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Prediction of Radiography Certification Examination Scores Using Astin's Input-Environment-Output Model

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Prediction of Radiography Certification Examination Scores Using Astin's Input-Environment-
Output Model

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Education in Adult Education and Lifelong Learning

by

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Abstract

Numerous health profession fields, including radiology, have attempted to identify predictors of success on their respective credentialing exams. This preregistered study seeks to determine if available academic performance measures may predict radiography national certification examination scores and help educators identify students for remediation and support. The study will use the Astin Input-Environment-Output Model, which ascertains that student outcomes are a result of what they bring into an academic program and the environment experienced during the program. The non-experimental retrospective study will look at the 2018 to 2021 Arkansas State University radiography cohorts. Multiple regression will be used to determine if reading comprehension, final course grade in college algebra, GPA in prerequisite sciences courses, and final grade in Image Acquisition and Evaluation II can predict success on the radiography certification examination. Findings from this study will help guide program admission criteria and identify students for remediation and support before taking the certification examination.

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Dedication

To my husband, Randy, you are my source of calm in the storm. Thank you for the unwavering support and encouragement. I love you more today than yesterday. To my children, Cameron and Grayson, you are the joys of my life. You give me strength when I can find none on my own. Shoot for the stars, my dears. You can do hard things! To my mother and late father, Kathy and Walter Davis, thank you for showing me that hard work and dedication payoff. Your love, support, and encouragement have pushed me to be all I can be.

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Chapter 1

Overview of Chapter

This chapter introduces a proposed study investigating how available academic performance measures may predict radiography national certification examination scores and help educators identify students for remediation and support. Such measures may include reading comprehension, grade point average in prerequisite science courses, final course grade in College Algebra, and the final course grade in Image Acquisition and Evaluation II. I discuss how there is minimal empirical research on radiography program admission criteria's impact on certification success and how this outcome impacts programmatic accreditation. After introducing the study's background, need, and purpose, I define concepts related to reading comprehension, admissions criteria, and the national credentialing examination. Next, I present the research questions guiding the study. The chapter concludes with a discussion of the study's scope and limitations.

Background of Study

X-rays, discovered at the end of the twentieth century, were quickly embraced by the medical community as a tool to diagnose patients' injuries and illnesses. Administering these new rays, however, was not without risk, and it soon became evident that education and demonstration of competence were essential for those practicing radiography (Frankel, 1996; Kansare et al., 2011; Whitmore, 1995). In the 1920s, the radiography profession began to grow in status as organizations were created to provide guidance and oversight. The American Registry of Radiologic Technologists (ARRT) was one of those organizations. In 1922, it administered the first certification examination for the field, a test consisting of 20 questions and

a skills demonstration (ARRT, n.d.a). This examination has evolved over the years to a 200-question multiple-choice assessment.

To be employed in the field, many states require individuals practicing in radiography to pass the certification examination (American Society of Radiologic Technologists [ASRT], 2021). To sit for the ARRT radiography examination, candidates must first complete an accredited education program (ARRT, 2021a). Programs may be programmatically accredited or accredited through a broader educational agency approved by the ARRT such as international, national, regional, or faith-related accreditations. The Joint Review Committee on Education in Radiologic Technology (JRCERT) offers programmatic accreditation. Program specific accreditations, such as JRCERT, offers the benefit of peer review specific to the field of radiology to ensure quality education. In addition, as part of the JRCERT accreditation standards, programs must demonstrate a five-year average certification pass rate of no less than 75% at the first attempt within the first six months after graduation (JRCERT, 2021, p. 44). A program's accreditation status may be placed on probation or revoked for failure to meet set standards. The national pass rate for 2021 was 83.8%, and Arkansas's average was 85% (ARRT, 2021b, p. 7). Arkansas State University, the institution used for this study, has a current five-year pass rate of 85.8% (Arkansas State University, 2020).

Given the high stakes involved with programmatic accreditation, the challenge for radiography program administrators is determining which students have the best chance of passing the certification examination. Most radiography programs use a competitive admission process for cohort selection with more applicants than available seats in the program (C. Hensley, personal communication, April 12, 2022; C.O. DuBose, personal communication, April 12, 2022; K. Haynes, personal communication, April 13, 2022). For this reason, program

administrators are interested in determining if there are measures that can predict success on the certification examination.

Previous research has examined different admission tests, prerequisite courses, program curriculum, and exit examinations as possible predictors of certification exam success (Iorio et al., 2021; Kavanagh, 1981; Kwan et al., 2009; Veale et al., 2017; Wynne, 2021). However, previous studies in radiology have not included a factor such as reading comprehension. Reading comprehension can play a vital role in a people's understanding of a subject and their ability to pass certification examinations (Aldridge et al., 2009; Ambrosino et al., 1974; Green, 2019). Students are coming to college under-prepared for the demands of college reading, and many are not reading at the required level (Flink, 2020; Nelson et al., 2019; Cline, 1973) The American College Test (ACT) (2006) demonstrated that reading comprehension can impact every subject area a student encounters. Previous studies have shown that students with poorer reading comprehension struggle academically and are less successful on certification exams (Aldridge et al., 2010; Ambrosino et al. 1974; Austin, 2011; Green, 2019; Entwisle & Hebel, 1977). If reading comprehension skills predict radiologic certification exam success, program administrators would have a valuable piece of information to ensure program viability.

Need and Purpose

Numerous health profession fields have attempted to identify predictors of success on their respective credentialing exams (Austin, 2011; Conway, Klaasen, 2016; Allen & Diaz, 2013; Aldridge et al., 2010; Sloas et al., 2013; Brown et al., 2013; Gale et al., 2016; Wambuguh et al., 2016). Many studies examine various combinations of prerequisite coursework, preadmission testing, program curricula, and program completion assessments. The most heavily researched variables include prerequisite science, math courses, and preadmission testing options (Aldridge

et al., 2010; Austin, 2011; Gale et al., 2016; Iorio et al., 2021; Kavanagh, 1981; Kwan et al., 2009; Sloas et al., 2013; Veale et al., 2017; Wambuguh et al., 2016).

Despite a great deal of research in other fields, there is little published research on radiologic technology program admission criteria and their relationships with student success on the certification examination. Epsen et al. (2006) surveyed 34 radiography programs about admission criteria and found no universal standards. The most common admission requirements included cumulative GPA, math and sciences course completion, interviews, and various standardized tests. Their findings showed that fewer than half of the surveyed programs assess admission criteria for possible correlations with program or certification success. Epsen et al. concluded by calling for researchers to investigate potential correlations between specific admission criteria and student success.

Several studies specific to radiologic technology have looked at prerequisite courses and student success. Menser and Hughey (2020) surveyed JRCERT programs to determine what admission criteria were being used and found that half of those surveyed used College Algebra and Anatomy and Physiology as prerequisite courses for program admission. This study supports the findings of Epsen, et al.(2006). College Algebra has been found to predict success in programs and certification examinations (Kavanagh, 1981; Kwan et al. 2009). Science courses, including anatomy, have also been shown to predict student success in academic programs and certification examinations (Kwan et al., 2009; Iorio et al., 2021; Wambuguh et al., 2016).

