CREATING A PREDICTIVE MODEL OF STUDENT SUCCESS IN CERTIFIED REGISTERED NURSE ANESTHETIST GRADUATE PROGRAMS

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ABSTRACT

The following study addressed the identified gaps in the literature with regards to graduate nursing students and the role critical thinking plays in developing a predictive model of student success in graduate nursing programs. The population for this study included individuals who provided application data to an MSN CRNA program between the years 2014 and 2018. The study participant sample included those candidates who were interviewed, offered a position, and started the CRNA program, and those candidates who were interviewed, yet failed to advance past the interview stage. Subsets of the sample population included students who enrolled and successfully completed the CRNA program between the years 2016 and 2020 and students who enrolled and did not complete the program. The quantitative nonexperimental study utilized existing data from admissions materials; self-reported data such as personal demographic attribute variables; and third-party verified data such as undergraduate and graduate grade point averages, GRE scores, HSRT scores, and NCE scores.

Findings indicated that critical thinking aptitude, as measured by the HSRT assessment, was a significant predictor of on-time completion. A statistically significant positive association was also found between HSRT scores and students' NCE exam scores. Results indicated that the development of a statistically significant ($p < .01$) predictive model comprised of multiple variables was possible. When all other predictor variables were held constant, two independent variables indicated statistically significant ($p < .05$) predictive relationships with programmatic

success, time away from school prior to enrolling in graduate programs (r = -.287, p = .001), and HSRT percentage scores (r = .257, p = .004).

The author concludes with implications for practice and recommendations for further research. The author suggests investigation of potential graduate students' time away from the academic environment and the amount of time spent in the work environment prior to enrollment is warranted given that these two factors were found to be negatively correlated with academic success. As the CRNA profession moves to the DNP programmatic model, the author suggests that additional study is warranted into factors that may serve as valid predictors of student programmatic success.

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LIST OF ABBREVIATIONS

ACT, American College Testing

ANOVA, Analysis of variance

BSN, Bachelor of Science in Nursing

COA, The Council on Accreditation of Nurse Anesthesia Educational Programs

CRNA, Certified Registered Nurse Anesthetists

GPA, Grade Point Average

GRE, Graduate Record Exam

HSRT, Health Sciences Reasoning Test

ICU, Intensive Care Unit

IRB, Institutional Review Board

NCE, National Certification Examination

NCLEX-RN, National Council Licensure Examination for Registered Nurses exam

NPTE, National Physical Therapy Examination

PCAT, Pharmacy College Admissions Test

SAT, Scholastic Assessment Test

SE, Standard Error of the Means

SON, School of Nursing

SPSS, Statistical Package for the Social Sciences

UTC, University of Tennessee at Chattanooga

VIF, Variance Inflation Factor

LIST OF SYMBOLS

B, Regression coefficient in a linear model

$\beta_{I,}$ Standardized regression coefficient

Δ, Greek Delta representing the difference between two integers

Df, Degrees of freedom

F, *F*-ration (test statistic used in ANOVA)

H, Kruskal-Wallis test statistic

k, Number of levels of a variable (the number of treatment conditions), or the number of predictors in a regression model

N, n, Sample size, N denotes the total sample size , whereas n denotes a group within the total sample

P, Probability (the probability value, the *p*-value or significance of a test denoted by *p*)

r, Pearson's correlation coefficient

R, The multiple correlation coefficient

R^2, The coefficient of determination (the proportion of the data explained by the model)

