination. "The purpose of The American Registry of Radiologic Technologists (ARRT) Radiography Examination is to assess the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required of radiographers" (ARRT, 2018c, p. 1). The student pass rate is a program assessment that must be tracked for programs accredited by the Joint Review Committee on Education in Radiologic Technology (JRCERT, 2018). The mission of the JRCERT is to promote "excellence in education and elevates the quality and safety of patient care through the accreditation of educational programs in radiography, radiation therapy, magnetic resonance, and medical dosimetry" (JRCERT, 2019a, para. 1). Radiography programs that are accredited by the JRCERT follow strict standards. If the standards are not followed, radiography programs may be at risk of losing accreditation and state and federal funding.

Along with pass rates, radiography programs may also track the average American Registry of Radiologic Technologists (ARRT) exam scores and compare to state and national averages. From 2013 to 2018, the exam average of Radiography Program X was below the state by an average of 1.5 points and 6 points nationally, along with lower first-time pass rates by an average of 2% compared to the state and 3% nationally (ARRT, 2013, 2014, 2015, 2016, 2017, 2018a). A factor to consider when evaluating ARRT exam scores after 2012 is the increase in the exam cut scores (ARRT, 2012b). To ensure professional performance standards are known and practiced, the increase in the exam cut score was implemented by the ARRT as the new passing standard (ARRT, 2012b).

Radiography students not only have to pass their certification exam, but they also need to have a substantive understanding of American Registry of Radiologic Technologists (ARRT) exam content to maintain competency in the field. The mission of radiography programs often includes graduating high-quality radiologic technologists. It is part of a program's obligation to adequately prepare students to not only pass but to excel on the ARRT exam which also prepares them for continuing high-quality standards throughout their career (JRCERT, 2019a).

The focus of this case study was to explore Radiography Program X's students' perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) certification exam after completing the last semester registry preparation course. The exam preparation tool used within the last semester course at Radiography Program X is from Health Education Systems, Inc. (HESI), which was originally designed for nursing students who take the NCLEX-RN exam. However, HESI expanded to provide resources to other health professions, including radiography (Nibert & Morrison, 2013). HESI products are developed by Elsevier publishing company and are maintained by a division called Evolve which provides ". . . one-stop online destination for exploring all of Elsevier's educational products and resources for nursing and health professions programs" (Elsevier, 2019, para. 1), including HESI tools.

HESI offers many resources and testing options to assist in preparation for the American Registry of Radiologic Technologists (ARRT) certification exam. The testing results offer students resources, which HESI calls remediation, regarding specific ARRT exam content areas needing additional attention (Evolve, 2019). The results of the HESI Radiography Exit Exam include a description of scores that may be used as a predictor of success on the ARRT exam. Evolve (2019) promoted the tool as "a comprehensive suite of products that combines proven HESI preparation and testing products with trusted Elsevier remediation content from market-leading Elsevier Radiography textbooks" (para. 2). Radiography Program X started using the

HESI Radiography preparation tool with their 2016 graduates. Due to the importance of passing the certification exam and maintaining competence within the field of radiologic technology, it is necessary to examine students' perspective of such a crucial component of a radiography program.

Purpose of the Study

The purpose of this case study was to examine radiography students' perceptions of exam preparedness as it related to assessments within the last semester registry preparation course and American Registry of Radiologic Technologists (ARRT) certification exam scores and pass rates. The information gained from this study offers program administration insight into the future use of this exam preparation tool and student preparedness for professional practice. Additionally, the purpose of the study and chosen methodology, a case study, was to examine the Radiography Program X's last semester registry preparation course's inclusion of HESI as an efficient and adequate American Registry of Radiologic Technologists (ARRT) certification exam preparation tool. There is no intent for this study to generalize to a larger population. However, it may be used as a resource for other radiography programs when researching ARRT exam preparation tools and designing registry preparation courses.

Design and Research Questions

The methodology that best fits the problem and research questions was a case study design. Creswell (2013) defines a case study as a "qualitative approach in which the investigator explores a real-life, contemporary bounded system. . . through detailed, in-depth data collection involving multiple sources of information, and reports a case description and case themes" (p. 97). Creswell (2013) continues to state that "…the intent of the case study may be to understand a specific issue, problem, or concern and a case or cases selected to best understand the problem" (p. 98), which aligns with the direction of this research study. This case study

provided student perceptions and assessment data specific to the Radiography Program X's last semester registry preparation course related to the preparedness for taking the ARRT certification exam. The intention of this case study was to elicit information that can assist in future decisions regarding student exam preparation. In addition, this case study gathered information about the site's use of the HESI Radiography preparation tool as it pertains to the degree of success on the ARRT certification exam. The results of the study can aid in determining future improvements specific to radiography student's ARRT exam preparation.

Radiography programs strive to graduate high-quality graduates, and most programs include a review course of examination content that has been presented throughout the program. Registry review courses allow students to focus their studying when preparing for the national certification exam, in this case the ARRT. After completing a radiography program, students should be prepared to successfully complete the national certification exam to practice as a radiologic technologist. Adequately preparing students for the certification exam not only assists students for practice but also maintains or increases program reputation. The Radiography Program X implemented the use of HESI in 2016 with the intention of seeing increased exam scores and pass rates. New tools within a program should be evaluated to ensure desired outcomes; therefore, this case study may help with such an assessment. The known importance of exam preparation requires programs to do their due diligence in assessing such tools and courses.

The case study design approach for this research study included a combination of strategies and criteria suggested by Yin, Merriam, and Stakes (Yazan, 2015). The criteria used in this case study design included: "epistemological commitments [theory], defining case and case study, designing case study, gathering data, analyzing data, and validating data" (Yazan, 2015, p. 136). Patton (2015) states "qualitative case study methods and design strategies can be

particularly useful for evaluation of individualized participant outcomes and organizational-level impacts" (p. 185). In order to evaluate the student perceptions of preparedness to take the American Registry to Radiologic Technologists (ARRT) certification exam and to practice as a radiologic technologist, this study strived to answer the following:

RQ1: What are the students' perceptions of their ARRT certification exam preparedness after completing the last semester registry preparation course?

SQ1: How did the use of the HESI Radiography Exit Exam preparation tool affect students' perception(s)?

SQ2: What is the relationship between students' perceptions of preparedness and their HESI Radiography Exit Exam scores?

RQ2: What is the relationship between students' perceptions of exam preparedness and ARRT certification exam scores and pass rates?

SQ1: What is the difference between students' perceptions that used the HESI Radiography Exit Exam preparation tool and those who did not?

RQ3: What is the relationship between students' perceptions of preparedness before and after taking the ARRT exam?

SQ1: How did the use of the HESI Radiography Exit Exam preparation tool affect students' perception(s)?

Data collected and analyzed in this case study provided answers to these research questions. The interpretation of the results provided radiography program faculty and administration a well-rounded perspective regarding the Radiography Program X's last semester registry preparation course.

Site Information and Population

The site of this case study was a small health professions college located in the Northeast of the United States. The Radiography Program X is accredited through the New England Commission of Higher Education (NECHE), along with the radiologic technology program accreditation, the Joint Review Commission on Education in Radiologic Technology (JRCERT). The Radiography Program X accepts approximately 25 radiography students each fall who graduate during the spring semester almost two years later. This case study played a role in assessing student perceptions as it relates to Radiography Program X's last semester registry preparation course and the relationship to American Registry of Radiologic Technology certification exam scores and pass rates.

The population of this case study were graduated cohorts from the Radiography Program X with American Registry of Radiologic Technologists (ARRT) certification exam scores and pass rates lower than state and national averages. Six graduated cohorts between 2013 and 2018, with a total population of 115 radiography students, were included in this case study. The first three cohorts contained 59 students who did not use the American Registry of Radiologic Technologists (ARRT) exam HESI preparation tool. The second three cohorts encompass 56 students who used the HESI preparation tool. The two different cohorts were used to investigate student perceptions of preparedness to take the ARRT exam after completing the end of semester preparation course and the relationship between student perceptions and ARRT exam scores and pass rates.

Data Collection and Analysis Procedures

The data collected in this case study included quantitative retrospective assessment data, qualitative retrospective end of the semester course student surveys (Appendix A), and qualitative post-graduation follow-up surveys (Appendix B). The variety of qualitative and

qualitative data sets provides triangulation to increase validity of the results (Creswell, 2015). Creswell (2015) discusses that triangulation "ensures that the study will be accurate because the information draws from multiple sources of information, individuals, or processes" (p. 259). The retrospective assessment data included American Registry of Radiologic Technologists (ARRT) certification exam scores and pass rates and Health Education Systems, Inc. (HESI) Radiography Exit Exam scores. The ARRT exam data were used to determine if a relationship exists with students' perceptions of preparedness to take the exam. The HESI Radiography Exit Exam data offered this case study a quantitative approach to students' preparedness to take the ARRT exam to provide a variety of methods to validate the results and future recommendations. Student perceptions of preparedness were examined by using the end of the semester course student surveys and post-graduation follow-up surveys. The open-ended portion of the end of the semester course surveys provided information regarding student perceptions before taking the American Registry of Radiologic Technologists (ARRT) exam, whereas the post-graduation follow-up surveys were perceptions after taking the ARRT exam.

The data for this case study were collected after University of New England Institutional Review Board (UNE IRB) approval. IRB approval was not required at the site due to the institution not having their own institutional review board. Permission to conduct the study was granted in the form of a letter from the president of the institution.

Retrospective assessment data from 2013 – 2018 were included in this case study: American Registry of Radiologic Technologists (ARRT) certification exam scores; ARRT certification exam pass rates; and HESI Radiography Exit Exam scores. A pre-existing data set of the retrospective assessment data were collected via the research site's computer database and student information system and provided to me after an independent volunteer at the site reviewed the data for errors to ensure accuracy. Along with reviewing the data for accuracy, the

independent volunteer also removed all participants' names so they were only identified by

graduating year and a random identification number; this helped maintain student confidentiality.

This case study explored the retrospective student assessment data using basic descriptive

analysis. The student assessment scores assisted in answering this case study's research question

to determine the relationship between students' perceptions and their American Registry of

Radiologic Technologists (ARRT) certification exam scores and pass rates and the influence of

the HESI Radiography Exit Exam. Basic descriptive data analysis was performed on the

retrospective assessment data collected: ARRT exam scores and pass rates and HESI

Radiography Exit Exam scores to determine the relationship to students' perceptions of

preparedness. The basic descriptive statistics used focused on the central tendency of the scores.

The central tendency gives a basic summary of the data, which includes mean, median, and mode

(Creswell, 2015).

End of the semester course survey open-ended data from the registry preparation course

from 2013 to 2018 were examined to identify key words and themes regarding student

perceptions. These surveys were given to me, the researcher, by the dean of Radiography

Program X in advance during the initial discussion of this case study. The six surveys had no

identifying information relating to the students or institution. On a 4-point scale, students rated

the course, the instructor, and resources. They had the option of providing additional comments

(See Appendix A for sample survey). Only the open-ended comments were used in this study.

The end of the semester course surveys were administered to students electronically via a

weblink during the last two weeks of their course; the surveys were anonymous and completed

voluntarily. I, the researcher, believe the open-ended questions from these student surveys

provided insight regarding student thoughts and feelings towards the exam preparation course.

The electronic end of semester course surveys from all six years were evaluated to look at

qualitative data specific to comments pertaining to student perceptions before and after the use of the HESI preparation tool was implemented. The coding analysis included student comments from surveys three years prior to using the HESI preparation tool and three years of using the tool; examining both cohorts assisted in evaluating students' perceptions of differences in preparation methods within the last semester preparation course.

The coding process for the student comments from the end of the semester course surveys consisted of a two-step process, as described by Saldana (2009). In the first step or cycle of the coding process, I performed an overview of the student comments and broke them down into single words and or sentences using/applying descriptive and in vivo coding methods (Saldana, 2009). Saldana (2009) states that "descriptive coding summarizes in a word or short phrase – most often as a noun – the basic topic of a passage of qualitative data" (p. 70). The in vivo coding method "refers to a word or short phrase from the actual language found in the qualitative data record" (Saldana, 2009, p. 74). This part of the process included circling, highlighting, and notes in the margins of the text. The second step or cycle in the coding process included evaluating all aspects of the first step to identify reoccurring or significant themes called pattern coding method (Saldana, 2009). Saldana's (2009) pattern coding method assisted in grouping the students' perceptions of preparedness into similar words or phrases.

Another method to gain understanding of students' perceptions of preparedness was a follow-up survey after the completion of the last semester preparation course and taking the American Registry of Radiologic Technologists (ARRT) certification exam. I, the researcher, had created and sent a post-graduation follow-up survey via an electronic open-ended survey via email. The creation of this post-graduation follow-up survey was to obtain students' perceptions of preparedness after taking the ARRT exam. The survey was anonymous and included two open-ended questions including graduation year and in what ways do the graduates believe the

last semester preparation course prepared them to take the ARRT exam. The graduation year was included to identify if the last semester preparation course included HESI or not. This post-graduation follow-up survey was emailed to all 115 graduates of the six cohorts graduating from 2013-2018 using REDCap, a web-based survey platform. The survey was sent to all 115 graduates to increase the response rate; I anticipated a 30% response rate. This response rate was based on the mail return being usually between 20% and 40% (Roberts, 2010). A potential low response rate may be due to recipients' changes of email addresses, survey being sent to junk mail, and potential technical problems (Creswell, 2015). However, Creswell (2015) states "such [web-based] surveys can gather extensive data quickly" (p. 386). The open-ended post-graduation follow-up surveys were to assess students' perceptions of preparedness and its relationship to the ARRT scores and pass rates received. The survey included an introduction to the study that included the purpose of the survey, informed the participants that their responses are anonymous, and completion of the survey acted as their consent (see Appendix B for sample survey). The graduates' email addresses were provided by the Dean of Radiography Program X. A week after the initial email was sent, I, the researcher, sent a reminder to all participants with the intention of increasing response rate. The collection period closed two weeks after the initial email requesting participation in the study.

Due to the creation of the two open-ended question post-graduation follow-up survey a pilot test was warranted to ensure reliability and validity (Roberts, 2010). This survey was created to gain students' perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) exam after the completion of their last semester registry preparation course. The pilot test for the post-graduation follow-up survey (Appendix C) was be emailed to all 2019 graduates of Radiography Program X comprising of 19 students. This selected group was chosen due to the similarities to the participants of this case study having

completed the last semester registry preparation course. The post-graduation follow-up survey was sent to the 2019 graduates with additional questions eliciting feedback (Appendix C). The collection period for this pilot test was one week, with the expectancy of a 25% response rate (Roberts, 2010), the survey was sent to all 19 graduates with the intention to increase response rate. A follow-up email was sent all 2019 graduates thanking them for participating in the pilot after the collection period closed. The follow-up was sent to all graduates due to the anonymity of the survey. The post-graduation follow-up survey was not revised based on feedback and the lack of recommendations (Creswell, 2015). The post-graduation follow-up survey was then emailed to the 115 participants in this study.