Two studies sought to determine if preadmission testing could predict student success on the radiography certification examination. Veale et al. (2017) studied the HESI Admission Assessment and certification success. They found that students with a score greater than 70 on the HESI A2 exam went on to pass the certification exam on the first attempt. Wynne (2021)

looked at the predictive value of the Test of Essential Academic Skills (TEAS) and Psychological Services Bureau-Health Occupations Aptitude Test (PSB-HOAT) admission examinations and the certification exam. This research showed that both assessments could equally predict success on the certification exam.

To date, there have been no studies linking reading comprehension and radiography certification results. However, studies in other healthcare fields have identified correlations between reading ability and certification exams. Entwisle and Hebel (1977) found that medical students with higher reading comprehension skills had higher academic performance than those with lower skills. Ambrosino et al. (1974) found that medical students who scored below the fiftieth percentile in reading comprehension often went on to have academic difficulties. Furthermore, Aldridge et al. (2010) and Green (2019) found a positive relationship between reading comprehension and physical therapy certification examination results. Research shows that better reading comprehension is associated with better student outcomes. Radiography programs could benefit from this information by evaluating reading comprehension during program admission to determine which students would benefit from additional assistance.

The purpose of this study is to determine if readily accessible information such as reading comprehension skills, grade point average on prerequisite science courses, final grade in College Algebra, and Image Acquisition and Evaluation II final course grade can predict success on the national certification examination. In the United States, forty-five states require those practicing in radiography to be licensed (ASRT, 2021a). Licensure requires the passing of the national certification examination. If radiography program graduates are unable to pass the certification examination, they are unable to practice clinically. In addition, programs must report first-time examination pass rates to maintain programmatic accreditation.

This study uses a non-experimental cross-sectional design and convenience sample from Arkansas State University's Medical Imaging and Radiation Sciences Radiography Program to identify predictors of success on the national certification examination. Arkansas State University is a public four-year institution located in Northeastern Arkansas with a student population of 14,085 (Arkansas State University, n.d.a). Data will be gathered from the classes of 2018 to 2021. Multiple linear regression will be used to evaluate the relationship between the variables and student outcomes.

Arkansas State University admits one radiography cohort per year. If admitted students do not complete the program, it results in a loss revenue for the school. In addition, students not accepted must wait one year to reapply or choose a different major costing them more time and money. The admission criteria used has never been evaluated to determine if it can predict student success. The results of this study will be used to adjust admission requirement and allow for better selection of students. One course from the radiography curriculum will also be included in this research. The imaging acquisition and evaluation course comprises 30% of the certification examination and has been a trouble area for students at Arkansas State University and nationally. Arkansas State University students score at or below the mean national average in this category annually. If a relationship is found between this course and the certification examination, plans can be established to help students proactively. This study could help identify students who could benefit from early intervention or remediation, thereby giving them a better chance at success on the certification exam.

Definition of Concepts

Admission criteria- A set of measures used to determine acceptance into a competitive admissions program. Typically, items such as overall GPA, program selected prerequisite

courses GPA, standardized testing, interviews, etc. are used to calculate admissions scores and allow for ranking of students.

Anatomy and Physiology I- “Introduction to the biology of atoms, molecules, organelles and cellular functions, tissues, functional anatomy of integumentary, skeletal, muscular and central nervous systems, interaction with external environment” (Arkansas State University, 2021, p 468).

Anatomy and Physiology I Lab- “The behavior of matter with respect to life processes, cells, tissues, functional anatomy of integumentary, skeletal, muscular and nervous systems, cat anatomy, nerve and muscle preparations and recordings” Arkansas State University, 2021, p 468).

College Algebra- “Equations and inequalities, functions and graphs, polynomial and rational functions, exponential and logarithmic functions, systems of equations and inequalities, and miscellaneous topics” (Arkansas State University, 2021, p 539).

Image Acquisition and Evaluation II- A course that “continues the study of image acquisition and evaluation begun in RAD 3213 with specific emphasis on digital image acquisition errors, image artifacts, pathology effects on image quality and technique chart development and use” (Arkansas State University, 2021, p 592).

Physical science course- A course designed to explore inanimate objects and concepts. These include courses in chemistry, physics, earth, and space sciences, etc.

Radiologic technologist- A medical professional who specializes in x-ray imaging examinations under the direction of a physician.

Reading comprehension- The ability to understand and apply the written word. Reading comprehension is achieved when readers can build upon previous knowledge and form connections with the intended meaning of new written material (Yeari & Van der Broek, 2011).

Scores on national certification examination- National certification provides recognition to individuals who are qualified by demonstration of knowledge and skills to perform a certain role (ARRT, n.d.b). The ARRT uses scaled scores of 1 to 99. A score of 75 is required to become certified (ARRT, 2021c, p. 54). The ARRT provides reports with alumni certification examination scores and details to Radiologic Technology Program Directors.

Student GPA- “A measure of scholastic attainment computed by dividing the total number of grade points received by the total number of credits or hours of course work taken” (Dictionary.com, 2021, para. 1). GPA in prerequisite science courses and the final course grade in College Algebra will be used for this study. For the radiography program at Arkansas State University, Human Anatomy and Physiology I with lab and Physical Science with lab or an equivalent are included in the prerequisite course GPA for the admission process.

Statement of Research Problem

Annually, radiologic technology programs have more applicants than available seats in a new cohort (C. Hensley, personal communication, April 12, 2022; C.O. DuBose, personal communication, April 12, 2022; K. Haynes, personal communication, April 13, 2022). The ASRT (2021) reported that an estimated 15,477 students were accepted to radiography programs while 8,599 students were turned away from admission in 2021. According to the Bureau of Labor Statistics (BLS), 20,800 new radiography jobs will be added annually between 2020-2030 (BLS, 2022). Given the growing need for radiologic technologists, selecting qualified candidates is imperative to increase the likelihood of student success in the program and passing the

certification examination. Finding a model that can assist programs in developing admission criteria and guide support initiatives is essential.

Research Question

One principal research question guides this study:

For radiologic technology students, do reading comprehension test scores, GPA in prerequisite science courses, final course grade in College Algebra, and final course grade in Image Acquisition and Evaluation II predict the score on the national certification examination?

Scope and Limitations

This study will utilize a convenience sample of bachelor's degree radiography graduates from one university in Arkansas. Arkansas State University requires students to complete radiography and an additional imaging specialty such as mammography or sonography. Due to the curriculum sequence, students must wait one year from completing the radiography curriculum until they graduate with their degree and are eligible to sit for the certification examination. In addition, the sample population is mainly white females and therefore lacks diversity. As such, it will be difficult to generalize to a broader population of radiography students.

GPA's and test scores are subject to participant motivation. Not all students strive for the highest GPA or test scores possible. It seems reasonable to believe students would attempt to perform to the best of their abilities given the competitive admissions process involved in radiography programs. However, this motivation may not carry over to performance within the radiography curriculum once the competition aspect is no longer a concern.