χ^2, Chi-squared test statistic

t, Test statistic for t-test

Z, Data point expressed in standard deviation units

CHAPTER I

INTRODUCTION

Student success research is based upon the assumptions that the core function of higher education is to educate and that these institutions have a commitment to support students in their efforts to be successful in their learning. However, according to Coates and Matthews (2018), academic success has become varied, complex, multidimensional, and dependent upon the context. “Every person who engages in helping any higher education student succeed sees that ‘success’ is defined, weighted, lived, achieved and appraised in myriad ways” (Coates & Matthews, 2018, p. 905). One means of defining student success is in terms of student outcomes, which includes student learning outcomes, student retention, and graduation rates. In a review of undergraduate student retention and graduation literature since 2010, Barbera, Berkshire, Boronat, and Kennedy (2017) determined that despite the abundance of both theoretical and empirical research, the increased emphasis placed upon this topic, and the increased investment in retaining students, not much has changed. The majority of high school seniors continue to aspire to college, yet college graduation rates have remained virtually stagnate for more than 30 years, with approximately only 50% of students enrolled in higher education successfully earning a college degree (Stephan, Davis, Linday, & Miller, 2015).

Much of the literature that focuses upon graduate level student success, attrition, and graduation rates is program and/or discipline specific given these programs often require unique areas of expertise, academic focus, and/or professional experience. Such is the case with

graduate nurse anesthesia educational programs. The Council on Accreditation of Nurse Anesthesia Educational Programs (Coates & Matthews, 2018) requires that all program candidates be at least baccalaureate-prepared registered nurses with at least one year of acute or critical care experience ("Standards for Accreditation of Nurse Anesthesia Education Programs," 2019). For all graduate programs, but especially nurse anesthesia programs, student success and attrition rates are of critical importance. The demanding 27 month long academic coursework and extensive clinical time commitments prevent students from being able to be employed outside of school. Therefore, failure to successfully complete a Certified Registered Nurse Anesthetist (CRNA) program results in losses that impact multiple stakeholders. For the student, the loss includes the nonrefundable tuition dollars and any potential income that could have been earned during the time they were a fulltime student.

For the institution, the loss is not only of a potential graduate, alumnus, and successful exemplar of the program but one of resources. Student failure leaves an empty spot in a program that could have been filled by another as well as impacting retention, attrition, and graduation rates, all of which can have program accreditation ramifications. For the nursing profession, the loss of a specialty nurse in the workforce, coupled with the loss of a potential CRNA, further strains an already understaffed profession (Conner, 2015).

Some degree of attrition is inevitable and impacts both the institution and students (Pitt, Powis, Levett-Jones, & Hunter, 2012). Identifying the candidates who are more likely to be successful in their program of study and then successfully transition into the workplace is the charge placed upon graduate nursing programs' admissions panels. However, often the best qualified candidate or the individual who is the most likely to succeed is not readily apparent. Criteria such as a candidate's grade point average (GPA) and his/her test scores on standardized

instruments, such as the Graduate Records Exam (GRE), are two cognitive measures traditionally required in the admissions process (Benham & Hawley, 2015). Current literature supports the idea that in addition to these standard cognitive measures, the candidate's critical thinking, emotional intelligence, safe/unsafe personality characteristics, clinical experience, and time away from educational settings should be incorporated to strengthen admission criteria (Beauvais, Stewart, DeNisco, & Beauvais, 2014; Burns, 2011; Collins, 2013; Crosby, Dunn, Fallacaro, Jozwiak-Sheilds, & MacIsaac, 2003; Pitt et al., 2012; Wong & Li, 2011; Wunder, 2016).

Stronger admissions criteria increase program retention by increasing the likelihood that candidates will have the capacity to master the required technical and nontechnical skills within the allotted timeframe (Burns, 2011). For the healthcare provider, nontechnical skills encompass the cognitive, social, and personal resource skills necessary for the delivery of patient care. In analyzing various methods of assessing these types of nontechnical skills and noncognitive constructs in graduate admissions, Megginson (2009) concluded that the majority of these constructs were being assessed through nonstandardized methods, such as letters of recommendation, interviews, and personal statements (Megginson, 2009).

Advanced practice nursing requires extensive academic preparation, clinical preparation and expertise, and the ability to evaluate patient care situations (Benham & Hawley, 2015). Inherent in this process is the healthcare provider's ability to process information, assess situations, analyze options, identify interventions, and then take appropriate action(s). This process is often referred to as critical decision making, critical thinking, or critical reasoning (Kahlke & White, 2013). Critical thinking is both a cognitive and nontechnical skill that is difficult to assess and has been examined in relation to graduate school admissions, educational

programming, clinical learning experiences, and students' emotional intelligence (Benham & Hawley, 2015). For the purposes of this study, critical decision making, critical thinking, and critical reasoning will refer to the same types of high-level thinking skills and will be referred to throughout this manuscript as critical thinking.