The coding process of the post-graduation follow-up survey responses was conducted similarly to the end of semester course surveys. Analysis of the open-ended answers to the post-graduation follow-up survey consisted of a two-step process, as described by Saldana (2009). The first step in the coding process included the descriptive coding method and involved circling, highlighting, and breaking down the comments into single words (Saldana, 2009). Direct quotations from the survey were used as appropriate, this method is called in vivo coding which also took place in the first step (Saldana, 2009). The second step used was the pattern coding method that evaluated the findings of the first step (Saldana, 2009). Pattern coding grouped common themes together "for development of major themes from the data" (Saldana, 2009, p. 152).

The themes collected from the end of semester survey and the post-graduation follow-up survey of both cohorts were reviewed along with American Registry of Radiologic Technologists (ARRT) exam scores and pass rates to determine if a relationship between student perceptions of preparedness and exams scores and pass rates existed. The two cohorts were also compared to examine if the use of the HESI Radiography Exit Exam tool impacted the relationship between

student perceptions and their ARRT scores and passes. Student perceptions may provide insight into preparedness to take the ARRT exam, however, their perceptions are not necessarily directly related to the exam scores and pass rates. Students' perceptions of preparedness before and after taking the ARRT exam were examined. The information gained from coding, provided triangulation with the other data sets to increase validity of the results (Creswell, 2015) which offered insight of Radiograph Program X's student perceptions of the exam preparation course and tools.

Limitations of the Research Design

The most significant limitation of a case study was generalizability (Creswell, 2013; Merriam, 2009; Meyer, 2001). This case study examined one radiography program, Radiography Program X. Investigating only one radiography program decreases overall generalizability to other radiography or other health professions programs (Creswell, 2013; Merriam, 2009; Meyer, 2001). Another limitation in this specific case study design was the use of electronic follow-up surveys (Creswell, 2015). The limitations of using electronic follow-up surveys may be the inaccurate contact information of the intended participants decreasing response rates. Along with low response rates, an additional limitation of using electronic follow-up surveys was the differences in length of time since graduation between the cohorts.

This study did not intend to provide causation of decrease in American Registry of Radiologic Technologists (ARRT) certification exam scores and pass rates as defined by the problem statement in this case study. The focus of this case study was to answer the presented research questions of investigating radiography students' perceptions of ARRT exam preparedness. However, students' perceptions of preparedness to take the ARRT exam may be used as a resource when considering the use of ARRT certification examination preparation tools.

Ethical Issues in the Study

Ethical issues may arise within any research study at various stages. Creswell (2013) states "ethical issues in qualitative research can be described as occurring prior to conducting the study, at the beginning of the study, during data collection, in data analysis, in reporting the data, and in publishing a study" (p. 57). Transparency is an essential element in decreasing ethical issues at may occur. I, the researcher and this study need to provide the reader with adequate information to reduce ethical concerns.

Before the study was conducted the necessary institutional review board (IRB) approval was gained along with continuous communication with the stakeholders at Radiography Program X. A volunteer at Radiography Program X reviewed the retrospective assessment data collected to assess errors throughout the entire process, including collection, analysis, and data presentation. The volunteer also scrubbed participant identification prior to analysis, as described in the data collection process. The assistance of the site volunteer assisted in decreasing researcher bias.

The web-based post-graduation follow-up survey included a brief description of the study and that participation was voluntary and anonymous (Appendix B). The survey used open-ended questions to elicit students' perceptions in which various viewpoints were reported. I, the researcher provided direct quotes along with major themes identified within the surveys, again to decrease researcher bias.

The case study design and data analysis processes were chosen to decrease researcher bias by using a variety of qualitative and quantitative data sets to provide triangulation of the results. Like other research design methods, case studies "search for meaning and understanding" (Merriam, 2009, p. 32). The purpose of this case study was to explore the Radiography Program X's students' perceptions after completing their registry preparation course and to explore the

relationship to the HESI Radiography Exit Exam preparation tool and American Registry of Radiologic Technologists certification exam scores and pass rates.

Conclusion and Summary

Radiologic technologists provide health services to patients around the world. Students completing radiography programs should be prepared to not only pass the American Registry of Radiologic Technologists certification exam but to be prepared to meet rigorous and ongoing professional standards and requirements (ARRT, 2017). With the demands of continued knowledge of best practice concepts for technologists to maintain certification, it is the responsibility of radiography programs to provide resources and tools to prepare students to take this exam.

Since 2013, the Radiography Program X students' ARRT exam scores on average have been below the state average by 1.5 points and 6 points below the national average, along with lower first-time pass rates by an average of 2% compared to the state and 3% nationally (ARRT, 2013, 2014, 2015, 2016, 2017, 2018a). There are many exam preparation tools available for radiography students and programs. HESI is a well-known resource for nursing education and has branched to other health professions, including radiography. The purpose of this study was to examine students' perceptions of American Registry of Radiologic Technologists (ARRT) certification exam preparedness after completing a last semester registry preparation course at Radiography Program X. This case study's investigation of six years of retrospective pre-existing data and electronic post-graduation follow-up surveys can provide Radiography Program X with information when making future decisions regarding American Registry of Radiologic Technologists exam preparation tools.

CHAPTER 4

RESULTS

The career of a radiologic technologist has been predicted to grow 9% by 2028 (U.S. Bureau of Labor Statistics, 2019). This increased demand for radiologic technologists may increase the need for educational opportunities in the field. Radiography programs need to ensure high quality to be the program of choice. Prospective students may research the quality of radiography programs by searching for assessment data including completion rates and American Registry of Radiologic Technologists (ARRT) 1st time pass rates. The ARRT 1st pass rates and exam scores at Radiography Program X have been below the state and national average from 2013 to 2018 which was the problem that initiated this study. The purpose of this study was to explore students' perceptions of preparedness to take the ARRT exam after taking the last semester registry preparation course at Radiography Program X. Additionally, this case study investigated if there was a relationship between perceptions of preparedness, assessment scores, and the use of a preparation tool at Radiography Program X. The following research questions guided this case study:

RQ1: What are the students' perceptions of their ARRT certification exam preparedness after completing the last semester registry preparation course?

SQ1: How did the use of the HESI Radiography Exit Exam preparation tool affect students' perception(s)?

SQ2: What is the relationship between students' perceptions of preparedness and their HESI Radiography Exit Exam scores?

RQ2: What is the relationship between students' perceptions of exam preparedness and ARRT certification exam scores and pass rates?

SQ1: What is the difference between students' perceptions that used the HESI

Radiography Exit Exam preparation tool and those who did not?

RQ3: What is the relationship between students' perceptions of preparedness before and

after taking the ARRT exam?

SQ1: How did the use of the HESI Radiography Exit Exam preparation tool affect

students' perception(s)?

To answer the research questions a case study design was utilized. Case studies are "designed to bring out the details from the viewpoint of the participants by using multiple sources of data" (Tellis, 1997, p. 3). To increase validity of the results, Creswell (2015) suggests using a variety of qualitative and quantitative data sets to provide triangulation. Creswell (2015) discusses that triangulation "ensures that the study will be accurate because the information draws from multiple sources of information, individuals, or processes" (p. 259). This case study explored data sets from multiple sources which included both qualitative and quantitative data. The examination of six years (2013 – 2018) of 115 sets of student data was included in this case study. The data consisted of

- end of the semester course surveys (open-ended comments),

- post-graduation follow-up surveys (open-ended comments),

- HESI Radiography Exit Exam scores (assessment data), and

- American Registry of Radiologic Technologists' (ARRT) certification exam

  scores and pass rates (assessment data).

The review of this data provided an opportunity to understand the student viewpoint at Radiography Program X regarding their perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) certification exam after the completion of the last semester registry preparation course.

Student perceptions were gained by examining two different surveys using the same set of participants. The open-ended questions from the end of semester course surveys and post-graduation follow-up surveys were used. The end of the semester course surveys were pre-existing at the institution, whereas I, the researcher developed the post-graduation follow-up survey which was distributed to participants after gaining University of New England Institutional Review Board (UNE IRB) approval. The two surveys provided student perceptions before (end of semester survey) and after (post-graduation follow-up survey) taking the ARRT certification exam. The assessment scores assisted with triangulation to increase the validity of the research and the results (Creswell, 2015). The six years of data provided me the opportunity to examine the last semester registry preparation course three years before Radiography Program X began using the HESI preparation tool and three years of students using the tool which assisted in determining correlation to the students' perceptions of preparedness and ARRT certification exam scores and first-time pass rates. This case study provides Radiography Program X information and insight for future decisions regarding student ARRT exam preparation tools and course design.

The remainder of this chapter includes descriptions, collection and analysis methods of the qualitative and quantitative data. Presentation of results follows the collection and analysis methods which includes response rates of the qualitative surveys and the answers to the research questions. A summary of findings concludes the chapter.

Collection and Analysis Methods

A case study design was chosen as the methodology for this research study to explore students' perceptions of preparedness at Radiography Program X. Creswell (2013) discusses the importance of examining multiple datasets. The variety of datasets used in this case study provided triangulation of the findings, recommendations, and added validity. The case study

design approach for this research study included a combination of strategies and criteria suggested by Yin, Merriam, and Stakes (Yazan, 2015) which included "epistemological commitments, defining case and case study, designing case study, gathering data, analyzing data, and validating data" (Yazan, 2015, p. 136). UNE IRB approval was granted before collecting and analyzing the datasets. IRB approval was not required through Radiography Program X due to the institution not having their own institutional review board. Permission to conduct the study was granted in the form of writing from the president of the institution. The following describes the collection and analysis methods for the qualitative data and the quantitative data.

Qualitative Data

The qualitative datasets included in this study were two different surveys pertaining to the last semester registry preparation course: the end of the semester course survey and the post-graduation follow-up survey. The retrospective end of the semester course surveys were used to gain students' perceptions of preparedness after completing a registry preparation course and before taking the ARRT exam. The post-graduation follow-up survey was developed for this study to investigate students' perceptions of preparedness after the completion of the last semester registry preparation course and after taking the ARRT exam.

A customary practice of Radiography Program X is to send end of the semester course surveys. These surveys were sent electronically to students within the last two weeks of the semester via a weblink, completed anonymously, and voluntarily. The end of the semester course surveys were sent to students enrolled in academic and clinical courses at Radiography Program X. This study evaluated the open-ended comment section of the end of the semester course surveys specific to the last semester registry preparation course. The retrospective end of semester course survey offered students' perceptions of preparedness after the completion of the registry preparation course but before taking the ARRT exam.

The post-graduation follow-up survey was created using REDCap and included the purpose of the survey and consent information. The post-graduation follow-up survey was emailed to all 115 graduates of the six cohorts from 2013-2018 with a two-week timeframe for completion, with a one-week reminder email. The survey was anonymous and included two open-ended questions: 1) graduation year and, 2) in what ways do you believe the last semester preparation course prepared you to take the American Registry of Radiologic Technologists (ARRT) exam. The graduation year identified if the last semester preparation course included the use of HESI or not. The creation of this post-graduation follow-up survey was to obtain students' perceptions of preparedness after completing the last semester registry preparation course and after taking the ARRT exam.

A pilot test of the post-graduation follow-up survey was conducted to ensure reliability and validity (Roberts, 2010). The pilot included the consent information, the survey, and additional questions eliciting feedback. The pilot test for the post-graduation follow-up survey was emailed to all 2019 graduates of Radiography Program X, comprising of 19 students with a response rate of 58%. This group was chosen due to similarities to the participants of this case study having completed the last semester registry preparation course at Radiology Program X. The post-graduation follow-up survey was not revised based on feedback and the absence of recommendations to modify.

The analysis of the open-ended comments from both the end of the semester course survey and the post-graduation follow-up survey consisted of Saldana's (2009) two-step process. The first step in the review of data included circling, highlighting, and breaking down the comments into single words or phrases. Direct quotations or in vivo coding (Saldana, 2009) from the survey were collected during the first step. The method of coding in the second step was the evaluation of the findings from the first step (Saldana, 2009). The method of pattern coding

grouped common themes together (Saldana, 2009). The results of the analysis of the open-ended comments from the qualitative surveys are shared in the presentation of results section of this chapter.

Quantitative Data

The quantitative data analyzed were assessment scores from Radiography Program X that included HESI Radiography Exit Exam scores captured within the last semester registry preparation course and ARRT scores and 1st time pass rates. The HESI Radiography Exit Exam, offered by the Elsevier publishing company, was proctored by faculty, accessed with a secure code, and completed by students on the last day of the final semester at Radiography Program X. This exam offered a similar experience to the American Registry of Radiologic Technologists (ARRT) certification exam. The HESI Radiography Exit Exam is promoted to be a potential predictor of success on the ARRT exam by applying the HESI Predictability Model (HPM) to the scores (Elsevier, 2018). The *acceptable* score of the HESI Radiography Exit Exam is 700, however, the *recommended* score is 750 as a predictor of passing the ARRT exam (Elsevier, 2018). Other score ranges include *below acceptable* 600-699 and *needs further preparation* a score of 599 and below. A brief explanation of performance levels is included with the results after students complete the HESI Radiography Exit Exam and the option for remediation. The HESI assessment data was used in this case study to determine if the use of the tool at Radiography Program X was beneficial to students' preparedness to take the ARRT exam.

The American Registry of Radiologic Technologists (ARRT) certification examination was used to "assess the knowledge and cognitive skill underlying the intelligent performance of the tasks typically required of radiographers" (ARRT, 2018a, para.1). Passing the ARRT exam with a 75 or higher score is required in most states to begin practicing as a radiologic technologist. The ARRT exam can only be taken three times before the requirement of repeating

an educational program. The ARRT exam is required in many states in order to practice as a radiologic technologist and last semester registry preparation courses are used to prepare students to take this exam.

The retrospective HESI Radiography Exit Exam scores and ARRT exam scores and 1st time pass rate data of all six years between 2013 and 2018 were collected and entered in an excel file at the site by an independent volunteer. The data were verified for accuracy by a different independent volunteer and scrubbed of any identifying student information only to be identified by graduation year and a random number. The excel file was then given to me for analysis.

The analysis of the HESI Radiography Exit Exam scores and the ARRT exam scores and 1st time pass rates were performed using formulas within an excel file. Descriptive statistics that focused on central tendency was performed that included mean, median, mode, standard deviation, minimum, and maximum of the assessment scores. The mean, median, and mode are measures to determine the center and spread of a dataset, how the assessment scores differ. The minimum, maximum and standard deviation are measures to evaluate dispersion (Vetter, 2017). Descriptive statistics can be "used to calculate, describe, and summarize collected research data in a logical, meaningful, and efficient way" (Vetter, 2017, para 1). Participant demographics were also collected and analyzed with the assessment data. Participant demographics were included in this study to provide insight into possible differences among categories or aggregates of participants. The quantitative assessment data were compared with the perceptions of preparedness codes and themes from the qualitative surveys to determine if differences or relationships existed.

The variety of data sets collected and analyzed in this case study provided triangulation of the results presented in the next section. The combination of qualitative and quantitative data included in this study offered insight into students' perceptions of preparedness to take the

American Registry of Radiologic Technologists (ARRT) exam and the relationship with HESI

Radiography Exam Exit scores and ARRT exam scores and 1st time pass rates. The analysis of

the qualitative and quantitative data are presented next within the presentation of results.