The number of academic factors evaluated is also a limitation of this study. Other academic courses or student situations may also play a role. These may include undisclosed learning disabilities, student employment status, and family issues which are not routinely documented by the program. The variables chosen for this study are readily available. Three of the four variables selected, College Algebra, prerequisite science courses, and reading comprehension, have been found to have an impact on student success in other healthcare professions. Radiography requires a strong understanding of math and science. Students must calculate technical factors that impact patient exposure and safety. They must also be able to identify and image the necessary anatomy to provide competent patient care. Furthermore, these variables are part of the program admission scores at Arkansas State University. The program has not accessed the value of these courses in predicting certification results. The fourth, final course grade in Image Acquisition and Evaluation II, corresponds with one-third of the certification examination content specification and has been a low scoring area for students at Arkansas State University. Based on the results of this study, course content could be modified to improve student success.

The Covid-19 pandemic is also a concern for this study. In the spring of 2020, didactic classes and labs transitioned from face-to-face to online learning. Many students and faculty voiced concern over the transition and its impact on learning. In addition, many of the clinical sites closed to student experiences for several months. This resulted in students having to simulate procedures, which may have decreased the learning that comes from hands-on real-world experiences. Of the four cohorts included, the class of 2021 is the only group in which radiography curriculum was impacted. To date, the pass rate of this cohort is similar to previous cohorts and there is no indication this has caused a significant issue for this group.

Summary

Empirical research on radiography program admission criteria and its impact on passing the national certification examination is exceptionally limited. Being able to obtain state licensure and work in the profession are heavily dependent on passing this examination. This study hopes to identify variables that can predict scores on the certification exam and identify students who could benefit from early intervention and remediation.

Chapter 2

Literature Review

This literature review begins with a historical review of the radiography profession. Providing an overview of the field's rich history is necessary to understand how and why regulations on practice standards and educational programs became required. It is essential to understand the process of becoming a registered radiographer, including education and certification examination requirements.

Next, the requirements for education program admissions practices are reviewed. Most programs use a combination of prerequisite courses and preadmission testing, but there is no standard for programs to follow. As part of this discussion, the literature on reading comprehension and student success in college is discussed.

The chapter concludes with an overview of predictive studies concerning certification examination success for other healthcare professions and radiography programs. Fields such as dental hygiene, medical laboratory sciences, nursing, physical therapy, and physician assistant have sought answers to what best predicts student success.

Literature Review Process

A search for relevant literature was performed using Cumulative Index of Nursing and Allied Health Literature (CINHAL) and Academic Search Complete. Keywords included combinations of reading comprehension, admission criteria, student success, certification, registry examination, radiologic technology, and medical imaging. Due to the scarcity of literature specific to radiologic technology, healthcare was added as a search term to include other professions. In addition, the reference lists of each source were used to identify additional resources.

History of the Radiography Profession

X-rays were discovered on November 8, 1895, by Dr. Wilhelm Roentgen (Frankel, 1996; Natale, 2011). His wife's hand served as the first subject for what would become radiographs. As word spread of the discovery, the potential for medical uses of these rays were quickly put into practice. In 1901, Roentgen won the first Nobel Prize in physics for the discovery (Frankel, 1996; Whitmore, 1995). It did not take long for the commercial uses of such technology to be exploited. X-rays began to be used as side-show attractions and various other non-medical uses such as demonstrating the fit of shoes in department stores (Frankel, 1996; Natale, 2011). It became apparent early on in its history that the use of X-rays was not without consequences. Scientists quickly discovered the ability of x-rays to cause burns and hair loss. Eventually, deaths were even tied to its use. The first documented death caused by radiation exposure was Clarence Dally, an assistant to Thomas Edison who had been heavily involved with research regarding x-rays (Frankel, 1996; Sansare et al., 2011; Whitmore, 1995). With the potential for injury and death to patients and x-ray operators, it became clear that training and regulation was needed in this newly developing field.

The American Society of Radiologic Technologists (ASRT) was founded in 1920 to improve education and legitimacy of the profession. The ASRT began with 13 individuals and today has over 156,000 members (ASRT, 2021b). The Registry, now known as the American Registry of Radiologic Technologists (ARRT), was also founded in 1920 to provide an avenue for practicing radiographers to demonstrate competence in the field. Radiographers would sit for a certification examination and, if successful, their names would be added to the Registry thus making them registered radiologic technologists (ASRT, 2021; Cullinan & Cullinan, 1995; Reid, 1995). The first certification examination was administered in 1922 to Sister M. Beatrice

Merrigan (ARRT, n.d.a). At that time, the examination consisted of 20 essay questions and required the demonstration of hands-on skills. The first year, the ARRT had 89 individuals on the Registry. Today, the ARRT has more than 330,000 registrants (ARRT, n.d.a).

Present Day Path to Becoming a Registered Radiographer

The ARRT developed the radiography examination to ensure competence of entry level radiologic technologists. An applicant for the ARRT examination must meet minimum education requirements including a clinical component, attest to ethical practices, and successfully pass the ARRT examination to become a Registered Technologist (R.T.). Applicants are required to complete an education program in radiography. The radiography program must be regionally accredited or programmatically accredited with the JRCERT or offered through the United States military to meet ARRT education requirements. Applicants must also possess an associate degree or higher (ARRT, 2021c). Upon completion of an educational program, applicants are allowed three attempts in three years to pass the examination. If the applicant fails to pass the exam on the third attempt, the radiography education component must be repeated (ARRT, n.d.c).

Today, the ARRT examination contains 220 multiple choice questions of which 200 are scored while 20 are used as pilot questions. Examination content is periodically reviewed and updated using task inventories. A task inventory questionnaire is sent to practicing registered radiographers to determine which skills an entry level radiographer should possess. Once the results of this have been compiled, questions are developed by item writers and vetted for accuracy, difficulty, and relevance to the profession. An examination committee then develops exams of equal difficulty to be used to assess competence as an entry level radiographer (ARRT, n.d.d). Content areas and their portion of the examination include patient care 16.5%, radiation

safety 25%, image production 25.5%, and imaging procedures 33% (ARRT, 2021a). Scaled scoring is used to determine if an applicant passes or fails the assessment. With scaled scoring, each item is assigned a score based on its level of difficulty. A scaled score of 75 on the ARRT examination is required to become a R.T.

JRCERT accredited educational programs are required to submit annual reports demonstrating that the graduates have met minimum outcomes. Programs must demonstrate a five-year average job placement rate of 75% or greater, a five-year average of credentialing examination pass rate of 75% or greater, and report on program completion. Programs that do not meet these outcome thresholds may be subject to accreditation probation or suspension (JRCERT, 2020).

Radiography Program Admissions and Selection Criteria

Most radiography programs include a competitive admission process. The availability of seats in a program often depends on the availability of limited clinical resources. As such, there are more program applicants than there are available spots. Given the impact of program outcomes on the accreditation status of the programs, selecting students who will be successful is of the utmost importance. While the ASRT does provide guidelines for programs to follow for curriculum development, there are no set admission requirements (ASRT, 2017). The lack of standardized admission criteria for various healthcare programs, including radiography, has been noted in previous research (Ingrassia, 2016; Sanderson, 2015). Ingrassia (2016) published a literature review discussing what admission criteria are being used by allied health programs. She concluded that further research should be performed to develop common admission criteria for radiography programs. Sanderson (2015) looked at admission criteria for dental hygiene and, like Sanderson, noted that programs could benefit from a standardized admission criterion.