Background to the Problem

Student success is the goal for institutions of higher learning, yet attrition rates remain high despite the myriad of strategies and programs that universities have instituted to reduce attrition rates (Beauvais et al., 2014). A student's admission to a program and then subsequent success, or failure, has a direct impact on the student, the institution's accreditation, retention, and graduation rates, and potentially threatens the availability of a well-qualified professional work force (Bossema, Meijs, & Peters, 2017; Creech & Aplin-Kalisz, 2011; Richard-Eaglin, 2017). The predictive value of various admissions criteria including the traditional cognitive measures and less traditional noncognitive variables such as clinical work experience, emotional intelligence, and resilience have been examined with various results and conclusions (Beauvais et al., 2014; Cunningham, Manier, Anderson, & Sarnosky, 2014; El-Banna et al., 2015; Hulse et al., 2007; Katz, Chow, Motzer, & Woods, 2009; Suhayda, Hicks, & Fogg, 2008).

Critical thinking aptitude, as measured by the health sciences reasoning test (HSRT), is one admissions criterion that has also been shown to have differing levels of correlation, or value, as a predictor of student success (Cox & McLaughlin, 2014; Cox, Persky, & Blalock, 2013; Huhn & Parrott, 2017; Kelsch & Friesner, 2014; Pitt et al., 2012; Pitt, Powis, Levett-Jones, & Hunter, 2015). Huhn and Parrott (2017) encouraged the undertaking of additional studies from multiple programs stating, "further work across a variety of cohorts could enhance understanding

of the role of the HSRT in predicting success across programs" (p. 12). The HSRT was incorporated into the University of Tennessee at Chattanooga's (UTC) Certified Registered Nurse Anesthetist (CRNA) admissions process as one of the preinterview criteria beginning with the 2017-2019 cohort. The HSRT assessment was included in UTC's CRNA program solely as a diagnostic tool from 2014-2017.

Statement of the Problem

Admissions criteria are the means that academic institutions use to select candidates believed to be the most likely to succeed, both academically and professionally (Creech & Aplin-Kalisz, 2011; Hulse et al., 2007). Critical examination of admissions criteria is a vital component of ensuring timely matriculation and completion (Richard-Eaglin, 2017). Multiple studies have examined various tools, predictive models, decision algorithms, and/or selection models designed to aid in the determination of the best candidates (Bossema et al., 2017; Creech & Aplin-Kalisz, 2011; Cunningham et al., 2014; El-Banna et al., 2015; Hulse et al., 2007; Katz et al., 2009; Ortega, Burns, Hussey, Schmidt, & Austin, 2013; Richard-Eaglin, 2017; Suhayda et al., 2008). Pitt et al. (2015) found a significant correlation between undergraduate students' critical thinking scores and academic performance. Students' critical thinking scores, as measured by the HSRT, were an important determinant of academic success and did predict students' ability to complete a nursing degree.

Possessing the ability to process information, reason effectively, and think critically is an essential component of skilled nursing practice (Pitt et al., 2012). Benham and Hawley (2015) indicated "additional studies should be performed to assess the use of unique tools in assessing critical thinking in graduate healthcare students" (p. 253) for possible use in admissions decision

making. The research presented in the following study addressed the identified gaps in the literature with regards to graduate nursing students and provides a better understanding of the role critical thinking plays in developing a predictive model of student success in graduate nursing programs.