Presentation of Results

The presentation of results includes participant demographics, response rates of the

qualitative surveys, and the development of the emergent themes. This section also includes

answers to the research questions. The quantitative assessment data and qualitative survey data

results will be presented with the respective corresponding research question(s).

Participant Demographics

The participants in this case study were six graduated cohorts from the Radiography

Program X between 2013 and 2018, with a total population of 115 radiography students. The

first three cohorts (2013-2015) contained 59 students who did not use the HESI Radiography

Exit Exam preparation tool. The second three cohorts (2016-2018) encompassed 56 students who

used the HESI preparation tool. Table 1 shows the population for each graduating year, age

average, and age range of the participants. The age of the participants was the only demographic

collected. Gender was not collected due to the limited number of males within the study which

had the potential to decrease participant anonymity. The average age of graduates from

Radiography Program X between 2013-2018 was 25 with age ranging from 20 to 49.

Table 1

Participant Demographics

Graduation			Age Statistics					
			20-	25-	30-	35-	40-	45-
Year	*n*	*M*	24	29	34	39	44	49
2013	20	25	13	3	2	1	1	0
2014	19	24	14	4	0	0	0	1
2015	20	27	11	2	5	1	0	1
2016	20	27	11	2	4	2	0	1
2017	19	24	13	4	1	1	0	0
2018	17	22	14	3	0	0	0	0
Total	115	25	65	18	12	5	1	3

Note. n = number of course element codes; *M* = mean.

Course Element Codes and Emergent Themes

The analysis of the open-ended comments from both qualitative surveys using Saldana's (2009) two-step process identified students' comments to be specific to a variety of aspects within the last semester registry preparation course at Radiography Program X from 2013-2018. The different aspects of the last semester registry preparation course found within the comments were then categorized into specific course element codes. For example, practice or prep tests, quizzes, and registries were categorized under the course element code mock exams. A total of twelve course element codes were extrapolated from the qualitative surveys. Seven were drawn from the end of the semester course survey: 1) course overall, 2) certification process, 3) mock exams, 4) reviews, 5) testing tool, 6) textbook, and 7) test-taking strategies; and, an additional five from the post-graduation follow-up survey: 1) exam format, 2) question type and format, 3) simulated testing environment, 4) study strategies, and 5) time management skills.

The second step in Saldana's (2009) coding process was pattern coding, grouping together similar codes found in step one. Step two in Saldana's (2009) coding process discovered three overarching or emergent themes. The emergent themes were identified by grouping

together similar course element codes. The emergent themes of students' perceptions of preparedness to take the ARRT exam after the completion of the last semester registry preparation course were 1) knowledge mastery, 2) exam familiarity, and 3) skill strategies. The course element code of course overall was not categorized under an emergent theme due to its broad nature. The course element codes and subsequent emergent themes used for analysis are shown in Table 2.

Table 2

Perceptions of Preparedness Course Element Codes and Emergent Themes

	Emergent Themes		
	Exam Familiarity	Knowledge Mastery	Skill Strategies
Course element codes			
Certification Process	X		
Exam Format	X		
Mock Exams		X	
Question Type/Format	X		
Reviews		X	
Simulated Testing Environment	X		
Study Strategies			X
Testing Tool		X	
Test-taking Strategies			X
Textbook		X	
Time Management			X

Note. X = the occurrence of course element code within the emergent theme.

Overall Perceptions of Preparedness

The first research question of this study asked *What are the students' perceptions of their ARRT certification exam preparedness after completing the last semester registry preparation course?* This research question was answered by combining open-ended comments from the end of the semester course survey and the post-graduation follow-up survey, this provided a broad look at students' perceptions of preparedness after taking the last semester registry preparation course at Radiography Program X. Table 3 shows the response rates and the number of open-

ended comments for both qualitative surveys for each of the six years. The open-ended

comments were used to gain an understanding of students' perceptions of preparedness.

The number of open-ended comments are included to show the difference between the

survey response rate and the actual data available for coding. The retrospective end of the

semester course survey had a total response rate of 74.33% with 32 open-ended comments that

were coded. The post-graduation follow-up survey had a response rate of 40% with 46 open-

ended comments that were coded. The response rates and number of open-ended comments are

included to provide insight into the influence each survey had on the data coded.

Table 3

Response Rates for Qualitative Surveys

Graduation Year	*n*	End of Semester Course Survey	Post-Graduation Follow-Up Survey
		Response Rate	Response Rate
2013	20	80% 1 open-ended comment	50% 10 open-ended comments
2014	19	95% 4 open-ended comments	36.8% 7 open-ended comments
2015	20	80% 5 open-ended comments	30% 6 open-ended comments
2016	20	55% 4 open-ended comments	35% 7 open-ended comments
2017	19	95% 11 open-ended comments	36.8% 7 open-ended comments
2018	17	41% 7 open-ended comments	52.9% 9 open-ended comments
Total	115	74.33% 32 open-ended comments	40% 46 open-ended comments

Note. n = number of course element codes.

The course element codes and emergent themes from both end of the semester and post-graduation follow-up surveys are displayed in Table 4. The course element codes are listed above the corresponding emergent theme. The three emergent themes discovered were: 1) knowledge mastery, 2) exam familiarity, and 3) skills strategies.

Table 4

Overall Course Element Codes and Emergent Themes

Course Element Codes and Emergent Themes	*n*
Certification process	3
Exam format	8
Question type/format	13
Simulated testing environment	2
Exam Familiarity Total	24
Mock exams	30
Reviews	15
Testing tool	5
Textbook	7
Knowledge Mastery Total	57
Study strategies	7
Test-taking strategies	5
Time management	4
Skill Strategies Total	16

Note. n = number of course element codes.

The emergent theme with the most course element codes pertaining to perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) exam was *knowledge mastery* (n=57). The most common course element code was the use of *mock exams* (n=30) within the last semester registry preparation course. Mock exams offer students the ability to test their knowledge of exam content. A student from the class of 2013 on the end of the semester course survey commented "The mock exam and review of material in class helped me identify my strengths and weaknesses so that I could focus on studying certain material that I had

not absorbed as well over the course of the program." Another comment from the end of the semester course survey and the class of 2013 stated "the mock registries [exams] definitely help to remember the information. The repetitiveness of the assignments is a great aspect." From the post-graduation follow-up survey, a 2016 graduate commented "The prep tests [mock exams] were invaluable." A graduate from 2017 stated "It [preparation course] prepared me in many areas, especially with the mock exams" on the post-graduation follow-up survey. Both of these comments from the post-graduation follow-up survey identified the use of *mock exams* as being beneficial in preparing for the ARRT exam.

The second emergent theme with the most course element codes was *exam familiarity* (n=26). The most commonly seen course element code for *exam familiarity* was *question type and format* (n=13). A 2013 graduate commented on the post-graduation follow-up survey by stating "It [preparation course] helped to give me insight to how the exam would be structured, the types of questions that would be asked, and how the questions would be structured." Another comment stated "I liked going over the formats in which questions could be asked by reviewing the ARRT website together" also found on the post-graduation follow-up survey from a 2018 graduate. The comments from the post-graduation follow-up survey revealed that understanding the *question type and format* of the ARRT exam was helpful in ARRT exam preparation.

The third emergent theme seen within the surveys was *skill strategies* (n=16). The most frequently seen course element code was *study strategies* (n=7). A 2018 graduate stated ". . . the registry preparation course provided study tools in order to pass my exam" on the post-graduation follow-up survey. Another 2018 graduate commented "The course . . . gave direction on the most effective study habits and ways to maximize your time spent studying" on the post-graduation follow-up survey, acknowledging the benefit of learning *study strategies*.

HESI Radiography Exit Exam Effect on Overall Perceptions of Preparedness

The first sub question of research question one asked *How did the use of the HESI Radiography Exit Exam preparation tool affect students' perception(s)?* An examination of the course element codes and the three emergent themes: 1) knowledge mastery, 2) exam familiarity, and 3) skills strategies, gathered from both qualitative surveys, provided insight in response to this research question. However, this sub question examined the perceptions of the cohort that used the HESI preparation tool and compared to the cohort that did not, this separation was to determine the effect of the use of the HESI Radiography Exit Exam. Table 5 displays the emergent themes and course element codes separated by the cohort (2013 – 2015) that did not use the HESI tool and the cohort (2015 – 2018) that did.

Table 5

HESI Use and Overall Course Element Codes and Emergent Themes

Course Element Codes and Emergent Themes	Did Not Use HESI (2013-2015) *n*	Used HESI (2016-2018) *n*
Certification process	1	2
Exam format	5	3
Question type/format	8	5
Simulated testing environment	0	2
Exam Familiarity Total	14	12
Mock exams	16	14
Reviews	9	6
Testing tool	0	5
Textbook	2	5
Knowledge Mastery Total	27	30
Study strategies	2	5
Test-taking strategies	2	3
Time management	3	1
Skill Strategies Total	7	9

Note. n = number of course element codes

The most common emergent theme for both cohorts was *knowledge mastery*. The most common course element code for the cohort that did not use the tool was *mock exams* (n=16) which was also the most frequent for the cohort that did use the tool (n=14). The second most frequently seen course element code was *reviews* for the cohort that did not use the tool (n=9) and the cohort that did use the tool (n=6). Both *mock exams* and *reviews* were course element codes categorized under knowledge mastery.

The HESI testing tool was specifically mentioned by students that used the tool, however, they had mixed feelings towards the overall benefit of the tool. Two comments from the end of the semester course survey from 2016 stated "I think that HESI was really helpful" and "I don't believe it [HESI] is a good resource for prepping for the registry. The questions seemed to be inconsistent with the answers." A graduate from 2018 commented on the post-graduation follow-up survey "I believe the HESI tests were an eye opener in both positive and negative ways." The course element code *testing tool* was seen 5 times out of the 52 total number of course element codes identified within the open-ended comments from both qualitative surveys.

Based on the coding of the open-ended comments from both the end of the semester course survey and the post-graduation follow-up survey, the perceptions of preparedness of the cohort that did not use the tool (2013-2015) and the cohort that did use the tool (2016-2018) were identical. Both cohorts had knowledge mastery as the emergent theme with the most course element codes and also shared *mock exams* and *reviews* as the top two course element codes.

HESI Radiography Exit Exam Scores Relationship with Overall Perceptions of Preparedness

The second sub question of research question one asked *What is the relationship between students' perceptions of preparedness and their HESI Radiography Exit Exam scores?* The course element codes and emergent themes from both surveys for the cohort (2016-2018) that

used the HESI preparation tool along with the HESI Radiography Exit Exam scores were

explored to answer this research question. Table 6 shows the emergent themes and course

element codes for the three years specific to the cohorts that used the HESI Radiography Exit

Exam preparation tool. Table 6 also includes the HESI score ranges for each cohort. This

information helps to determine the overall effectiveness of the HESI preparation tool for

Radiography Program X.

Table 6

HESI Radiography Exit Exam Scores and Course Element Codes and Emergent Themes

	2016	2017	2018
Course Element Codes and Emergent Themes	*n*	*n*	*n*
Certification process	0	0	2
Exam format	1	1	1
Question type/format	1	1	3
Simulated testing environment	0	1	1
Exam Familiarity Total	2	3	7
Mock exams	5	4	5
Reviews	3	0	3
Testing tool	3	0	2
Textbook	1	3	1
Knowledge Mastery Total	12	7	11
Study strategies	0	1	4
Test-taking strategies	0	1	2
Time management	0	0	1
Skill Strategies Total	0	2	7
HESI Radiography Exit Exam Scores			
M	888.35	843.84	835.53
Mdn	873	809	841
Mode	n/a	734	n/a
SD	153.74	141.97	186.37
Min	541	682	493
Max	1254	1280	1167
HESI Score Ranges			
Recommended (750 or <)	90%	74%	65%
Acceptable (700-749)	0%	21%	12%
Below Acceptable (600-699)	5%	5%	12%
Needs Further Preparation (599 or >)	5%	0%	12%

Note. n = number of course element codes; *M* = mean; *Mdn* = median; *SD* = standard deviation.

The cohort with the highest average HESI score was 2016 at 888.35 and had the highest

percent of students' scores to fall within the Recommended range of 750 and higher. 2016 was

the first year that Radiography Program X used the HESI Radiography Exit Exam tool. The

emergent theme for 2016 was *knowledge mastery* (n=12) with *mock exams* (n=5) as the most seen course element code. A 2016 graduate stated "It was nice to be able to sit down and take a practice [mock] exam over and over again" on the post-graduation follow-up survey. The second most frequently seen course element code was *reviews* (n=3) and *testing tool* (n=3). Both course element codes of *reviews* and *testing tool* were categorized under *knowledge mastery*. Another comment from a 2016 graduate was ". . . we were able to talk as a group about questions that we had in terms of wording and answers to the questions" which was also noted on the post-graduation follow-up survey. A comment regarding the testing tool was from a 2017 student that stated "I think that HESI really was helpful" on the end of the semester course survey.

The 2017 cohort had a HESI score average of 843.84. The 2017 cohort included the student with the highest HESI score of all students at 1280. The most frequently seen course element code was *mock exams* (n=4) within the emergent theme of *knowledge mastery* (n=7). A student from the class of 2017 commented "We took many practice tests [mock exams] that enabled us to get ready for the registry" on the end of semester course survey. The second most frequently seen course element code was *textbook* (n=3) which was also within the emergent themes of *knowledge mastery*. A 2017 graduate stated ". . . sharing other resources like ASRT and utilizing review books helped prepare" on the post-graduation follow-up survey. In many cases radiography programs require course and semester specific textbooks; in preparing to take the ARRT exam, reviewing textbooks acquired over the entire program may be overwhelming for students. ARRT preparation textbooks are a convenient and condensed version of the required knowledge and concepts specific to the exam.

The 2018 cohort had the lowest HESI score average at 835.53. This cohort included the student with the lowest HESI score of all students at 493. *Knowledge mastery* (n=12) was the emergent theme for 2018 with *mock exams* (n=5) as the most frequently seen course element

code. A 2018 graduate stated, "This course prepared me for the ARRT certification exam by continuous test questions [mock exams] that we were given, many of the questions above the level we would be tested at to give us extra knowledge to apply to the exam" on the post-graduation follow-up survey. Mock exams provide students with the opportunity to identify their strengths and weakness in certain concept areas. The insight gained from the mock exams may assist the study into directed studying. The second most frequently seen emergent theme was *skill strategies* (n=7) with the *study strategies* (n=4) as the most common course element code. Another comment from a 2018 graduate of, "The course . . . gave direction on the most effective study habits and ways to maximize your time spent studying" was also gathered from the post-graduation follow-up survey and identified the benefit of learning *study strategies.* Studying for a comprehensive exam such as the ARRT certification exam may be daunting for some students. Providing students with different methods of studying may aid in retention of the exam concepts.