Programs can only use their best judgment and previous data to make decisions regarding what to include when trying to determine which students will complete the program and successfully pass the certification exam. Many programs accept one cohort per year. Selection of students who will not complete the program or are not likely to pass the certification exam results in other students missing an opportunity in the program and the loss of revenue to the educational institution.

Prerequisite Courses Grade Point Average

Many programs use specific courses to aid in computing a total admissions score (Kavanagh, 1981; Kwan et al., 2009). The use of specific courses allows for a more accurate comparison of applicants. This is due to the inconsistent nature of course selections made by students that make up an overall GPA and differences in grading between disciplines (Goldman & Slaughter, 1976; Iorio et al., 2021). Typical courses included in the prerequisite GPA are physical science, anatomy and physiology, and college algebra among others. However, there are no set rules for programs to follow. Kavanagh (1981) found a significant correlation between college algebra and success in a radiation physics course. Kwan et al. (2009) found a significant relationship between prerequisite science courses and success in medical radiation programs as well as strong correlations between undergraduate math grades and certification examination composite scores. Research performed by Iorio et al. (2021) found that prerequisite anatomy scores were equally significant when it comes to the certification examination for both first and non-first generational students. Concerning the certification exam for registered nursing, Wambuguh et al. (2016) found pre-admission science GPA of at least 3.8 provided a 98 percent probability of passing the NCLEX-RN exam. These studies support the use of GPA in

prerequisite science and math courses as an indicator of student success and the ability to pass the required certification examinations.

Preadmission testing

Several studies have examined preadmission tests. The Health Education Systems, Inc (HESI) Admission Assessment (A2) was a variable of interest in a study by Veale et al. (2017). This entrance exam evaluates reading comprehension, anatomy and physiology, math, and chemistry in student pursuing healthcare related fields. The researchers found students scoring over 70 on the HESIA2 successfully completed the radiography program and passed the certification examination on the first attempt whereas those below 70 did not pass on the first attempt. Wambugh et al. (2016) studied the predicative value of the Test of Essential Academic Skills (TEAS) preadmission test. Students scoring 82 or above on the TEAS test showed a 96 percent probability of passing the nursing certification exam.

Reading Comprehension

More students are entering college underprepared for the rigors of college reading (Flink, 2020). Undergraduate students are expected to dedicate a significant amount of time to reading and understanding course materials. In a study by St. Clair-Thompson et al. (2018), it was reported that students read an average of 14.1 hours per week. During the focus group portion of the study, students cited a lack of confidence in comprehending reading assignments as a reason for spending less time on reading. Students completing programs in healthcare are often required to read a larger quantity of material than those in other fields and increased comprehension is important given the difficulty of the material (Haught & Walls, 2002). In addition, reading comprehension impact all academic areas. ACT (2006) found that student scoring at the

benchmark level for college readiness in reading also scored higher in English, math, and science.

The impact of reading ability on academic performance in undergraduate and graduate level students has been studied for many decades (Aldridge et al., 2010; Ambrosino et al., 1974; Entwisle & Hebel, 1977; Austin, 2011; Jackson & Brooks, 1985). Studies have found reading comprehension difficulties in medical students resulted in students having struggles in their studies (Ambrosino et al., 1974; Entwisle & Hebel, 1977). Aldridge et al. (2010) found a significant correlation between the reading comprehension of physical therapy students and the test scores on the national physical therapy licensure examination. In another study, the reading portion of the ACT exam was found to be a strong predictor of success on the national dental hygiene board examination (Austin, 2011).

Nelson et al. (2019) studied the readability of college general education textbooks, specifically physical science, life sciences, and social sciences. The researchers found readability of these materials to be at a grade 12 reading level for a 75% comprehension level. Terry Cline (1973) looked at the reading level of 17 different textbooks meant for university freshman and compared this against the reading levels of the students engaged in these courses. The study found that most of the textbooks were written at a level above 50% of the students' comprehension levels. This highlights the need for students to be at an appropriate reading comprehension level to understand the material being presented to them.

For medical textbooks and medical information in general, comprehension can prove more difficult (Baker & Gollop, 2004; Bange et al. 2019). Bange et al. looked at the readability level of information available to the public on RadiologyInfo.org. The researchers determined the average readability level to be at the 12th grade level. It is important to note that the American

Medical Association and the National Institutes of Health recommend medical information available to the public be at or below the sixth-grade level so that a larger population can comprehend what is being read (Baker & Gollop, 2004; Bange et al. 2019). Baker and Gollop (2004) studied the readability of 10 medical textbooks using graduate students enrolled in graduate level Library Professionals and Gallop's Information Resources and Services courses. Their results showed that all the medical textbooks chosen had a Flesch Reading Ease (FRE) score of less than 60 and the average FRE score was 14.08. The FRE for normal writing is between 60-70 with lower numbers indicating more difficult reading. The students in the study were asked to circle words that were unfamiliar to them. These words were often anatomical, pathological, or pharmaceutical in nature and are heavily studied in healthcare programs.

Overall, the results of the studies on reading comprehension indicate that students with poorer reading comprehension struggle more in academic courses and are less likely to pass certification examinations on the first attempt. There are various measurements tools available to determine a student's reading abilities such as the ACT, SAT, MCAT, TEAS test, etc. For this study, the Nelson Denny Reading Test is being used.

Nelson Denny Reading Test. The Nelson Denny Reading Test (NDRT) has been in use since 1929. This assessment is used to determine the reading ability of individuals from ninth grade through graduate school. One of the measures of reading comprehension provided by the NDRT is a grade level equivalent for the test taker; meaning a score of 13.3 correlates with a freshman in college during the third month. This assessment can identify those above or below their peers in reading ability which could impact learning (Fishco, 2019). The examination consists of two sections; an 80-item vocabulary section with a 15-minute time limit and a 38-

question comprehension section which uses seven different reading passages with a 20-minute time limit (Fishco, 2019, p. 2).

The reliability and validity of the NDRT has been documented. The reliability has been measured using coefficient alpha, alternate form- immediate administration, test-retest, and alternate form- delayed administration. All measures of reliability were over the .80 threshold (Fishco, 2019). Among the information provided by the exam publisher is the concept of time sampling error. In their research, this was not found to be an issue for individuals taking the assessment on two occasions two weeks apart (Fishco, 2019, p. 47). Validity of the instrument was confirmed in high school and college level learners, and the assessment has not demonstrated any bias among demographic subgroups. However, in a study by Ready et al. (2012), it was found that individuals taking the NDRT without reading the accompanying passages correctly answered double the number expected by chance bringing into question the validity of the reading comprehension component of the assessment. While this study may call the issue of validity into question, Fishco (2019) states, “a test’s validity must be investigated repeatedly until a conclusive body of research has accumulated. The study of a test’s validity is an ongoing process” (p.57). One study questioning validity is not strong enough reason to discount an instrument that has been in use for many decades. In fact, studies have been conducted evaluating the NDRT with other reading assessments. A study by Jackson and Brooks (1985) found the NDRT to be a better predictor of student success when compared to the reading portion of the Medical College Admission Test (MCAT). It is believed this instrument has the necessary reliability and validity to be used as a measure of a student’s reading comprehension in this study.