Purpose of the Study and Research Questions

This study investigated the relationship between one or more variables and candidates' program admission, retention, and programmatic success. The following questions were addressed in this study:

- RQ1: Is a Certified Registered Nurse Anesthetist student's critical thinking aptitude, as measured by the health sciences reasoning test, a predictor of programmatic success as measured by the student's completion of their program of study within the prescribed timeframe?
- RQ2: For those candidates in cohorts 17-19 and 18-20 only: Is a Certified Registered Nurse Anesthetist candidate's critical thinking aptitude, as measured by the health sciences reasoning test, a predictor of a candidate's admissions status?
- RQ3: Is the inclusion of the health sciences reasoning test, as an element of a candidate's admissions status, a predictor for Certified Registered Nurse Anesthetist programmatic success?
- RQ4: Can a predictive model for Certified Registered Nurse Anesthetist students' programmatic success, as measured by NCE exam scores, be developed based upon one or more variables?

Rationale

There is a general consensus that the ability to problem solve, reason logically, and think critically are qualities essential to the nursing profession (Crouch, 2015; Pitt et al., 2012). High level thinking skills such as deduction, induction, inference, reasoning, and evaluation are important skill sets for both academic and professional success. A nurse's ability to think critically enables him/her to practice the right action for the right reason (Pitt et al., 2015). The constant development of new technologies and new patient care models has placed a growing emphasis on the healthcare providers' need to possess both the critical thinking skills necessary to address complex patient-care problems, and the nontechnical skills required to work effectively within interprofessional teams (Cox & McLaughlin, 2014; Pitt et al., 2015). While 21st century healthcare has become more effective, it has also become an increasingly sophisticated array of technological changes and advances (Crouch, 2015; "Patient Safety," 2016; Wunder, 2016). The 1999 Institute of Medicine research report, "To Err is Human: Building a Safer Health System", identified several initiatives designed to universally improve patient safety (Wakefield, 2000). Judgment errors often are a result of an inadequate critical analysis in which the provider chooses an incorrect strategy to address a clinical problem (Greco, 2015; Ross, Loeffler, Schipper, Vandermeer, & Allan, 2013). One identified teaching strategy used to help prevent making such judgement errors is the development of teaching environments that more closely parallel the real-world, fast-paced, critical thinking environment that is 21st century healthcare (Havens & Boroughs, 2000; Wakefield, 2000).

The presumption is that as nursing programs examine new ways to facilitate and promote student success, the factors that influence nursing academic success will be better understood as well (Beauvais et al., 2014). The ability to more efficiently and effectively assess an advanced

nursing program candidate's nontechnical skillset is one such factor that will enable educational institutions to better meet the needs of current and future students, healthcare institutions, and more importantly, the needs of patients (Cunningham et al., 2014). By refining and redefining admissions criteria, nursing admissions administrators may facilitate the entry of students who possess the cognitive and nontechnical skills that will support academic success, progression, and retention (Collins, 2013).

Conceptual Framework

The conceptual framework developed for this study has been informed by the literature review and focuses upon the interactions between a candidate's various dispositions, experiences, and abilities as well as his/her likelihood of programmatic success. The visual representations (see Figure 1a and Figure 1b) provide a graphic depiction of this interaction. This study was designed to test the following hypothesis as illustrated in the conceptual model. A predictive model for graduate nursing students' programmatic success can be developed based upon the relationship between the candidate's admissions variables, his/her professional experience, and his/her critical thinking aptitude.