The HESI Radiography Exit Exam applies the HESI Predictability Model (HPM) to the scores to predict success on the ARRT exam (Elsevier, 2018). A 2018 graduate stated "There was only a 5-point difference from the final mock [HESI Exit Exam] to my registry exam" on the post-graduation follow-up survey, indicating HESI's predictability to the ARRT exam. The 2016 cohort has the highest percent of students within the *recommended* score range. The 2018 cohort had the lowest HESI score average of the three cohorts that used the tool and when examining the HESI score ranges, 2018 also had the lowest percentage of students with scores within the *recommended* score range and the highest in the *needs further preparation* range.

The HESI Radiography Exit Exam score averages of the cohorts (2016-2018) that used the tool were all above the *recommended* score range of 750. The emergent theme of *knowledge mastery* was shared between all three cohorts (2016-2018) as the theme with the greatest amount of course element codes. In addition to all three cohorts (2016-2018) sharing *knowledge mastery*

as the emergent theme, the course element code *mock exam* was also seen the most. A slight difference between the second most frequent course element codes was seen, these codes included *reviews* and *testing tool* for the 2016 cohort, *textbook* for the 2017 cohort, and *study strategies* for the 2018 cohort.

ARRT Exam Scores and 1st Time Pass Rates with Overall Perceptions of Preparedness

The second research question asked *What is the relationship between students' perceptions of exam preparedness and ARRT certification exam scores and pass rates?* This research question was answered by examining course element codes that supported the development of emergent themes and ARRT exam scores and 1st time pass rates. Table 7 displays emergent themes and course element codes along with ARRT exam scores and 1st time pass rates for each of the six years. Table 8 presents ARRT exam scores and 1st time pass rates for Radiography Program X compared with the state and national averages.

Table 7

ARRT Exam Scores & 1ˢᵗ Time Pass Rates and Course Element Codes and Emergent Themes

Course Element Codes and Emergent Themes	2013	2014	2015	2016	2017	2018
	n	*n*	*n*	*n*	*n*	*n*
Certification process	0	1	0	0	0	2
Exam format	3	1	1	1	1	1
Question type/format	4	2	2	1	1	3
Simulated testing environment	0	0	0	0	1	1
Exam Familiarity Total	7	4	3	2	3	7
Mock exams	7	3	6	5	4	5
Reviews	1	5	3	3	0	3
Testing tool	0	0	0	3	0	2
Textbook	0	2	0	1	3	1
Knowledge Mastery Total	8	10	9	12	7	11
Study strategies	1	0	1	0	1	4
Test-taking strategies	2	0	0	0	1	2
Time management	1	1	1	0	0	1
Skill Strategies Total	4	1	2	0	2	7
ARRT 1ˢᵗ Time Pass Rate	90%	79%	85%	90%	89%	82%
ARRT Exam Score *M*	81.3	82.5	83.3	81.8	79.7	80.7
ARRT Exam Score *Mdn*	80.5	84	84	82	80	81
ARRT Exam Score Mode	83	81	93	82	80	88
ARRT Exam Score *SD*	5.52	5.67	7.90	6.24	4.58	6.34
ARRT Min	73	72	64	61	73	70
ARRT Max	94	90	94	90	94	92

Note. n = number of course element codes; *M* = mean; *Mdn* = median; *SD* = standard deviation.

Table 8

ARRT 1ˢᵗ Time Pass Rates and Exam Scores Compared to State and National

	ARRT 1ˢᵗ Pass Rates			ARRT Exam Scores Mean		
Year	Radiography Program X	State	National	Radiography Program X	State	National
2013	90%	87.3%	89.6%	81.3	81.5	84.1
2014	78.95%	86%	88.9%	82.53	84.1	83.8
2015	85%	91.1%	88.4%	83.25	83.5	93.7
2016	90%	87.9%	87.2%	81.75	83.6	83.3
2017	89.47%	86.9%	89.3%	79.68	81.4	89.3
2018	82.35%	91.2%	89.4%	80.65	83.8	89.4
Total	85.96%	88.4%	88.8%	81.56	82.98	87.27

The 2013 cohort had the highest ARRT 1ˢᵗ time pass rate at 90%, higher than the state and national average. The average ARRT score for the 2013 cohort was 81.3, which was below the average of all six cohorts, the state and national averages. The surveys gathering students' perceptions of preparedness for the 2013 cohort identified *mock exams* (n=7) and *question type and format* (n=4) to be the most frequent course element codes. From the post-graduation follow-up survey, a 2013 graduate stated, "Having all the prep test [mock exams] and seeing the different example questions taught me a lot as to what to study." The course element code of *mock exams* was categorized under the emergent theme of *knowledge mastery* (n=8), which had the most course element codes; and, *question types and format* course element code was under the second most apparent emergent theme of *exam familiarity* (n=7).

The 2014 cohort had the lowest ARRT 1ˢᵗ time pass rate 78.95% of all the cohorts and was below the state and national rates. The ARRT exam score average of the 2014 cohort of 82.53 was just above the average of all the cohorts as well as the state and national averages. When analyzing the end of semester course survey and the post-graduation follow-up survey the 2014 cohort identified *reviews* (n=5) and *mock exams* (n=3) as the most common course element

codes. Both *reviews* and *mock exams* course element codes fall under the emergent theme of *knowledge mastery* (n=10). A 2014 graduate commented on the post-graduation follow-up that "reviews were vital for remembering important facts, numbers, and terminology that could have easily been lost over time". This statement reflects the benefit of *reviews* within the last semester registry preparation course. *Reviews* allow students the opportunity to gain clarity and ask questions specific to exam content that may have been presented early in the program.

The 2015 cohort 1st time pass rate of 85% was below the average of all cohorts and below the state national rates. The 2015 cohort had the highest ARRT average of all the cohorts at 83.25, however, was below the state and national averages. The 2015 cohort identified the course element codes of *mock exams* (n=6) and *reviews* (n=3) to be the most common, making *knowledge mastery* (n=9) the emergent theme with the most course element codes. A 2015 graduated stated "Being able to do mock exams and then ask our instructors why we got specific questions wrong was super beneficial," which revealed the necessity of *mock exams* as a method of preparing to take the ARRT exam. *Mock exam* questions and results provide students with insight into their knowledge and understanding of ARRT exam content. Students can seek a deeper knowledge of content by understanding why of the question.

The 2016 cohort had the highest ARRT 1st time pass rate at 90% which was the same as the 2013 cohort and was higher than the state and the national rate. The 2016 cohort included the student with the lowest of all ARRT certification exam scores at 61. The 2016 cohort's average of 81.56 was below the state and national averages, however, just above the average of all the cohorts. The top two course element codes identified by the 2016 cohort were *mock exams* (n=5) and *testing tool* (n=3), and *reviews* (n=3). All three of the most frequently seen course element codes for 2016 were under *knowledge mastery* (n=12). On the post-graduation follow-up survey, a 2016 graduate commented "The prep tests [mock exams] were invaluable as well as instructor

feedback [reviews]." A 2016 students stated on the end of semester course survey "I like how we did tests [mock exams] in class, I thought this way very helpful." As identified by the comments from both the end of the semester course survey and the post-graduation follow-up survey *mock exams* were beneficial in ARRT exam preparation. *Mock exams* may be beneficial in preparing to take the ARRT exam due to its comprehensive nature and availability to reflect on strengths and weaknesses of exam content.

The 2017 cohort's ARRT 1st time pass rate was above the average of all the cohorts at 89.47% which also placed 2017 cohorts above the state and national pass rates. The 2017 cohort had the lowest ARRT exam score average of all the cohorts at 79.68 which was lower than the state average and below the national average by almost 10 points. The top two emergent themes identified by the 2017 cohort that aided in ARRT exam preparation were *mock exams* (n=4) and *textbook* (n=3). The emergent theme for the 2017 cohort based on course element themes was *knowledge mastery* (n=7). A 2017 graduate on the post-graduation follow-up survey stated "It [course] prepared me in many areas, especially with the mock exams." On the end of semester course survey, a 2017 student commented "We took many practice tests [mock exams] that enabled us to get ready for the registry." Both comments from the post-graduation follow-up survey and the end of the semester course survey identified the use of *mock exams* as a helpful in preparing to take the ARRT exam. *Mock exams* are comprehensive and include all topic areas of the ARRT exam enabling students to test their knowledge of the concepts.

The 2018 cohort's ARRT 1st time pass rates of 82.35% was below the average of all cohorts, as well as the state and national rates. The 2018 cohort's ARRT exam average of 80.65 was lower than the average of all cohorts and below the state and national averages. The top two course element codes identified by the 2018 cohort were *mock exams* (n=5) and *study strategies* (n=4). The course element code of mock exams was included under the emergent theme of

knowledge mastery (n=7), which had the most course element codes. The second most frequent course element code *study strategies* was within the emergent theme of *skill strategies* (n=7). A 2017 graduate stated "The registry prep course taught us how to manage our study techniques and organize in order to feel more relaxed and confident while taking the registry" on the post-graduation follow-up survey identifying the benefit of learning *study strategies*. Students may be unfamiliar with strategies necessary to study for a comprehensive exam, providing study strategies and resources may assist the student in retention of the ARRT content.

The 2013, 2015, 2016, 2017, and 2018 cohorts all identified *mock exams* as the most beneficial in preparing for the ARRT exam. The 2014 cohort identified *reviews* as the aspect of the last semester registry preparation course to be the most helpful. Furthermore, all six cohorts had the highest number of course element codes categorized under the emergent theme of *knowledge mastery*. In turn, this study identified findings common to all cohorts, there were no differences in perceptions of preparedness when compared to American Registry of Radiologic Technologists (ARRT) exam scores and 1st time pass rates.

ARRT Exam Score and 1st Time Pass Rates, HESI Radiography Exit Exam, and Overall Perceptions of Preparedness

The sub question of research question two asked *What is the difference between students' perceptions that used the HESI Radiography Exit Exam preparation tool and those who did not?* This sub question specifically examined differences between the cohorts that did not use HESI and the cohort that did use the preparation tool. Table 9 shows emergent themes and course element codes as well as the ARRT exam scores and 1st time pass rates divided into the cohort that used the HESI tool (2016 – 2018) and the cohort that did not (2013 – 2015).

Table 9

ARRT Exam Scores & 1ˢᵗ Time Pass Rates and Course Element Codes and Emergent Themes

Course Element Codes and Emergent Themes	Did Not Use HESI (2013-2015)	Used HESI (2016-2018)
	n	*n*
Certification process	1	2
Exam format	5	3
Question type/format	8	5
Simulated testing environment	0	2
Exam Familiarity Total	14	12
Mock exams	16	14
Reviews	9	6
Testing tool	0	5
Textbook	2	5
Knowledge Mastery Total	27	30
Study strategies	2	5
Test-taking strategies	2	3
Time management	3	1
Skill Strategies Total	7	4
ARRT 1ˢᵗ Time Pass Rate	86%	87%
ARRT Exam Score *M*	82.4	80.7
ARRT Exam Score *Mdn*	83	81
ARRT Exam Score Mode	83	82
ARRT Exam Score *SD*	6.52	5.83
ARRT Min	64	61
ARRT Max	94	94

Note. n = number of course element codes; *M* = mean; *Mdn* = median; *SD* = standard deviation.

The American Registry of Radiologic Technologists (ARRT) average exam score of the cohort (2016-2018) that used the HESI Radiography Exit Exam was almost 2 points lower compared to the cohort (2013-2015) that did not use the tool. The ARRT exam average during the three years of the cohorts that did not use the tool was 82.4. Whereas the average of the three years for cohorts that used the HESI tool was 80.7. When examining course element codes from

the qualitative data of the cohort that did not use the HESI tool, *mock exams* (n=16) was the most frequent. *Mock exams* (n=14) was also the most frequent course element code for the cohort that did use the HESI tool. *Mock exams* was a course element code that was categorized under the emergent theme of *knowledge mastery*. *Knowledge mastery* was the emergent theme with the highest number of course element codes for the cohort (2016-2018) that used the tool (n=30) and the cohort (2013-2015) that did not (n=27). The second most frequent course element code for the cohort (2013-2015) that did not use the tool was *reviews* (n=9). *Reviews* (n=6) was also the second most frequently seen course element code for the cohort (2016-2018) that did use the HESI preparation tool. In addition to *mock exams*, *reviews* was also a course element code within the *knowledge mastery* emergent theme.

Overall, there were no differences between students' perceptions of preparedness regarding ARRT exam scores and 1st time pass rates of the cohort that used the HESI Radiography Exit Exam preparation tool compared to the cohort that did not. Both cohorts had *mock exams* and *reviews* as the two most common course element codes under the emergent theme of *knowledge mastery*. Furthermore, when examining the differences in ARRT exam scores of the cohort that used the tool and the cohort that did not, the cohort that did not use the tool had a higher ARRT exam average compared to the cohort that did use the tool. The 1st time pass rates, however, were higher for the cohort that used the tool compared to the cohort that did not.

To assist Radiography Program X in determining the effectiveness of the HESI Radiography Exit Exam preparation tool, Table 10 shows the ARRT exam scores and 1st time pass rates that fall within the HESI score ranges. Table 10 also demonstrates the relationship between the HESI Radiography Exit Exam scores and the ARRT 1st time pass rates and scores.

Table 10

ARRT Exam Scores Within HESI Score Ranges

HESI Score Ranges	n	ARRT 1st Time Pass Rate	ARRT Exam Scores					
			M	*Mdn*	Mode	*SD*	Min	Max
Recommended (750 or <)	43	95%	82.35	82	82	4.84	73	94
Acceptable (700-749)	6	100%	78.5	78.5	n/a	2.63	75	82
Below Acceptable (600-699)	4	25%	73.5	73	73	2.87	70	78
Needs Further Preparation (599 or >)	3	33%	71.33	72	n/a	8.18	61	81

Note. n = number of course element codes; *M* = mean; *Mdn* = median; *SD* = standard deviation.

After examining the ARRT exam scores within the HESI score ranges, the average

ARRT exam scores within each range were relatable. The passing score of the ARRT exam was

75 (ARRT, 2018c), the average ARRT exam score for the HESI score range of *recommended*

was 82.35 with a 1st time pass rate of 95%. The HESI score range of *acceptable* had an ARRT

average of 78.5 with a 100% 1st time pass rate. *Below acceptable* HESI score range had an

ARRT exam average of 73.5 which is not passing, with a 25% 1st time pass rate. The lowest

HESI score range, *needs further preparation*, had an ARRT exam average of 71.33, again, not

passing, with a 33% 1st time pass rate. Overall, the HESI Radiography Exit Exam scores ranges

are comparable to the American Registry of Radiologic Technologists (ARRT) exam score

averages of the 2016-2018 cohorts from Radiography Program X.

Perceptions of Preparedness Before and After Taking the ARRT Exam

The third research question asked *What is the relationship between students' perceptions*

of preparedness before and after taking the ARRT exam? This research question was answered

by comparing the course element codes and emergent themes discovered from the end of the

semester course surveys and the post-graduation follow-up surveys. Table 11 displays the

emergent themes and course element codes separated by the two different surveys: the end of the

semester course survey and the post-graduation follow-up survey. The end of the semester course

survey provides insight into students' perceptions of preparedness before taking the ARRT,

whereas the post-graduation follow-up survey reports their perceptions afterward.