Predicative Studies for Credentialing Success

Many healthcare fields have explored various methods of predicting credentialing success for program graduates. These fields include dental hygiene, laboratory sciences, pharmacy, physical therapy, physician assistant, and radiography. Studies use different combinations of pre-admission testing examinations, prerequisite coursework, specific program curriculum, and exit testing in attempts to predict success. The follow summarizes such research.

Dental Hygiene.

Determining which admission factors can be used to predict success on the National Board Dental Hygiene Examination (NBDHE) was the focus of a study by Lynn Austin (2011). Austin reviewed the admission scores and NBDHE scores of 214 dental hygiene students from Western Kentucky University. A specific focus of the study was to evaluate if reading comprehension, as measured by the reading portion of the ACT, played a role in predicting success on the NBDHE given the large number of case presentation questions on the examination. The study looked at correlations between factors including specific course grades in microbiology and lab, anatomy and physiology, psychology, English, overall GPA, ACT composite score and scores on each individual component and the overall NBDHE score and the case-based section score. For the overall NBDHE score and the case-based score, the most significant predictors of success were microbiology lecture course grade and ACT reading score.

Medical laboratory sciences.

As a result of above normal attrition in one medical laboratory sciences (MLS) program, Conway-Klaasen (2016) reviewed the admission process to determine if any factors could predict student success measured by on-time program completion. Initially, the program used only overall and prerequisite coursework GPA to determine admission. The study aimed to

compare the old admission process with a new two-step admission process which involved first looking at cognitive factors such as cumulative GPA, science specific GPA, and prerequisite completion and then selecting candidates to continue with an interview and multiple skills assessment activity. The study looked at two cohorts of students totaling 121 research subjects. Science GPA and prerequisite science courses showed a significant difference between students who graduated on-time verses those who were delayed or did not graduate. Concerning the interview process, only conflict management ratings displayed a moderate effect on student success. The cognitive measures on the skills test included items such as object measurement, chemistry problems, writing, and Purdue Pegboard. The cognitive measures showed a large effect size concerning student success. Board of Certification (BOC) scores were compared to determine if there was a significant difference between groups. While there was not significant difference between groups, all measured GPAs did show a significant correlation with BOC scores. In addition, some interview and skill test measures showed significant correlations with BOC scores. The MLS program in this study saw a decrease in student attrition from 14% prior to implementation of the new admission criteria to 4% after implementation.

Pharmacy.

Allen and Diaz (2013) researched prepharmacy and pharmacy program predictors of success on the North American Pharmacist Licensure Examination (NAPLEX). A total of 432 students were included in the research. The study specifically looked at pre-admission science and math GPA, cumulative GPA, existence of unsatisfactory grades, previous degree earned, and transfer status. Prepharmacy GPA showed the most significant correlation with success on NAPLEX. In addition, the presence of at least one unsatisfactory grade (D or F) decreased the

likelihood of passing NAPLEX on the first attempt. There was no difference in pass rates between internal and transfer students.

Physical Therapy (PT) and Physical Therapy Assistant (PTA).

Correlation between the Nelson Denny Reading Test (NDRT) and the National Physical Therapy Licensure Examination (NPTE) was the focus of a study performed by Aldridge et al. (2010). The study showed a significant correlation between NDRT and the NPTE with a moderate positive relationship. Of those who passed the NPTE on the first attempt, reading comprehension could explain 25% of the variance as opposed to 15% of those who did not pass on the first attempt. In addition, there was a weak relationship between NDRT and NPTE for those who failed the first NPTE attempt. In its conclusion, the research team determined that NDRT could be included in admission criteria to better predict which students would be successful on the NPTE.

Sloas et al. (2013) sought to find a regression formula that would predict student failure on the NPTE to proactively provide remediation. The study looked at pre-admission GPA, the NDRT, eight specific physical therapy assistant academic courses, and three mock registry examination scores as possible predictors of NPTE scores of 111 students. The eight courses included Patient Care Fundamentals, Movement Science, Physical Agents and Massage, Musculoskeletal Physical Therapy, Neuromuscular Physical Therapy I, Cardiopulmonary Physical Therapy, Seminar, and Neuromuscular Physical Therapy II. Of the PTA courses, Physical Agents and Massage was found to have a strong correlation, Seminar had a weak correlation, and the other six had moderate correlations. The NDRT was broken down into vocabulary, comprehension, composite, and total score with comprehension showing the strongest positive correlation but vocabulary showing the most promise in the predicative

regression formula. The three mock examinations demonstrated moderate correlation.

Regression models were developed for end-of-first semester, end-of-second semester, and end-of-program. In the initial cohort studied, six students failed the NPTE on the first attempt. Of those six, all six failures were identified when the predicted score was raised to 620 for the end-of-first semester, 615- for the end-of-second semester, and 617 for end-of-program. The NPTE requires a score of 600. As a result of this study, students with a predicative score of less than 620 are required to develop a plan to assist in successfully passing the NPTE on the first attempt.

Physician Assistant (PA).

Brown et al. (2013) sought to determine if overall undergraduate GPA, specific science GPA, science pre-requisite taken at a two-year or four-year institution, or the amount of previous healthcare experience correlated with student success on the Physician Assistance National Certifying Exam (PANCE) score. The study looked at 119 students spread across three cohorts of students from one midwestern university. There was no correlation identified between student success and preadmission GPA, science GPA, or healthcare experience. Students who took most of their prerequisite science courses at a two-year institution demonstrated a moderate correlation with being unsuccessful on PANCE compared to students who took prerequisite science courses at a four-year institution. The PA program GPA and specific PA course grades did demonstrate strong correlations with PANCE scores. The study concluded that further information is needed to determine what admission criteria could be used to determine PA student success. In addition, the study did find that pharmacology and anatomy courses included in the PA program could be used as guides in determining which students might benefit from remediation.

Nursing.

Gale et al. (2016) studied the use of multiple mini-interview (MMI) during the admission process as a way to predict academic success and to assess whether bias in terms of age, gender, nationality, or location of secondary education was present with such measures. The study looked at one cohort of 204 students retrospectively at years one, two, and three. In this study, MMIs were used in addition to literacy and mathematical ability assessments. The MMIs were designed to measure a student's caring, compassion, competence, communication, courage, and commitment. MMIs involved applicants moving through a series of timed activities. Activities included role play, talking through scenarios, or completing a task. Each scenario was observed by faculty or healthcare professional and scored. Findings showed MMIs and mathematical ability significantly predict student success whereas literacy did not. Bias was not identified.