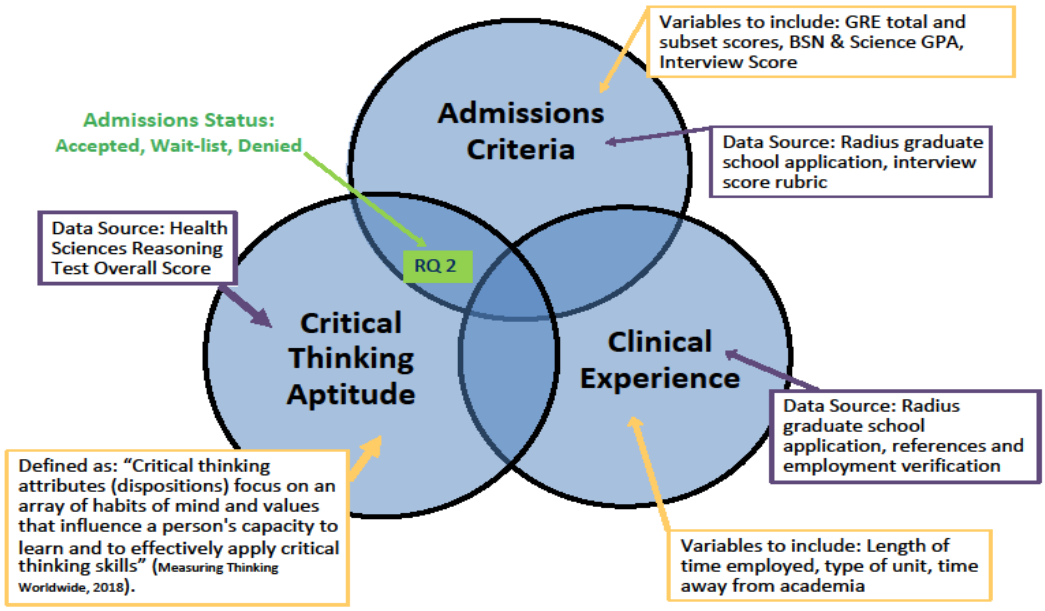

Figure 1.a Conceptual Model: Acceptance Status

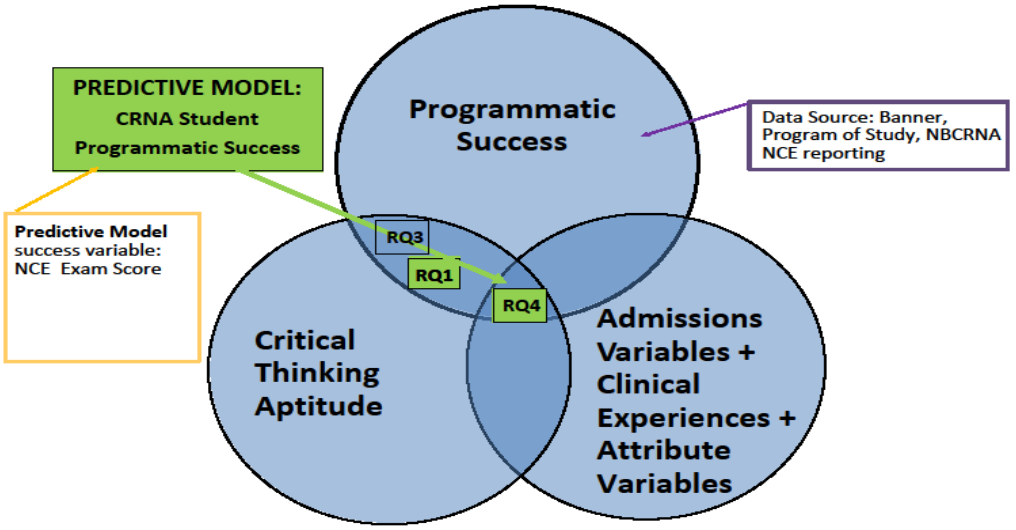

Figure 1.b Conceptual Model: Programmatic Success

Importance

Student success is the goal for institutions of higher learning, yet graduation rates have not changed over the past 30 years (Barbera et al., 2017; Stephan et al., 2015). A student's admission to a program and then subsequent success, or failure, has a direct impact upon the student, the institution, and potentially threatens the availability of a well-qualified professional work force (Bossema et al., 2017). The ability to successfully identify, admit, retain, and graduate advanced nursing practitioners is of critical importance to both the academic institution and the healthcare profession. By optimizing the admissions process, attrition is minimized, the potential number of students graduating on time is maximized, thereby increasing the numbers of advanced practice nurses entering the workforce (Beauvais et al., 2014; Richard-Eaglin, 2017). The development of a predictive tool that identifies various factors that may increase the likelihood of students' programmatic success is a powerful tool. This tool can be used to support not only recruitment and admissions, but student retention and matriculation by helping to identify those cognitive and noncognitive skills sets and dispositions that institutions can foster and develop in students.