Table 11

Course Element Codes and Emergent Themes Before and After Taking ARRT Exam

Course Element Codes and Emergent Themes	End of Semester Course Survey	Post-Graduation Follow-Up Survey
	n	*n*
Certification process	1	2
Exam format	0	8
Question type/format	0	13
Simulated testing environment	0	2
Exam Familiarity Total	1	25
Mock exams	4	26
Reviews	4	11
Testing tool	2	3
Textbook	4	3
Knowledge Mastery Total	14	43
Study strategies	0	7
Test-taking strategies	1	4
Time management	0	4
Skill Strategies Total	1	15

Note. n = number of course element codes.

Upon examining the differences in perceptions of preparedness between the two surveys,

a difference in course element codes were revealed. Differences seen were the number of course

element codes discovered and the emergent themes revealed between the end of the semester

course survey and the post-graduation follow-up survey. A total of 16 course element codes were found on the end of semester course survey, whereas the post-graduation follow-up survey revealed 83 course element codes. Perceptions of preparedness to take the ARRT exam after actually taking the exam from the post-graduation follow-up survey had the greatest impact on the total number of course element codes compared to the end of semester course survey.

The end of the semester course survey only had one course element within the theme of *exam familiarity*, while the post-graduation follow-up survey had 25 course element codes for *exam familiarity*. Three course element codes categorized under the emergent theme of *exam familiarity* where only found on the post-graduation follow-up survey: 1) exam format, 2) questions type and format, and 3) simulated testing environment. The one and only course element code from the end of semester course survey categorized under the theme of *exam familiarity* was *certification process.* A 2014 student commented on the end of semester course survey "It [last semester registry preparation course] answered a lot of questions about what to do after the program was over;" this comment was specific to the benefit of understanding the *certification process* required to enter the profession. Applying for the ARRT certification exam is a multistep process (ARRT, 2018c) and may seem complicated to some students. Understanding the certification process may decrease some of their stress by knowing what to expect.

Similar to the emergent theme of *exam familiarity*, the end of the semester course survey only had one course element code under the emergent theme of *skill strategies* while the post-graduation follow-up survey had 15 codes. *Study strategies* and *time management* were course element codes that were found only on the post-graduation follow-up survey and not on the end of semester course survey. *Study strategies and time management* were course element codes categorized under the emergent theme of *skill strategies.* The one and only course element code

categorized under *skill strategies* from the end of semester course survey was *test-taking strategies*. On the end of semester course survey, a 2017 student commented "We learned a lot about test-taking that benefitted me," that pertained to the benefit of understanding *test-taking strategies*. The ARRT exam is comprehensive covering the content learned throughout a radiography program; learning *test-taking strategies* may assist in their preparation.

The emergent theme of *knowledge mastery* had 14 course element codes from the end of the semester course survey and the post-graduation follow-up survey had three times as many at 43 course element codes. Both surveys, end of semester course survey and the post-graduation follow-up survey, revealed the same course element codes within the emergent theme of *knowledge mastery*. *Knowledge mastery* was the emergent theme with the highest number of course element codes discovered for both surveys.

The end of the semester course survey revealed the emergent theme of *knowledge mastery* (n=43) had the greatest number course element codes seen. *Mock exams* (n=4) was tied as the most frequent course element code with *reviews* (n=4) and *textbook* (n=4). The end of the semester course survey only had one course element code within the theme of *exam familiarity* (n=1) and *skill strategies* (n=1). The one course element code within *exam familiarity* was *certification process* and *skill strategies* had the course element code of *test-taking strategies.*

The post-graduation follow-up survey also had the emergent theme of *knowledge mastery* (n=43) with the most course element codes. The most frequently seen course element code for *knowledge mastery* was the same as the end of the semester course survey, *mock exams* (n=26). The second most frequent course element code under the emergent theme of *knowledge mastery* was *reviews* (n=11). The post-graduation follow-up survey had *exam familiarity* (n=25) as the second most common emergent theme with the most frequent course element code being *question type and format* (n=13) and the second as *exam format* (n=8). The emergent theme of

skill strategies (n=15) had the least number of course element codes. The most frequent course element code under the skill strategies was *study strategies* (n=7) with *testing-taking strategies* (n=4) and *time management* (n=4) as the second most frequently seen codes.

Both the end of semester course survey and the post-graduation follow-up survey had *knowledge mastery* as the emergent theme with the greatest number of course element codes. When examining the number of course element codes between the two surveys, the post-graduation follow-up survey provided more codes compared to the end of the semester course survey, which is important to note as the majority of the perceptions of preparedness were from graduates after taking the ARRT certification. The post-graduation follow-up survey provided perceptions of preparedness after taking the ARRT exam, whereas the additional course element codes provided insight into specific aspects of the last semester registry preparation course that students may not have realized were beneficial before taking the ARRT when completing the end of the semester course survey.

Perceptions of Preparedness Before and After Taking the ARRT Exam and HESI Radiography Exit Exam

The sub question of research question three asked *How did the use of the HESI Radiography Exit Exam preparation tool affect students' perception(s)?* Exploring course element codes and emergent themes from both qualitative surveys and comparing the cohort that used the HESI Radiography Exit Exam preparation tool and those that did not was used to answer this research question. The emergent themes and course element codes shown in Table 12 are separated by the two different surveys and by cohorts that used HESI or not. The most frequently seen emergent theme based on the number of course element codes for both surveys and both cohorts was *knowledge mastery.*

Table 12

HESI Use Effect on Perceptions Before and After Taking the ARRT Exam

	End of Semester Course Survey		Post-Graduation Follow-Up Survey	
	Did Not Use HESI (2013-2015)	Used HESI (2016-2018)	Did Not Use HESI (2013-2015)	Used HESI (2016-2018)
Course Element Codes and Emergent Themes	*n*	*n*	*n*	*n*
Certification process	1	0	0	2
Exam format	0	0	5	3
Question type/format	0	0	8	5
Simulated testing environment	0	0	0	2
Exam Familiarity Total	1	0	13	12
Mock exams	2	2	14	12
Reviews	4	0	5	6
Testing tool	0	2	0	3
Textbook	1	3	1	2
Knowledge Mastery Total	7	7	20	23
Study strategies	0	0	2	5
Test-taking strategies	0	1	2	2
Time management	0	0	3	1
Skill Strategies Total	0	1	7	8

Note. n = number of course element codes.

The end of the semester course survey found that the cohort (2013-2015) that did not use the HESI preparation tool had a total of seven course element codes under the emergent theme of *knowledge mastery* which included *reviews* (n=4) and *mock exams* (n=2) as the top two course element codes. A student from the class of 2013 commented ". . . mock registries [exams] definitely help to remember the information" on the end of the semester course survey. The cohort (2016-2018) that used the HESI preparation tool also had a total of seven course element codes categorized under *knowledge mastery* from the end of semester course survey, however,

had different course element codes. The course element codes from the cohort (2016-2018) that used the HESI preparation tool from the end of semester course survey were *textbook* (n=3) (the most frequently seen code) with *testing tool* (n=2) and *mock exams* (n=2) tied for the second most frequent course element code. A 2016 student stated "I have found it [textbook] to be very helpful and relevant to what we have learned these past 2 years" on the end the semester course survey, indicating the benefit of the *textbook*. A radiography student may acquire many textbooks specific to individual courses during their program, preparation *textbooks* provide a condensed version of the exam content.

The emergent theme of *exam familiarity* was not found on the end of the semester course survey for the cohort (2016-2018) that used the HESI preparation tool. Only one course element code under the *exam familiarity* theme, *certification process*, was seen from the cohort (2013-2015) that did not use the tool. On the end of the semester course survey, a 2014 student commented "It [the last semester registry preparation course] answered a lot of questions about what to do after the program was over," identifying the benefit of learning the *certification process* of entering the field. The emergent theme of *exam familiarity* was not found to be a common theme regarding students' perceptions of preparedness before taking the ARRT exam from the end of semester course survey and for the cohort (2013-2015) that did not use the HESI tool and the cohort (2016-2018) that did.

The end of semester course survey for the cohort (2013-2015) that did not use the HESI preparation tool did not reveal any course element codes under the emergent theme of *skill strategies*. The end of semester course survey found that the cohort (2016-2018) cohort that used the tool only had one course element code, *test-taking strategies* within the emergent theme of *skill strategies*. A 2017 student stated "We learned a lot about test-taking that benefitted me" on the end of the semester course survey. The perceptions of preparedness discovered from the end

of semester course survey for the cohort (2013-2015) that did not use the tool and the cohort (2016-2018) that did not include *skills strategies* as a common emergent theme which provides insight into the differences between the perceptions of preparedness before taking the ARRT exam.

The post-graduation follow-up survey for the cohort (2013-2015) that did not use the HESI preparation tool had *mock exams* (n=14) as the top most often seen course element code under the emergent theme of *knowledge mastery* (n=20). A 2013 graduate stated "The mock exams and review of material in class helped me identify my strengths and weaknesses so that I could focus on studying certain material that I had not absorbed well over the course of the program," on the post-graduation follow-up survey. *Mock exams* enable students the opportunity to reflect on their knowledge of ARRT exam content. The second most seen course element code on the post-graduation follow-up survey for the cohort (2013-2015) that did not use the HESI tool was *question type and format* (n=8) under the emergent theme of *exam familiarity.* A 2015 graduate commented "It [last semester registry preparation course] helped to get an idea of the variety of questions and to see the different was the questions may be presented on the exam" on the post-graduation follow-up survey. Insight into the *question type and format* of the ARRT exam may better prepare students in the preparation due to the variety of questions on the exam. The emergent theme *exam familiarity* (n=13) had the second most course element codes seen on the post-graduation follow-up survey for the cohort (2013-2015) that did not use the HESI tool.

The course element codes seen most often from the cohort (2016-2018) that did use the tool were also *mock exams* (n=12) and *reviews* (n=6) categorized under *knowledge mastery* (n=23). A 2017 graduate stated "It [last semester registry preparation course] prepared me in many areas, especially with the mock exams" on the post-graduation follow-up survey. The post-graduation follow-up survey for the cohort (2016-2018) that used the HESI tool provided

additional insight into perceptions of preparedness with the element codes of *certification process* (n=2) and *simulated testing environment* (n=2) which were under the emergent theme *exam familiarity* (n=12). A 2018 graduate commented on the post-graduation follow-up survey that the course ". . . administered practice tests in an environment similar to what the actual testing center would be like" identified the benefit of a *simulated testing environment*. A simulated testing environment affords students the opportunity to take a comprehensive exam in an environment similar to the ARRT exam. *Question type and format* (n=5) and *exam format* (n=3) were the top two course element codes found under the emergent theme of *exam familiarity*. A 2016 graduate on the post-graduation follow-up survey stated "A prep course, prepared you for the format of the test, not just studying course material" which revealed the benefit of understanding the *exam format* of the ARRT exam. The ARRT exam format is complex with a timeframe, online calculator, and consent forms along with the 220 questions (ARRT, 2018c).

The emergent theme of *skill strategies* (n=7) from the post-graduation follow-up survey for the cohort (2013-2015) that did not use the HESI tool included *time management* (n=3) as the most frequently seen course element code with *study strategies* (n=2) and *test-taking strategies* (n=2) tied as the second. On the post-graduation follow-up survey, a 2015 graduate commented "It [last semester registry preparation course] really helped with end of the year time management," which identified *time management* as being helpful in preparation to take the ARRT exam. During the last semester of most radiography programs, students are completing course work and study for the ARRT exam, understanding time *management skills* may assist students in balancing multiple priorities. The cohort (2016-2018) that did use the HESI tool had *study strategies* (n=5) followed by *testing-taking strategies* (n=2) as the most frequently seen course element codes under the emergent theme of *skill strategies* (n=8). A 2018 graduate

commented on the post-graduation follow-up survey "The course . . . gave direction on the most effective study habits and way to maximize your time spent studying," which revealed the benefit *study strategies*. Some students may find it difficult to know how to study the comprehensive content of the ARRT exam, identifying different study strategies may assist with different learning styles.

Overall, the emergent theme with the most common course element codes from both surveys, the end of the semester course survey and the post-graduation follow-up survey, and both cohorts, the cohort (2013-2015) that did not use the HESI tool and the cohort (2016-2018) that did was *knowledge mastery*. Based solely on both cohorts from both surveys having the emergent theme of *knowledge mastery* the HESI Radiography Exit Exam preparation tool did not affect students' perceptions of preparedness before or after taking the American Registry of Radiologic Technologists (ARRT) certification exam, however, small differences within the number of course element codes were found. Both cohorts from the post-graduation follow-up survey had the most frequent course element code of *mock exams*, whereas the end of the semester course survey for the cohort (2013-2015) that did not use the HESI preparation tool had *reviews* and the cohort (2016-2018) that did use the tool had *textbook*.

Summary of Findings

The increase in job demand for radiologic technologists (U.S. Bureau of Labor Statistics, 2019) may lead to the increase of people pursing educational opportunities in the field. Radiography program outcomes may be the deciding factor for students when choosing a program. American Registry of Radiologic Technologists (ARRT) certification exam pass rates is a program outcome that is required by accrediting bodies to be displayed publicly. The ARRT exam scores and pass rates at Radiography Program X have been below the state and national from 2013-2018. This study examined the perceptions of preparedness to take the ARRT

certification exam after completing the last semester registry preparation course at Radiography Program X from 2013-2018.

Examining the perceptions of preparedness to take the ARRT exam at Radiography Program X provided insight into the aspects of the last semester registry preparation course students believed was beneficial in preparing to take the exam. A student from the class of 2018 commented "This course was very helpful in preparing for the registry" on the end of the semester course survey. Another comment from the end of the semester course survey from 2014, a student stated "I found this class to be very helpful to prepare for the future as a technologist." Students' perceptions of preparedness after taking the last semester registry preparation course at Radiography Program X identified three emergent or overarching themes.

The three emergent themes were discovered after categorizing the course element codes found within the open-ended comments from the end of the semester course survey and the post-graduation follow-up surveys. The three emergent themes revealed were 1) knowledge mastery, 2) exam familiarity, and 3) skill strategies. *Knowledge mastery* had the most course element codes and was the emergent theme found when answering the research questions.

Knowledge mastery, the most commonly seen emergent theme, included course element codes 1) mock exams, 2) reviews, 3) testing tool, and 4) textbook. The other emergent themes that were discovered during the coding process were *exam familiarity* and *skill strategies*. The emergent themes indicate that Radiography Program X students from 2013-2018 found a variety of aspects within the last semester registry preparation course to be beneficial in their preparation to take the American Registry of Radiologic Technologists (ARRT) certification exam. The emergent themes and course element codes provide Radiography Program X and other radiography programs insight into future course design when developing registry preparation courses.