Wambuguh et al. (2016) studied admission criteria in relation to nursing program success. The researchers in this study sought to determine if pre-program science GPA, previous experience in healthcare, scores on the Test of Essential Academic Skills (TEAS), post baccalaureate status, and transfer versus in-house students could predict nursing student success in completing the nursing program, nursing program GPA, and/or passing the nursing credentialing examination. The TEAS test was the only independent factor significantly predicting program completions. The study found that applicants scoring at or above an 82 on TEAS had a 93% chance of successful program completions. However, those below an 82 on TEAS still had an 85% chance of program completion. TEAS and pre-program science GPA were found to be significant predictors of NCLEX-RN success. Again, these results should be viewed cautiously as a TEAS score at or above 82 predicts NCLEX-RN success by 96%, a score below 82 still had an 87% success rate. The same applies to pre-program science courses. A pre-

program science course GPA of at least 3.8 has a 98% probability of passing NCLEX-RN on the first attempt while those with a pre-program science GPA of less than 3.8 have an 87% probability of first attempt NCLEX-RN success. Prior healthcare experience, post baccalaureate status, nor transfer status proved significant in determining student success as measured by program completion, nursing program GPA, or passing the NCLEX-RN examination.

Radiography.

The correlation of the Health Education Systems, Inc (HESI) Admission Assessment (A2), HESI radiography exit examination, program exit examination, and first-time pass rates on the ARRT radiography examination was the focus of a research study performed by Veale et al. (2017). The HESI radiography exit examination is a commercially available exit examination while the program exit examination is created by program faculty. This study looked at two cohorts of radiography students. The HESI radiography exit exam, program exit exam, and ARRT radiography exam showed a strong positive correlation for the first cohort. For the second cohort, there was a weak correlation between the HESI exit exam with both the program exit exam and the ARRT radiography exam. However, there was a positive correlation between the program exit exam and the ARRT radiography exam for cohort two. The data from the HESI A2 exam demonstrated that a cut score of 70 resulted in students successfully matriculating through the program and passing the ARRT radiography examination on the first attempt. The findings of this study suggest the HESI A2 may be a good addition to program admission processes as it correlates well with program and certification examination success. In addition, findings suggest the HESI radiography exit examination is a good predictor of student success on the ARRT radiography examination and may allow for remediation efforts prior to students sitting for the national credentialing examination.

Kwan et al. (2009) evaluated admission criteria, program performance, and successfully passing the Canadian credentialing examinations for radiography, nuclear medicine, and radiation therapy. The credentialing exam for Canada is similar in requirements and content to the ARRT examination. Due to a small sample size, no regression analysis was performed, and results were correlations only. The study found a significant correlation between certification exam in radiography results and undergraduate mathematics and overall undergraduate GPA as well as significant correlations between certification exam in radiation therapy results and undergraduate biology and overall undergraduate GPA. Nuclear medicine was not evaluated due to the exceptionally small sample size opting to participate in the study. There was no correlation between the non-cognitive admission criteria, such as interviews, and performance in the programs or the certification examinations. Overall, the study found that admission criteria at this radiation sciences program was doing an adequate job at predicting student success.

Summary of Predicative Literature.

The literature presented above highlight the vast variety of admission criteria and attempts to predict success in academic programs and certification results. Greater science and math abilities are one common theme that was found (Austin, 2011; Kavahagh, 1981; Kwan, et al., 2009; Iorio et al, 2021, Wambuguh et al., 2016; Gale et al., 2016). A second common theme was preadmission testing, particularly one that measures reading comprehension. The better a student's reading ability, the more likely they are to be successful on certification examinations (Veale et al., 2017; Wambuguh et al., 2016; Aldridge et al., 2010; Austin, 2011; Sloas et al., 2013).

Theoretical Framework

A theoretical framework helps to guide a research study. For this research Austin's IEO Model of Assessment in higher education will be used. This model asserts that outcomes are the result of what a student brings into the educational process as well as what is experienced within the educational environment.

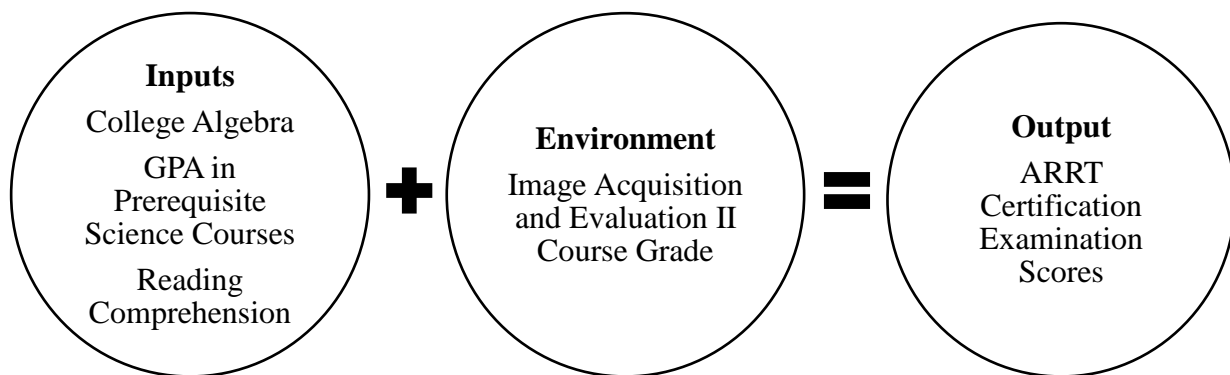
According to Astin and Antonio (2012), inputs fall into two categories: fixed or invariant. Fixed inputs include items such as gender, race and ethnicity, parental income, etc. Invariant inputs include cognitive measures such as test scores and grades, attitudes about education, self-expectations and ratings, and behaviors.

Environmental factors can be divided into the education institution as a whole or the educational experience within the institution. Experiences within the institution may include variables such as classes taken within curriculum, faculty teaching practices, extracurricular activities, physical surroundings, living conditions, etc., whereas the educational institution would include student population, public versus private, etc. as environmental variables. Astin and Antonio (2021) state environmental measures closer to the individual student have greater significance on the measured output.

Outputs or outcomes may be classified as cognitive and noncognitive. Noncognitive outputs would include variables such as student satisfaction and attitudes. Cognitive outputs tend to carry greater weight from an institutional or accreditation standpoint and may include variables such as final grade point average and certification examinations. Professional outcomes such as those tested on certification examinations are designed to measure entry level competence required to be successful in a particular field (Astin & Antonio, 2021).

The IEO model fits the proposed research problem as it seeks to identify relationships between the inputs of reading comprehension and prerequisite course work, the environment variable of a specific course final grade, and the certification exam results as the output. Cheven, et al. (2017) used IEO to explain the process for early acceptance into a physical therapy program. The study looked at admissions requirements as inputs, curriculum structure as environment, and program measured required outcomes like first time credentialing results and employment as outputs. In a radiology specific study, Wynne (2021) sought to determine if there was a predictive validity to selective math GPA, science GPA, TEAS admission exam, health occupational aptitude test, radiologic equipment course GPA, and passing the ARRT examination. The study drew its sample from five different two-year programs over the course of three years. Results showed science GPA and preadmission testing (TEAS and PSB-HOAT) to be significant predictors of success on the ARRT examination. The other courses had no statistical significance on the measured output. The study proposed here follows the structure of the studies laid out by Wynne (2021) and Cheven et al (2017). Figure 1 shows the relationship between the independent and dependent variable using the IEO model.

Figure 1 *IEO Model*



Hypothesis

Previous studies have shown reading comprehension plays a role in predicting student success on various certification examinations (Aldridge et al., 2010; Allen & Diaz, 2013); Austin, 2011; Sloas et al., 2013). Studies in nursing and radiography have shown correlations between prerequisite math and science courses and success on certification examinations (Iorio, Edmunds & Becerra, 2021; Kavanagh, 1981; Kwan et al., 2009; Wambuguh et al., 2016). In addition, previous studies have shown a positive correlation between specific courses in professional curriculum and success on certifications examinations (Brown et al., 2013; Sloas, et al., 2013; Wynne, 2021). Image Acquisition and Evaluation II was selected for this study due to the amount of content included on the certification examination. This section of the examination has historically been a problem area for Arkansas State University radiography students as well as one of the lowest scoring areas reported by the ARRT for national results (ARRT, 2021a).

From a review of the literature, the following hypothesis was formed:

For radiologic technology students, increases in reading comprehension scores, prerequisite science course GPAs, College Algebra course grades, and Image Acquisition and Evaluation II course grades will be associated with increases in national certification examination scores.

This hypothesis aligns with the IEO model which states the desired outcomes result from student input and the educational environment.

Summary

Many different healthcare fields have attempted to discover what variables predict student success on certification examinations. Factors considered for evaluation included various pre-admission testing, prerequisite coursework, specific courses in the professional curriculum,

program specific grade point average, exit examinations, and overall grade point average. Most studies include more than one of the mentioned variables in various combinations.

To date, no studies concerning radiologic technology have included reading comprehension skills as part of the inquiry. Radiographic technology students are expected to read and comprehend advanced level texts yet many students continue to struggle in this area. Research results from other healthcare disciplines have indicated that early identification of reading difficulties can assist in identifying students that could benefit from additional intervention and remediation.

Chapter 3

Introduction

This chapter begins with a review of the research questions and hypotheses. Next, a detail description of the research methods, setting, participants, materials, and measures is presented. Data collection and analysis procedures is then discussed. The chapter concludes with potential issues surrounding internal and external validity.

Research Questions and Hypotheses

This study seeks to identify variables that can predict scores on the national certification examination for radiography. The research question is, for radiologic technology students, do reading comprehension skills, GPA in prerequisite science courses, final course grade in College Algebra, and final course grade in Image Acquisition and Evaluation II predict success on the national credentialing examination? Based on previous research, I propose four hypotheses that specify the relationship between each variable and the outcome.

Hypothesis 1: As reading comprehension scores increase, national certification examination scores will increase. The null hypothesis is $b_1 = 0$. The alternate hypothesis is $b_1 > 0$.

Hypothesis 2: As GPA in prerequisite science courses increases, national certification examination scores will increase. The null hypothesis is $b_2 = 0$. The alternate hypothesis is $b_2 > 0$.

Hypothesis 3: As the course grade in College Algebra increases, national certification examination scores will increase. The null hypothesis is $b_3 = 0$. The alternate hypothesis is $b_3 > 0$.

Hypothesis 4: As the final grade in Image Acquisition and Evaluation II increases, national certification examination scores will increase. The null hypothesis is $b_4 = 0$. The alternate hypothesis is $b_4 > 0$.

Methods

Study Design

The study uses a non-experimental retrospective cross-sectional design with secondary data from the radiography cohorts of 2018 through 2021. Austin's I-E-O model guides the study. The I-E-O model looks for relationships between input students bring with them to a program, environment factors experienced by the students during a program, and an output measure that assesses what the students took from a program (Astin & Antonio, 2010; Chevan et al., 2017). For this study, inputs include the independent variables of NDRT score, GPA in prerequisite science courses, and final course grade in College Algebra. The environmental factor will be assessed through Image Acquisition and Evaluation II and the output is the dependent variable, certification examination results. Data from the radiography graduates in the 2018 to 2021 cohorts are used to determine if a predicative model for certification examination scores can be obtained from the input and environmental factors.

Study Setting

The study setting is Arkansas State University. Arkansas State University began in 1909 as an agricultural high school. It transitioned to a college offering bachelor level degrees in 1930 and finally received university status in 1967 (Arkansas State University, n.d.b). In the Fall 2021, A-State reported a total student population of 14,085. The campus population consists of 60% females and 74% Caucasian, 13% African American, and 13% other ethnicities (A-State, n.d.a). A-State offers 114 undergraduate degree programs not including certificates and minors.

The Radiologic Technology program at A-State began in 1981 as an associate degree program (Medical Imaging and Radiation Sciences, n.d.). The curriculum transitioned to a bachelor's degree in Radiologic Sciences in 2018. Students complete 18 months of radiography curriculum followed by 12 to 18 months of specialty curriculum. The program receives 80 to 120 student applications annually to fill approximately 35 spots depending on clinical site availability. Once students graduate, they are eligible to sit for the national certification examinations. Available specialties include cardiovascular interventional (CVI), diagnostic medical sonography (DMS), mammography, magnetic resonance imaging (MRI), and radiation therapy. DMS, MRI, and radiation therapy are primary pathway specialties meaning the national certification examinations for those can be taken without first passing the radiography examination. CVI and mammography are post primary specialties and require the passage of the radiography certification examination prior to taking the corresponding specialty certification (ARRT, n.d.e).

Participants and Placement

Participants are graduates of the Bachelor of Science in Radiologic Sciences program from the cohorts of 2018 to 2021. A nonrandom convenience sample is used for ease of access. Only students who have taken the NDRT and the same prerequisite courses will be included in the study. Students with advanced placement credit for prerequisite science and math courses, those who did not take the NDRT as part of the admissions process, and those who have not taken the national radiography examination are excluded from this study. It is important to note that, during program application, students have the option to submit ACT scores instead of taking the NDRT. The demographic of the sample population is predominately white females.

The total sample size is projected to be 90 graduates. A G-Power analysis was performed to determine the number of participants needed to have adequate statistical power for the analysis. Using a two-tailed T test, an alpha error probability of 0.05, a power of 0.80, and four predictors, at least 85 participants are necessary to identify a medium sized effect ($f^2 = .15$).

Table 3.1 Cohort composition

Cohort	Students Admitted	Students Graduating	Students included in the study
2018	35	34	28
2019	37	33	22
2020	35	33	20
2021	29	28	20
Totals	136	128	90

Materials

All materials needed for this study are available through student transcripts, admission documents, and the director of the radiography program. The GPA in prerequisite science courses, course grade in College Algebra, and the NDRT score are part of the students' admission documents. The final course grade in Image Acquisition and Evaluation II will be found in the students' transcripts and certification examination results will be obtained from the radiography program director.

Measures

Dependent Variable

Individual national certification examination scores serve as the dependent variable. National credentialing provides recognition to individuals who are qualified by demonstration of

knowledge and skills to perform a certain role (ARRT, n.d.b). The ARRT uses scaled scores of 1 to 99. A score of 75 is required to become credentialed (ARRT, 2021, p. 54). The ARRT provides reports with alumni credentialing examination scores and detailed section reports to Radiologic Technology Program Directors.

Independent Variables

Reading Comprehension Skills score. The ability to understand and apply the written word defines reading comprehension. It is achieved when readers can build upon previous knowledge and form connections with the intended meaning of new written material (Yeari & Van der Broek, 2011). For this study, reading comprehension is operationalized with the NDRT. This assessment uses separate vocabulary and reading passage sections to obtain a grade equivalent reading level score for the individual test taker.