When exploring students' perceptions of preparedness and the different assessment scores only small differences were found. The emergent theme of *knowledge mastery* was found when examining the cohort (2016-2018) that used the HESI Radiography Exit Exam preparation tool and the cohort (2013-2015) that did not. Also, *knowledge mastery* was the emergent theme when examining the HESI Radiography Exit Exam scores and perceptions of preparedness. Likewise, the emergent theme *knowledge mastery* was found when investigating ARRT exam scores and 1st time pass rates and perceptions of preparedness. The most common course element codes were the only difference seen when examining perceptions of preparedness and the assessment data. In most situations, *mock exams* was the most frequently seen course element code, however, *reviews* and *textbook* was also seen as one of the top course element codes.

Chapter five presents an interpretation of the results discussed in chapter four and aligns the findings with literature. Chapter five will discuss the implications and recommendations for action, along with recommendations for further study. Chapter five concludes with a summary.

CHAPTER 5

CONCLUSION

According to the U.S. Bureau of Labor Statistics (2019), the "Employment of radiologic technologists is projected to grow 9 percent from 2018 to 2028, faster than the average for all occupations" (para. 7). The increase in job demand may also increase the demand for education in the field. Radiography programs need to ensure their quality is known through program outcomes for perspective students to make an informed decision. On average, Radiography Program X's American Registry of Radiologic Technologists (ARRT) 1st time pass rate has been below the state by 2% and the national rate by 3% from 2013 to 2018 (ARRT, 2013, 2014, 2015, 2016, 2017, 2018a). Additionally, Radiography Program X's ARRT exam score average has been lower than the state by an average of 1.5 points and the nation by an average of 6 points for the same six years (ARRT, 2013, 2014, 2015, 2016, 2017, 2018a). Radiography programs such as Radiography Program X have curricula designed around the content specifications set forth by the ARRT (ARRT, 2018c). The ARRT requires students to complete a program of study that includes both didactic and clinical components and is accredited by bodies such as the Joint Review Committee on Education in Radiologic Technology (JRCERT) in order to qualify to take the ARRT certification exam (ARRT, 2018c; JRCERT, 2018). Due to the decreased ARRT exam scores and 1st time pass rates from Radiography Program X, the purpose of the research questions in this case study were to explore students' perceptions of their preparedness to take the ARRT certification exam after taking a last semester registry preparation course. The research questions that were asked to understand students' perceptions of preparedness were:

RQ1: What are the students' perceptions of their ARRT certification

exam preparedness after completing the last semester registry preparation course?

SQ1: How did the use of the HESI Radiography Exit Exam preparation tool affect students' perception(s)?

SQ2: What is the relationship between students' perceptions of preparedness and their HESI Radiography Exit Exam scores?

RQ2: What is the relationship between students' perceptions of exam preparedness and ARRT certification exam scores and pass rates?

SQ1: What is the difference between students' perceptions that used the HESI Radiography Exit Exam preparation tool and those who did not?

RQ3: What is the relationship between students' perceptions of preparedness before and after taking the ARRT exam?

SQ1: How did the use of the HESI Radiography Exit Exam preparation tool affect students' perception(s)?

The research questions in this case study were answered by exploring several datasets specific to the last semester registry preparation course at Radiography Program X from 2013 – 2018. Retrospective quantitative assessment explored American Registry of Radiologic Technologists (ARRT) exam scores and 1st time pass rates and HESI Radiography Exit Exam scores. Retrospective qualitative data to gain students' perceptions of preparedness after completing the last semester registry preparation course and before taking the ARRT exam were collected from the end of the semester course survey. In addition to the retrospective qualitative data, a post-graduation follow-up survey was designed specifically for this study and used to gather students' perceptions of preparedness to take the ARRT exam after taking the exam.

The methodology chosen for this study was a case study design. A case study, as stated by Creswell (2013), is a "qualitative approach in which the investigator explores a real-life, contemporary bounded system. . . through detailed, in-depth data collection involving multiple

sources of information, and reports a case description and case themes" (p. 97). This case study explored students' perceptions and assessment data specific to the Radiography Program X's last semester registry preparation course that was intended to prepare students to take the American Registry of Radiologic Technologists (ARRT) certification exam. The exploration of perceptions of preparedness was to elicit information that may inform future decisions regarding radiography student ARRT exam preparation. Differences in students' perceptions of preparedness relating to ARRT assessment data were also examined. In addition, this case study gathered information about Radiography Programs X's use of the HESI Radiography Exit Exam preparation tool as it related to students' perceptions of and success on the ARRT exam. The results of the study can aid in future improvements specific to radiography students' ARRT exam preparation and registry preparation course design.

This chapter interprets the findings presented in chapter four. The interpretation of findings includes how the results align with the literature reviewed. Chapter five also discusses the limitations of the study, along with recommendations for action and further research. The chapter concludes with closing statements.

Interpretation of Results

The significance and importance of this case study examining students' perceptions of their preparedness to take the American Registry of Radiologic Technologists (ARRT) certification exam is to provide insight into ARRT exam preparation tools and registry preparation courses to better prepared students for certification. Better preparation of radiologic technology students to take the ARRT exam has the possibility of improving the quality of imaging services and patient care due to the increased understanding and overall knowledgeability of the tasks of a radiologic technologist. Understanding students' perceptions of preparedness to take the ARRT exam may increase students' quality of imaging services and

patient care due to increased understanding and overall knowledgeability of the tasks of a radiologic technologist.

The conceptual framework for this study referenced the need to explore students' perceptions of preparedness to take the ARRT certification exam after taking a last semester registry preparation course. The theory-practice gap was the theoretical lens of this study and was defined by Botwe et al. (2017) as ". . . the discrepancy between what is taught (theory) in the classroom and what is actually practiced clinically" (p. 147). The theory-practice gap provided background to the necessity of this study and possible contributing factors in the decrease of the ARRT exam scores of radiography students. The Bowte et al. (2017) study concluded "It is considered detrimental to radiography education and effective practice and has profound implications for the future of the profession" (p. 147). The differences between didactic and clinical environments may potentially be providing misleading perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) certification exam due to students not performing best practices within the clinical setting. Due to the lack of literature pertaining to the didactic aspect of the theory-practice gap, this study focused on the last semester registry preparation course at Radiography Program X.

The interpretation of the results includes a discussion regarding participant demographics and the impact of response rates had on the results of this study. The emergent themes discovered during coding and answering the research questions are presented with a connection to literature. Limitations of the study are also be presented.

Participant Demographics

This case study included six graduated cohorts (2013 – 2018) with a total of 115 students from the Radiography Program X that completed the last semester registry preparation course. The first three cohorts (2013-2015) had 59 students who did not use the HESI Radiography Exit

Exam preparation tool. The second three cohorts (2016-2018) had 56 students who used the HESI preparation tool. The average age of all graduates from Radiography Program X between 2013-2018 was 25 with ages ranging from 20 to 46. The average age for the 2013 – 2015 cohort was 25 and 24 for the 2016 – 2018 cohort both cohorts also had ages ranging from 20 to 46.

Acknowledging the variety of ages within the radiography program plays an important role in providing support for differences in learning styles that may be seen as generational and possibly increase student success and satisfaction in the classroom (Cox, et al., 2013; Dungey & Yielder, 2017; Ward & Makela, 2010). Having a variety of learning and review methods for different learning styles is a necessity in a radiography program (Bahadure, Thsar, & Vagha, 2016; Hills & Levett-Jones, 2017; Lourenco & Cronan, 2017; Mangold, 2007; Skiba & Barton, 2006; Williams, Medina, & Clifton, 2017). Providing multiple methods of learning and testing within a registry preparation course may contribute to how students are best prepared for the exam and in turn, score on the ARRT exam.

Response Rates

This case study examined two surveys: end of semester course survey (before taking the ARRT exam) and the post-graduation follow-up survey (after taking the exam). The response rate for both surveys had a total of 57%, with a 74% response rates on the end of the semester course survey and 40% on the post-graduation follow-up survey. The end of the semester course survey had an overall higher response rate compared to the post-graduation follow-up survey, however, only the open-ended comments were used in this study. The total number of open-ended comments from both surveys were 78, 32 from the end of the semester course survey and 46 from the post-graduation follow-up survey. Even though the response rate for the end of the semester course survey was significantly higher than the post-graduation follow-up survey, more open-ended comments were from the post-graduation follow-up survey. In turn, the perceptions

of preparedness were from students after taking the ARRT exam. The post-graduation follow-up survey allowed students the opportunity to reflect on aspects of the last semester registry preparation course that they believed were beneficial in their preparation.

This case study also explored the effectiveness of the HESI Radiography Exit Exam preparation tool at Radiography Program X. The response rate for the cohort (2013-2015) that did not use the tool was higher at 65% compared to 53% for the cohort (2016-2018) that did use the tool. Moreover, the open-ended comments from the cohort that used the tool was 45 compared to 33 that did not use the tool. Most of the comments in this study were from the cohort (2015-2018) that used the HESI preparation tool and the post-graduation follow-up survey. With the focus of this study on perceptions of preparedness to take the ARRT exam and the effectiveness of the HESI preparation tool, it is important to note that the majority of the comments were from the cohort (2016-2018) that used the tool and after taking the ARRT exam.

Summary of Results, Emergent Themes and Course Element Codes

Students' perceptions of preparedness of the last semester registry preparation course at Radiography Program X from 2013-2018 revealed three emergent themes 1) knowledge mastery, 2) exam familiarity, and 3) skill strategies. *Knowledge mastery* was the most common emergent theme seen when answering each of the research questions. *Knowledge mastery* had *mock exams*, *reviews*, *testing tool*, and *textbook* as course element codes. *Knowledge mastery* provides students with ways to gain a deep understanding of the concepts on the ARRT exam. The course element code *mock exams* was found most frequent when answering the research questions. The other two emergent themes that were discovered during the coding process were 1) exam familiarity and 2) skill strategies. *Exam familiarity* had course element codes 1) certification exam process, 2) exam format, 3) questions type/format, and 4) simulated testing environment. *Exam familiarity* allows students to focus on content rather than the process and format of the

exam. The third emergent theme, *Skill strategies* included 1) study strategies, 2) test-taking skills, and 3) time management course element codes. *Skill strategies* offer students methods necessary to gain mastery of the required knowledge of a radiologic technologist. The emergent themes and course element codes provide Radiography Program X and other radiography programs insight into potential course design for a registry preparation course.

As mentioned previously, *knowledge mastery* was the most frequently seen emergent theme discovered when answering the research questions. When exploring perceptions of preparedness and assessment scores the most frequently seen theme was *knowledge mastery*. The perceptions were assessed with the HESI Radiography Exit Exam scores and American Registry of Radiologic Technologists (ARRT) exam scores and 1st time pass rates. The emergent theme found between the assessment scores and perceptions of preparedness were identical, which found *knowledge mastery* again to be the emergent theme.

In addition to student perceptions of preparedness, the research questions focusing on the effectiveness of the HESI preparation tool found that the tool had a positive impact on ARRT 1st time rates although not on the ARRT exam scores when comparing the assessment data of the cohort (2016-2018) that used the tool to the cohort (2013-2015) that did not. The HESI Radiography Exit Exam applies the HESI Predictability Model (HPM) to the scores and are placed within ranges to predict success on the ARRT exam (Elsevier, 2018). When comparing the ARRT exam score averages within the HESI score ranges a relationship existed. The average ARRT exam scores in the ranges lower than Acceptable were below the 75 required to pass the ARRT exam. It was difficult to determine the effectiveness of the HESI Radiography Exit Exam preparation tool based on the inconsistencies of the findings including mixed reviews found within the survey comments.

The perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) certification exam discovered from coding the end of the semester course survey and the post-graduation follow-up survey revealed 12 course element codes and three subsequent emergent themes. The 12 course element codes were 1) course overall, 2) certification process, 3) mock exams, 4) reviews, 5) testing tool, 6) textbook, 7) test-taking strategies, 8) exam format, 9) question type and format, 10) simulated testing environment, 11) study strategies, and 12) time management skills. The three emergent themes were 1) knowledge mastery, 2) exam familiarity, and 3) skill strategies. Each of the emergent themes provide insight into what students believe prepared them to take the ARRT exam and can be used in preparing future radiography students. These emergent themes and course element codes can be the foundation of a registry preparation course. Students' perceptions of preparedness to take the ARRT exam need to be considered when designing a registry preparation course to promote success on the exam and in practice. The following sections discuss each of the three emergent themes.

Exam familiarity. *Exam familiarity* was based on course element codes that were from open-ended comments, which pertained specifically to the format of the American Registry of Radiologic Technologists (ARRT) exam. The course element codes that contributed to the theme *exam familiarity* were 1) certification exam process, 2) exam format, 3) questions type/format, and 4) simulated testing environment. Students expressed not only the benefit of being familiar with the exam itself but also the process of applying for the certification exam. A graduate from the class of 2018 stated "This class gave guidance for the whole testing process from how to full out the application until the day of taking the test and I think it was one of the most important factors in my preparedness for the ARRT exam." Another 2018 graduate on the post-graduation follow-up survey commented "…receiving instructions on how to properly fill out any forms, as

well as tips to help relax/prepare the day before and the day of the exam gave me the ability to remove some of the anxiety and unknowns and focus solely on the test." Understanding the process of gaining certification may alleviate stress for students and allow them to focus on the content of the exam.

Students also reported that they felt understanding how the exam was formatted, the different formats of questions, and the exam timeframe was helpful in preparation. A 2013 graduate on the post-graduation follow-up survey stated, "The registry prep course prepared me by giving me a look into the exam style, question format, and time restraint." A 2016 graduate commented "A prep course, prepares you for the format of the test, not just studying course material" in their response to the post-graduation follow-up survey. In addition to students' insight into exam format being helpful, they also believed that taking mock exams in a simulated environment was beneficial in their preparation. On the post-graduation follow-up survey, a 2018 graduate said "The course . . . administered practice tests in an environment similar to what the actual testing center would be like." Therefore, it appears that students' familiarity with the ARRT exam can reduce stress and anxiety so they can focus on the content of the exam and not the process.

Gqweta's (2012) study examined students' perceptions regarding poor performance in the final year of their radiography program. The results indicated that poor academic performance was due to difficulty with understanding content, inadequate preparation, absence of independent study, confusion with assessment questions, and ineffective studying techniques (Gqweta, 2012). As indicated by Gqwerta's (2102) study and the results of this research study, it is important ensure students are familiar with exam format and question types/format. A graduate from the class of 2018 on the post-graduation follow-up survey stated,

I liked going over the formats in which questions could be asked by reviewing the ARRT website together. This is something I would never have thought about doing on my own. This, combined with receiving instructions on how to properly fill out any forms, as well as tops to help relax/prepare the day before and day of the exam, game me the ability to remove some of the anxiety/unknowns and focus solely on the test.

The emergent theme of *exam familiarity* offers students the opportunity to focus on the content of the exam not the process.

Knowledge mastery. *Knowledge mastery* was based on course element codes from open-ended comments that were related to methods of gaining a deeper understanding of the ARRT exam content. The course element codes for *knowledge mastery* were 1) mock exams, 2) reviews, 3) testing tool, and 4) textbook. *Mock exams, reviews, testing tools*, and *textbook* are all methods to assist in gaining mastery of exam concepts. Providing students with a variety of methods and activities to assist in mastering the knowledge required to pass the ARRT exam and practice as a radiographer offers educational opportunity for various learning styles.