The NDRT has been in use since 1929 to evaluate the reading ability of the test takers (Fishco, 2019). Since its inception, this instrument has undergone 5 revisions to update content. 3,487 students were used to determine normative values. These students ranged from high school students to college students with no less than 100 cases being required per grade level (Fishco, 2019, p. 26). The reliability of the NDRT was confirmed through coefficients alpha, alternate form- immediate administration, test-retest, and alternate form-delayed administration assessments. (Fishco, 2019, p. 43). The reliability coefficients were found to be consistently above the .80 minimum. Validity of the instrument was supported with data concerning content-description validity, criterion-prediction, and construct-identification validity (Fishco, 2019, p. 57). To date, research results have shown the NDRT to be a valid and reliable instrument to assess reading ability and comprehension. The producers of the NDRT assessment noted the

need for continued evaluation of the tools validity as this is something that may change with the times and a greater body of research (Fishco, 2019).

The assessment consists of a vocabulary section and a reading comprehension section. The vocabulary section consists of 80 items for students to answer with a 15-minute time limit. Reading comprehension consists of 38 questions requiring the reading of seven passages with a 20-minute time limit. The total test administration, including time for verbal instructions, takes 45 minutes (Fishco, 2019).

NDRT administration at A-State occurs over several days to allow students to schedule a time that works best with their schedule. The assessment is administered in small groups in a classroom with two faculty proctors. The NDRT provides a grade or age equivalent score. For this study, grade equivalent is the chosen measure of reading comprehension. The minimum score accepted to progress in the application process is 14. This would translate to a student who is has a reading comprehension level expected for the 14th grade level or a sophomore in college. The reading comprehension score is used as part of the overall admission score. Scores are included on the student's program admissions scoring record. These documents are maintained by the Radiography Program Director.

Prerequisite science GPA and College Algebra grade. Specific courses required for application to the radiologic technology program at A-State include MATH 1023 College Algebra, BIO 2203 and 2201 Human Anatomy and Physiology I, and a physical science course and laboratory. The prerequisite science GPA is calculated by dividing the credits earned by the total credits. A traditional four-point scale is used where an A = 4 points, B = 3 points, C = 2 points, D = 1 point, and F = 0 points. The final course grade for College Algebra follows the same five-point scale.

Final course grade in Image Acquisition and Evaluation II. This course covers image production and assessment. Imaging artifacts, the impact of disease processes on imaging, and appropriate equipment technique settings are discussed in depth. The course concludes with a comprehensive final examination covering all content taught in the current and previous image acquisition course. The information contained within these two courses make up 30 percent of the certification examination and has traditionally been an area of concern nationally as well as for the students at Arkansas State University (ARRT, 2021b). A traditional five-point scale is used where an A = 4 points, B = 3 points, C = 2 points, D = 1 point, and F = 0 points.

Data Collection

Once IRB had been approved and it is appropriate to review student records, I will perform all data collection. Final course grade for Image Acquisition and Evaluation will be gathered through academic transcript reviews of individual students. Currently, all the data for three of the four cohorts is available. All the data for the fourth cohort will be available once the national certification exams are complete. When data collection begins, individual students will be assigned a numeric identification code that will be used as their identifier. A separate document will have the student names listed with the codes which will be maintained in a secure location on a password protected computer in the event additional information is needed or if questions arise concerning data entry. This will be done to protect student identity.

Data Analysis

Multiple linear regression will be used to analyze the data for this study. Multiple regression uses multiple independent variables to establish relationships with a dependent variable that can be used to predict values on that dependent variable (Vesey et al., 2011; Uyanik & Guler, 2013). For multiple regression, the dependent variable must be continuous, but the

independent variables may be continuous or categorical (Vesey et al., 2011). Variables will be entered in a hierarchical manor. This requires the independent variables studied in previous research to be entered in the first model with other variables being added into additional models (Fields, 2018, p. 295; Vesey et al., 2011). Many predicative studies have included science and math grades as variables (Allen & Diaz, 2013; Austin 2011; Iorio, 2021; Kavanagh, 1981; Kwan et al., 2009; Wambuguh et al., 2016). For this reason, the first model will include the GPA in prerequisite science courses and the final course grade in College Algebra. The second model will include the final course grade for Image Acquisition and Evaluation II and the NDRT score.

The regression equations for this study are:

Model 1

$$Y = b_0 + b_1X_1 + b_2X_2$$

Model 2

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4$$

Y is the score on the national certification examination.

b_0 is the intercept.

X_1 is the final course grade in college algebra.

X_2 is the GPA in prerequisite science.

X_3 is the score on the NDRT.

X_4 is the final course grade in Image Acquisition and Evaluation II

The use of linear regression carries with it certain associated assumptions. Fields (2018) lists these assumptions as additivity and linearity, normal distribution errors, homoscedasticity, and independence. Previous research on this topic has shown an additive and linear relationship with similar variables (Aldridge, R.L., 2008; Austin, L.D., 2011; Green, L.L., 2019; Kucheria et

al., 2018; Sloas et al., 2013; Wynne, P.F., 2021; Yeari & Van den Broek, 2011). I will test this assumption in my dataset by examining scatterplots between all variables. I will test the assumption of normally distributed errors by obtaining histograms of the error distribution in each model. Log transformation may be necessary and will be carried out if the errors are not normally distributed. I will test the assumption of homoscedasticity by obtaining a zpred X zres plot for each model. To test the assumption of independence, I will review the dataset to ensure it contains no replicate cases.

Statistical Package for the Social Sciences (SPSS) version 26 will be used for data analysis. SPSS can calculate and graph the needed statistical information including descriptive statistics, correlations, and multiple linear regression.

Internal and External Validity

Threats to internal validity include selection bias, testing effect, student motivation, and confounding variables. The use of selection bias results from the use of the convenience sample. There are a few incidences of students applying to the program multiple times and therefore, would have more knowledge of the NDRT than first time applicants. This opens the study up to testing effect issues. Student motivation is different from person to person. They may not give the same effort to routine course work compared to preparing for a certification examination. There are several other confounding variables such as undeclared learning disabilities, family issues, work demands, etc. that are not accounted for in this study.

External validity threats include the inability to apply the results to the general radiography student population. The results are only applicable to students who obtain degrees from similar institutions having similar demographics and using similar admission criteria. The cross-sectional time frame used for this study includes the 2019-2020 and 2020-2021 academic

years in which the world was facing a major pandemic. During these academic years, course delivery switched from face-to-face to remote learning. Students and faculty dealt with isolations and quarantines due to sickness or potential exposure. In addition, many clinical affiliates closed their facilities to students. This limited the real-world application component of all healthcare education programs. The 2021 cohort was the most impacted by this event. If a larger than normal number of students from this cohort fail the certification examination, this will be evaluated further but early data indicates this is not the case.

Summary

This chapter discussed the research design, participants, methods, and validity of this study. A non-experimental cross-sectional design using multiple linear regression is presented. The study uses a convenience sample from a four-year university in Arkansas. The data collection and analysis are discussed in detail along with threats to internal and external validity.

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