Mock exams offer students the ability to test their knowledge of exam content. From the 2013 end of the semester course survey a student commented "The mock exam and review of material in class helped me identify my strengths and weaknesses so that I could focus on studying certain material that I had not absorbed as well over the course of the program." From the post-graduation follow-up survey, a 2016 graduate commented "The prep tests [mock exams] were invaluable." A graduate from 2017 stated "It [preparation course] prepared me in many areas, especially with the mock exams" on the post-graduation follow-up survey. Comprehensive mock exams offer students the opportunity to identify strengths and weakness specific to ARRT exam content. The comprehensive nature of the ARRT exam may be overwhelming for some students and *mock exams* provide insight into what to expect on exam day. When strengths and

weaknesses are identified students can focus their study to increase their understanding of the concepts.

In addition to mock exams, in class reviews before and after taking mock exams were found to be beneficial in preparing students to take the ARRT exam. In class reviews allow students the opportunity to ask instructors clarifying questions to better understand the concepts and how to evaluate and breakdown questions. A 2014 graduate on the post-graduation follow-up survey commented "I found that the reviews during the last semester tied all the prior education together." Also, on the post-graduation follow-up survey a graduate from 2018 stated "We were able to go over everything we had learned while being able to ask questions." Another graduate from the class of 2018 said "I think the most beneficial part of the course was the free time that was allowed for student / instructor discussion. We had many opportunities to ask questions about certain topics that we weren't quite understanding or struggling with." The comments regarding *reviews* indicate the benefit of *reviews* in ARRT exam preparation. In class reviews allow for students to ask clarifying questions regarding areas of weakness after completing mock exams. Instructors can offer interpretation and clarity to sometimes wordy and confusing textbooks.

Also categorized under knowledge mastery was *testing tool*. Testing tools may be used as a supplement in registry preparation courses. Radiography Program X used the HESI Radiography Exit Exam preparation tool which was found to have mixed perceptions . Two comments from the end of the semester course survey from 2016 stated "I think that HESI was really helpful" and "I don't believe it [HESI] is a good resource for prepping for the registry. The questions seemed to be inconsistent with the answers." A graduate from 2018 commented on the post-graduation follow-up survey "I believe the HESI tests were an eye opener in both positive and negative ways." Differences in learning styles may contribute to the differences in

perceptions of the preparation testing tool. Even though Radiography Program X presented

mixed perceptions specific to the HESI Radiography Exit Exam tool, the tool can provide

students with insight into their understanding of the concepts on the ARRT certification exam.

The tool also provides a format similar to the ARRT exam. Tools such as the HESI Radiography

Exit Exam can offer students with remediation after identifying areas of weakness for studying

and predictability of passing the ARRT exam.

In addition to mock exams, reviews, and testing tool, *textbook* was a course element code

under the emergent theme of *knowledge mastery*. Registry textbooks provide students with a

condensed version of concepts learned throughout a radiography program. In most cases, registry

preparation books are organized by exam topics and provide students with important need to

know concepts. From the end of the semester course survey a student from the class of 2017

commented they "…used the registry prep book a lot." A 2017 graduate stated on the post-

graduation follow-up survey "…utilizing review books helped me prepare." Registry preparation

courses are designed to review content on the ARRT exam and preparation *textbooks* can be

helpful in students' preparation to take the exam. In preparing to take the ARRT exam, reviewing

textbooks acquired over the entire program may be overwhelming for students. ARRT

preparation textbooks are a convenient and condensed version of the required knowledge and

concepts specific to the exam. In addition to providing radiography students with methods to

gain mastery of the knowledge require to pass the exam such as mock exams, reviews, and

testing tools, to ensure deeper understanding of the concepts, preparation courses should include

reflective practice.

Reflective practice has been growing in popularity within health professions education

(Mann, Gordon, & MacLeod, 2009). Reflective practice may construct in a variety of ways,

however, "most models of reflection include critical reflection on experience and practice that

would enable identification of learning needs" (Mann, Gordon, & MacLeod, 2009, p. 596). Reflective practice can be used within a registry preparation course by the use of mock exams which was discovered to be the most frequently seen course element code. Reflective practice can be applied in the classroom as well has the clinical setting (Baird, 2008; Falk et al., 2016; Mgbekem et al., 2016; Roth, Mavin, & Dekker, 2014; Scully, 2011). Having students take multiple mock exams allows for reflection on performance and prior learning to identify gaps in knowledge. The students would then review and take the mock exam again, with the anticipation of increased scores. Studies by Falk et al. (2016) and Mgbekem et al. (2016) provide some insight into methods such as reflective practice that are being used in the classroom specific comprehensive preparation courses such as the course in this study at Radiography Program X.

Skill strategies. The course elements categorized under the emergent theme of *skill strategies* were 1) study strategies, 2) testing-testing strategies, and 3) time management skills. Students may be unaware of different strategies for skills such as studying, test-taking, and time management. These skills can assist students in gaining mastery of content and passing the exam. Often students do not know how to study for a comprehensive exam such as a certification exam and how to manage their time properly. A 2017 graduate stated "The registry prep course taught us how to manage our study techniques and organize in order to feel more relaxed and confident while taking the registry" on the post-graduation follow-up survey. Another comment from the post-graduation follow-up survey from a 2015 graduate stated "It [preparation course] really helped with end of the year time management." Along with understanding different ways to study, awareness of test-taking strategies was also seen as a value in the last semester registry preparation course at Radiography Program X. On the end of the semester course survey a 2017 student stated "We learned a lot about test taking that benefitted me." Two 2018 graduates on the post-graduation follow-up survey commented "We were taught test-taking skills and how to

study even more on our own" and "The course …gave direction on the most effective study habits and way to maximize your time spent studying." Based on the emergent theme of *skills strategies*, students need to have an understanding of different studying methods to determine what works best for them in order to prepare on their own, outside of a registry preparation course.

Chamberlain (2015) conducted a study that asked nine radiography students questions pertaining to study skills helpful in passing the American Registry of Radiologic Technologists (ARRT) exam and what experiences they felt were most beneficial. The students revealed that self-motivation and self-monitoring were the most helpful in preparing for the exam. This study aligns with Chamberlain's (2015) study regarding students' acknowledgement for the need to know how to study and the necessity to study on their own. A 2017 graduate on the post-graduation follow-up survey commented "The registry prep course taught us how to manage our study techniques and organize in order to feel more relaxed and confident while taking the registry." Also on the post-graduation follow-up survey a graduate from the class of 2015 stated "having mandated set class time to study for the registry was extremely beneficial in many ways, it helped me and many of my classmates stay on target, it help us accountable for our own studying." The nature of the ARRT certification exam is to ensure radiologic technologists entering the field are knowledgeable of the of what is required of the profession (ARRT, 2018a).

Limitations of the Study

This study's focus on student perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) certification exam at one institution, Radiography Program X, makes it difficult to generalize to other radiography programs (Creswell, 2013; Merriam, 2009; Meyer, 2001). The focus on one institution only provides insight regarding how students were prepared at Radiography Program X. However, the methodology of this case study may be

transferable for future studies investigating radiography students' perceptions of preparedness (Patton, 2015). This case study and the nature of qualitative research does not determine causation of the problem, the decrease in ARRT exam scores and pass rates; this case study was intended to only be used as a resource when investigating student perceptions of exam preparedness and considering the use of radiography certification exam preparation tools.

This case study included the use of anonymous electronic surveys. The use of an anonymous survey may be considered a limitation due to the inability to ask participants clarifying questions regarding the open-ended comments (Creswell, 2015). The post-graduation follow-up survey only asked two questions: 1) graduation year and, 2) in what ways do you believe the last semester preparation course prepared you to take the American Registry of Radiologic Technologists (ARRT) exam, not asking if the student passed the exam the first time may be considered a limitation. Having awareness of those that passed compared to those who did not would differentiate perceptions and provide additional insight into preparedness. The end of semester course survey was a generic end of semester course survey used by all courses offered at Radiography Program X's institution. The end of semester course survey did not specifically ask students questions about their preparation to take the ARRT exam, merely evaluating the last semester registry course.

Implications and Recommendations for Action

With the increased job demand for radiologic technologists (U.S. Bureau of Labor Statistics, 2019) and the decrease in American Registry of Radiologic Technologists (ARRT) certification exam scores and 1st time pass rates at Radiography Program X, understanding perceptions of preparedness could increase the quality of registry preparation courses and radiologic technologists entering the field. The quality of a radiography program is important for practice due to radiologic technologists providing direct patient care and services.

The recommendations for action are developed from the emergent themes and course element codes discovered from answering the research questions and sub questions. The course design and what elements are used are important for students' exam preparation. The following were course element codes from perceptions of preparedness and based on frequency should be included as part of a registry preparation course design:

- Mock exams: provide students the opportunity to assess their knowledge to determine strengths and weaknesses,

- Reviews: allow students the opportunity to ask questions related to how questions are asked or to achieve a deeper understanding of the content,

- Question types and format: familiarity with how questions will be asked and presented allows for students to focus solely on the content,

- Exam format: knowing how to navigate the exam such as flagging questions, how to find the calculator and the timeframe gives students an idea of what to expect,

- Study strategies: provide students with different methods to study for a comprehensive exam, and

- Preparation textbook: a text that is a condensed version of the textbooks used throughout a radiography program that presents the need to know information for the exam.

Other course element codes indicate additional aspects such as reviewing the certification process where students review and practice filling out the application to take the exam is beneficial to a registry preparation course. Along with the certification application process, students also felt that understanding what to expect the day of the exam beforehand was beneficial and decreased anxiety and stress. A 2018 graduated stated on the post-graduation follow-up survey "receiving instructions on how to properly fill out any forms, as well as tips to

help relax/prepare the day before and day of the exam gave me the ability to remove some of the anxiety /unknowns and focus solely on the test." The American Registry of Radiologic Technologists (ARRT) website provides resources regarding the application process, the exam, and the testing site (ARRT, 2020); these resources can be used and shared with students within the last semester registry preparation course.

In addition to a multi-faceted last semester registry preparation course, it is important to understand the different learning styles of students (Cox, et al., 2013; Ward & Makela, 2010). A recommendation for Radiography Program X and other radiography programs is to have a greater understanding of their students' learning styles. Conducting a learning style questionnaire such as the Learning Styles of the Clinical Practice Questionnaire (LSCPQ) used in the Ward and Makela (2010) study may provide insight into the variety of students' learning styles. This information would assist in providing all students with optimal learning opportunities. Along with registry preparation course design, the results of a learning style questionnaire may also be beneficial to students. Students may not be aware of their own learning styles and the insight of a learning style questionnaire has the possibility of increasing their success within both the classroom and clinical environments.

A multifaceted registry preparation course assists student with the goal of in-depth understanding of concepts on the American Registry of Radiologic Technologists (ARRT) certification exam. A multifaceted registry preparation course could take into consideration the differences in learning styles of students to aid in the pursuit of gaining this knowledge. This in-depth mastery of the knowledge required to be a radiologic technologist may assist in decreasing the theory-practice gap, increase ARRT exam scores and 1st time pass rates, and increase the quality of radiologic technologists.

Recommendations for Further Research

Current literature explores a variety of elements specific to radiography programs, however, perceptions of preparedness as related to assessment scores were not found. This study provided details of how students/graduates believed the last semester registry preparation course at Radiography Program X prepared them to take the American Registry of Radiologic Technologists (ARRT) certification exam. Literature regarding perceptions of preparedness to take the ARRT exam is limited (Babcock, 2016; Chamberlain, 2015; Schmuck & Cook, 2018; Vealé et al., 2017; West, 2016). Prior studies have examined the perceptions of radiography students (Chamberlain, 2015; Gqweta, 2012; West, 2016) and studies that present assessment scores throughout a radiography student's program (Chamberlain, 2015; Davis, Groom, & Friesner, 2018; Finnel, 2018; Ferenchak, 2009; Gqweta, 2012; Kridiotis, Bezuidenhout, & Raubenheimer, 2016; Levy, 2018; Michael, 2018; Siemens, 2011; Vealé, Clark, Killion, & Sharma, 2017) however, studies that investigated the relationship between perceptions and assessment scores were not found. Due to the void in literature, this study contributes to literature regarding radiography education. While this case study focused on perceptions of preparedness to take the ARRT exam after completing a registry preparation course, a study examining students' perceptions regarding other aspects of their radiography program that were seen to be beneficial in exam preparation could also be conducted. A study with an aim on elements other than the registry preparation course may offer perceptions of additional aspects of a radiography program that could be emphasized to introduce exam preparation prior to the last semester.

The purpose of this study was to explore students' perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) certification exam after taking the last semester registry preparation course at Radiography Program X. The limitation of one program

leads to the need for additional studies investigating other radiography programs' perceptions of preparedness. Other radiography programs' students' perceptions may offer additional methods of exam preparation. Investigating additional radiography programs would increase validity of this study and increase the awareness for necessity of a multifaceted registry preparation course design.

This study focused solely on the didactic aspect of students' perceptions of preparedness, in turn, further research into the perceptions of preparedness to take the ARRT exam as it relates to the clinical environment is also recommended. Student perceptions focusing on how they believed the clinical environment prepared them to take the ARRT exam could offer insight into the relationship between theory and practice. Studying how the clinical component of a radiography program affects perceptions of preparedness to take the ARRT exam would complement this case study's focus on the didactic portion. Studies combining didactic and clinical radiography education is lacking. Better preparing students to take the American Registry of Radiologic Technologists (ARRT) certification exam has the potential to increase the quality of radiologic technologists entering the field.

The theoretical lens of this study was the theory-practice gap, the discrepancy of what is taught in the classroom and what is practiced in the clinical environment (Allen, 2014; Botwe, Arthur, Tenkorang, & Anim-Sampong, 2017; Falk, K., Falk, H., & Ung, 2016; Hanberg & Brown, 2006; Mgbekem, Ojong, Lukpata, Armon, & Kalu, 2016; Scully, 2011; Wilkinson, Smallidge, Boyd, & Giblin, 2015; Wright & Homer, 2017). This discrepancy between theory and practice may be a contributing factor of the American Registry of Radiologic Technologists' (ARRT) implementation of Continuing Qualifications Requirements (CQR). CQR is intended to fill knowledge gaps of practicing technologists (ARRT, 2017). Radiologic technologists who gained certification after 2010 are required to complete additional continuing educational

requirements to ensure they are knowledgeable of current best practice standards. Prior to CQR, registered radiologic technologists were considered 'once certified, forever qualified' (ARRT, 2012a, para.7); in order to meet the demands of the profession and patients this statement no longer applies. 'Once certified, forever learning, evolving and developing as a qualified professional' (ARRT, 2012a, para.7) is a statement now used to describe the requirements of maintaining ARRT registration; this is to ensure technologists are practicing based on current standards of practice. Extending research focusing on perceptions of preparedness to radiologic technologists who have completed the CQR requirements is recommended. A study investigating perceptions of preparedness of radiologic technologists that have completed CQR may provide insight for radiography students and programs to assist in methods of preparation and offer reflection of approaches to maintain knowledge of best practice standards required of a radiologic technologist.

Conclusion

The goal of radiography programs is to prepare students for a career as a high-quality radiologic technologist. Radiography programs must have both clinical and didactic portions for graduates to be eligible to be certified and registered by the American Registry of Radiologic Technologists (ARRT) (ARRT, 2018c). The purpose of this study was to examine students' perceptions of preparedness to take the ARRT certification exam after completing a registry preparation course. The consensus of the emergent themes and course element codes were that the registry preparation course at Radiography Program X was beneficial to their success on the ARRT exam. This study also showed that the HESI Radiography Exit Exam preparation tool was not frequently mentioned as a method of preparation, however, it does not mean that it did or did not contribute to student's success on the exam. Outside of the course itself, the three emergent themes discovered were 1) knowledge mastery, 2) exam familiarity, and 3) skill strategies. The

emergent theme that was most frequently found when answering the research questions and had the most course element codes was *knowledge mastery*. The most frequently seen course element code was *mock exams* which was categorized under knowledge mastery. A student said mock exams "helped me identify my strengths and weaknesses" another student commented "It [course] prepared me in many areas, especially with mock exams." In class *reviews* was the second most frequently seen course element code within the emergent theme of knowledge mastery, a student commented "we had many opportunities to ask questions about certain topics that we weren't quite understanding or were struggling with."

The second emergent theme with the most frequently seen course element codes was *exam familiarity*. Q*uestion types and format*, along with *exam format* were course element codes under the theme of exam familiarity. Mock exams may provide students with insight into different types and formats of questions and have a structure similar to the ARRT exam, however, registry preparation courses can include resources directly from the ARRT specific to the question types and exam structure to assist in students' preparation to take the exam.

The third emergent theme with the least frequently seen course element codes was *skill strategies*. Even though the emergent theme of skill strategies was not the most common, *study strategies* was found to be one of the top five course element codes. Some students may not know where to begin studying or how to study all the information acquired in a radiography program. Students felt that the registry preparation course "gave direction on the most effective study habits and ways to maximize your time spent studying." Students need to be aware of the skills necessary to study for and successfully take a comprehensive exam such as the American Registry of Radiologic Technologists (ARRT) certification exam.

The necessity and benefit of offering a registry preparation course within a radiography program was made apparent when analyzing open-ended comments from students and graduates

at Radiography Program X. A graduate from 2013 said "I work with students from a different school and they do not have a course like this and they all say that they wish they did." Another graduate from 2016 commented "they [fellow radiologic technologist] told me they had no prep course like I had previously and over half of their class failed the registry."

The benefit of a registry preparation course was also demonstrated from the class of 2017 by a participant sharing "I always say how great it was to have that class in my program, and [am] shocked that not every program has it." Post-graduation follow-up surveys reflect the benefit of the registry preparation course in ARRT certification exam readiness. Gaining the perspective of others regarding a registry preparation course may offer students reflection and greater appreciation for the last semester registry preparation course.

This case study examined the perceptions of preparedness at Radiography Program X from 2013-2018 and the results indicated that the last semester registry preparation course was helpful in preparing students to take the American Registry of Radiologic Technologists (ARRT) certification exam. The recommendations for Radiography Program X faculty and administration is to continue a multifaceted registry preparation course that considered learning styles, however, investigating how the clinical environment affects students' perceptions of preparedness may provide additional insight into low ARRT scores and pass rates. Radiologic technologists are the third largest health profession only to be exceeded by nurses and doctors (ARRT, n.d.c.). Radiologic technologists are an integral part of the healthcare team that provides care and services to patients in a variety of settings. Radiography education needs to prepare students to take the ARRT exam to become certified to start a career as radiologic technologists producing high-quality images and providing exceptional patient care.

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APPENDIX A

End of semester course survey

Q1 Please rate your experience of the instructor:

Answered: 1   Skipped: 0

	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	N/A	TOTAL	WEIGHTED AVERAGE
Content is consistent with course objectives.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00
Instructor presents material in an organized manner.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00
Instructor facilitates the understanding of the subject matter through the use of examples.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00
Instructor uses a variety of teaching methods and technique such as AV aids, demonstration, lecture, role play, etc.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00
Instructor encourages questions through class discussion or online forum.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00
Instructor encourages students to problem solve and think critically.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00
Instructor includes new trends and information.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00

#	PLEASE INCLUDE ANY ADDITIONAL COMMENTS REGARDING THIS INSTRUCTOR:	DATE
1	.	3/21/2020 11:21 PM

Q2 Please evaluate your experience of the course:

Answered: 1   Skipped: 0

	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE	N/A	TOTAL	WEIGHTED AVERAGE
The course objectives were met.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00
The course objectives gave me a clear idea of what was expected.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00
The course built on my previous knowledge and experience.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00
Learning activities were related to the course objectives.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00

Learning aids enhanced my understanding of the material.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00
Required readings clarified lecture content.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00
Test questions were related to subject matter.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00
Written assignments enhanced learning of the subject matter.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00
Overall, I am satisfied that the environment at ▮▮▮▮▮▮ meets my learning needs.	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 1	1	0.00

#	PLEASE COMMENT ON QUALITIES OF THE COURSE THAT YOU FOUND BENEFICIAL, AND AREAS/WAYS WE CAN IMPROVE:	DATE
1	.	3/21/2020 11:21 PM

Q3 Please identify the "USAGE" of each of the resources:

Answered: 0   Skipped: 1

	USED FREQUENTLY	USED OCCASIONALLY	NOT USED AT ALL	TOTAL	WEIGHTED AVERAGE
Text:	0.00% 0	0.00% 0	0.00% 0	0	0.00
Canvas:	0.00% 0	0.00% 0	0.00% 0	0	0.00

#	PLEASE INCLUDE ANY ADDITIONAL COMMENTS REGARDING THE USAGE OF THE RESOURCES:	DATE
1	.	3/21/2020 11:22 PM

Q4 Please identify the "QUALITY" of each of the resources:

Answered: 0   Skipped: 1

	EXCELLENT	GOOD	POOR	TOTAL	WEIGHTED AVERAGE
Text:	0.00% 0	0.00% 0	0.00% 0	0	0.00
Canvas:	0.00% 0	0.00% 0	0.00% 0	0	0.00

#	PLEASE INCLUDE ANY ADDITIONAL COMMENTS REGARDING THE QUALITY OF THE RESOURCES:	DATE
1	.	3/21/2020 11:22 PM

APPENDIX B

Post-graduation follow-up survey

Survey Email

Subject of Email: Help Improve Radiography Student ARRT Exam Preparation

Hi [Graduate's Name],

It's one of your favorite instructors from ███████████████! I am currently in my third year of a doctoral degree program at the University of New England and I am looking for radiography graduates to fill out a quick survey pertaining to the research study I am conducting.

UNIVERSITY OF NEW ENGLAND
CONSENT FOR PARTICIPATION
IN ANONYMOUS SURVEY RESEARCH

Project Title: American Registry of Radiologic Technologists Exam Preparation: A Case Study
Principal Investigator(s): Sarah E. Harradon
Introduction:

- Please read this form. The purpose of this form is to give you information about this research study.
- You are encouraged to ask any questions that you may have about this study, now, during or after the project is complete.
- Your participation is voluntary.

Why is this research study being done?

The purpose of this research study is to examine students' perceptions of preparedness to take the American Registry of Radiologic Technologists (ARRT) certification exam as it relates to different exam preparation tools and ARRT exam scores and 1st time pass rates.

Who will be in this study?

███████████ Radiologic Technology graduates from 2013 – 2018.

What will I be asked to do?

You will be asked to answer two questions regarding the last semester registry preparation course you completed at ██████████.

What are the possible risks of taking part in this study?

There are no reasonably foreseeable risks for participating in this study.

What are the possible benefits of taking part in this study?

There are no foreseeable benefits to participating in this study. However, the data collected may enhance exam preparation of future radiography students.

What will it cost me?

There is no cost to participate in this study.

How will my privacy be protected?

You will be completing this survey anonymously, only including graduation year. The college nor program name will not be included in the study.

PLEASE NOTE: THE UNE INSTITUTIONAL REVIEW BOARD MAY REVIEW THE RESEARCH RECORDS.

<u>How will my data be kept confidential?</u>

The results of the survey will only be used for the purpose of this dissertation research study. No personal identifiers apart from graduation year will be collected. The name of the college nor the program will be identified within the dissertation. All collected data will stored on a password protected home computer and deleted after five years.

PLEASE NOTE: IF YOU HAVE BEEN TOLD THAT THIS SURVEY IS ANONYMOUS, PLEASE DO INCLUDE ANY INFORMATION THAT CAN IDENTIFY YOU.

<u>What are my rights as a research participant?</u>

- Your participation is voluntary. Your decision to participate will have no impact on your current or future relations with the University.
- Your decision to participate will not affect your relationship with Sarah Harradon.
- You may skip or refuse to answer any question for any reason.
- If you choose not to participate there is no penalty to you and you will not lose any benefits that you are otherwise entitled to receive.
- You are free to withdraw from this research study at any time, for any reason.
    - If you choose to withdraw from the research there will be no penalty to you and you will not lose any benefits that you are otherwise entitled to receive.
- You will be informed of any significant findings developed during the course of the research that may affect your willingness to participate in the research.
- If you sustain an injury while participating in this study, your participation may be ended.

<u>What other options do I have?</u>

- You may choose not to participate.

<u>Whom may I contact with questions?</u>

- The researcher conducting this study is Sarah Harradon
    - For more information regarding this study, please contact 207-795-2461
- If you choose to participate in this research study and believe you may have suffered a research related injury, please contact William Boozang, Ed.D., researcher's advisor at (508) 446-7685 or wboozang@une.edu
- If you have any questions or concerns about your rights as a research subject, you may call Mary Bachman DeSilva, Sc.D., Chair of the UNE Institutional Review Board at (207) 221-4567 or irb@une.edu.

<u>Will I receive a copy of this consent form?</u>

- You print and keep a copy of this consent form.

I understand the above description of the research and the risks and benefits associated with my participation as a research subject. I understand that by proceeding with this survey I agree to take part in this research and do so voluntarily.

REDCap Survey Link:

Thank you for your time in assisting my endeavor to prepare radiography students of the future.

Sarah Harradon

REDCap Survey Questions will include:
1. *Graduation year*

2. *In what ways do you believe the last semester graduation registry preparation course prepared you to take the American Registry of Radiologic Technologist (ARRT) certification exam?*

APPENDIX C

Pilot test of post-graduation follow-up survey

Subject of Email: Pilot My Research Study Survey Questions
Hi [Graduate's Name]
As you know I am working towards my doctoral degree at the University of New England and I
am looking for some feedback regarding survey questions I intend to ask in my research study.
Below you will find the intended email correspondence and survey questions, along with
questions to help me determine if modifications are necessary.
Thank you in advance for your assistance,
Sarah

Subject of Email: Help Improve ARRT Exam Preparation
Hi [Graduate's Name],
It's one of your favorite instructors from ████████████! I am currently in my third year of
a doctoral degree program at the University of New England and I am looking for radiography
graduates to fill out a quick survey pertaining to the research study I am conducting.
Project Title: American Registry of Radiologic Technologists Exam Preparation: A Case Study
Principal Investigator(s): Sarah E. Harradon
Introduction:

- Please read this form. The purpose of this form is to give you information about this
  research study.
- You are encouraged to ask any questions that you may have about this study, now, during
  or after the project is complete.
- Your participation is voluntary.

Why is this research study being done?
The purpose of this research study is to examine students' perceptions of preparedness to take
the American Registry of Radiologic Technologists (ARRT) certification exam as it relates to
different exam preparation tools and ARRT exam scores and 1st time pass rates.
Who will be in this study?
████████████ Radiologic Technology graduates from 2013 – 2018.
What will I be asked to do?
You will be asked to answer two questions regarding the last semester registry preparation
course you completed at ████████████.
What are the possible risks of taking part in this study?
There are no reasonably foreseeable risks for participating in this study.
What are the possible benefits of taking part in this study?
There are no foreseeable benefits for participating in this study. However, the data collected may
enhance exam preparation of future radiography students.
What will it cost me?
There is no cost to participate in this study.
How will my privacy be protected?

You will be completing this survey anonymously, only including graduation year.

PLEASE NOTE: THE UNE INSTITUTIONAL REVIEW BOARD MAY REVIEW THE RESEARCH RECORDS.

How will my data be kept confidential?

The results of the survey will only be used for the purpose of this dissertation research study. No personal identifiers apart from graduation year will be collected. All collected data will stored on a password protected home computer and deleted after five years.

PLEASE NOTE: IF YOU HAVE BEEN TOLD THAT THIS SURVEY IS ANONYMOUS, PLEASE DO INCLUDE ANY INFORMATION THAT CAN IDENTIFY YOU.

What are my rights as a research participant?

- Your participation is voluntary. Your decision to participate will have no impact on your current or future relations with the University.
- Your decision to participate will not affect your relationship with Sarah Harradon.
- You may skip or refuse to answer any question for any reason.
- If you choose not to participate there is no penalty to you and you will not lose any benefits that you are otherwise entitled to receive.
- You are free to withdraw from this research study at any time, for any reason.
  - If you choose to withdraw from the research there will be no penalty to you and you will not lose any benefits that you are otherwise entitled to receive.
- You will be informed of any significant findings developed during the course of the research that may affect your willingness to participate in the research.
- If you sustain an injury while participating in this study, your participation may be ended.

What other options do I have?

- You may choose not to participate.

Whom may I contact with questions?

- The researcher conducting this study is Sarah Harradon
  - For more information regarding this study, please contact 207-795-2461
- If you choose to participate in this research study and believe you may have suffered a research related injury, please contact William Boozang, Ed.D., researcher's advisor at (508) 446-7685 or wboozang@une.edu
- If you have any questions or concerns about your rights as a research subject, you may call Mary Bachman DeSilva, Sc.D., Chair of the UNE Institutional Review Board at (207) 221-4567 or irb@une.edu.

Will I receive a copy of this consent form?

- You print and keep a copy of this consent form.

I understand the above description of the research and the risks and benefits associated with my participation as a research subject. I understand that by proceeding with this survey I agree to take part in this research and do so voluntarily.

REDCap Survey Link: *will be provided here. The survey questions include:*
  1. *Graduation year*

2. *In what ways do you believe the last semester graduation registry preparation course prepared you to take the American Registry of Radiologic Technologist (ARRT) certification exam?*

Thank you for your time in assisting my endeavor to prepare radiography students of the future.
Sarah Harradon
Please answer the following questions regarding the introduction email and survey questions:

1. *Did the introduction email provide adequate information to justify participation in the study?*

2. *Did the introduction email provide enough clear information:*

   a. *That your participation in the study would be kept anonymous?*

   b. *That your participation in the study was voluntary?*

   c. *That you would be consenting to participate in the study by completing the survey?*

3. *Were the survey questions easy to answer?*

Thank you for taking the time to assist me in this endeavor. If you have any questions regarding this pilot test of my survey, please don't hesitate to ask.

Sarah