Definition of Terms

The following definitions were used in this study:

- Admissions Criteria: For the purposed of this study, admissions criteria referred to the measures used by an institution to determine a candidate's eligibility to apply to a program.

- Admissions Status: For the purposes of this study, admissions status referred to a nominal categorical variable. There were three categories including accepted, wait-listed, denied.
- Admissions Variables: For the purpose of this study, the admissions variables included GRE total and subset scores, cumulative undergraduate grade point average, Bachelor of Science in Nursing (BSN) grade point average, science course work grade point average, length of time employed, and the candidate's healthcare environment.
- Advanced Practice Nurse: A nurse who has a master's, postmaster's certificate, or practice-focused doctor of nursing practice degree in one of four specific roles. The four specific roles currently defined in practice are: Nurse Practitioners, Clinical Nurse Specialists, Certified Nurse midwives, and Certified Registered Nurse Anesthetists ("APRN Definition," 2019).
- Analysis: Analytical skills used to identify assumptions, reasons, themes, and the evidence used in making arguments or offering explanations. Analytical skills enable the consideration of the key elements in any given situation and the ability to determine how those elements relate to one another ("Measuring reasoning skills: Analysis," 2018).
- Bachelor of Science in Nursing (BSN): The minimum prerequisite nursing degree required of all applicants for nurse anesthesia education programs ("National Certification Examination," 2019).

- BSN Grade Point Average: For the purposes of this study, BSN grade point average (BSN-GPA) referred to the program applicant's average of BSN course work based upon a 4.0 scale.
- Cognitive Measures: Psychological testing informed evaluation of an individual's functional capacity, particularly within the domain of cognitive functioning. The term cognitive functioning encompasses a variety of skills and abilities, including intellectual capacity, attention and concentration, processing speed, language and communication, visual spatial abilities, and memory (Committee on Psychological Testing, 2015).
- Cohort: People treated as a group ("Cohort ", 2020). For the purpose of this study, cohort referred to each admission year of students. For example, the 14-16 cohort referred to those students who were admitted into the program and began their studies in May 2014 with the expectation that they would complete their program of study in August of 2016.
- Certified Registered Nurse Anesthetists (CRNA): An advanced practice nurse who has successfully completed a master's, postmaster's certificate, or practice-focused doctor of nursing practice degree and has successfully passed the certification examination administered by the National Board of Certification and Recertification for Nurse Anesthetists ("National Certification Examination," 2019).
- Critical Thinking: For the purpose of this study, critical thinking was defined as the process of purposeful, self-regulatory judgment that gives reasoned consideration to evidence, context, conceptualizations, methods, and criteria (Facione, 1990).

- Critical Thinking Aptitude: An individual’s dispositions and habits of mind that influence his/her capacity to learn and to effectively apply critical thinking skills ("Measuring Thinking Worldwide," 2018).
- Decision-Making: The process of reaching a judgment or choosing an option to meet the needs of a given situation (O'Connor & Crichton, 2008).
- Deduction: Deductive reasoning is rigorously logical and clear-cut. Deductive skills determine the precise logical consequences of a given set of rules, conditions, beliefs, values, policies, principles, procedures, or terminology ("Measuring reasoning skills: Deduction," 2018).
- Emotional Intelligence: The capacity to be aware of, control, and express one's emotions, and to handle interpersonal relationships judiciously and empathetically ("Emotional intelligence ", 2018).
- Evaluation: Evaluative reasoning skills support one’s ability to assess the credibility of sources of information and claims made. These skills are used to determine the strength or weakness of a position. Application of evaluation skills enables one to judge the quality of analyses, interpretations, explanations, inferences, options, opinions, beliefs, ideas, proposals, and decisions ("Measuring reasoning skills: Evaluation," 2018).
- Graduate Record Exam (GRE): The GRE general test measures one’s verbal reasoning, quantitative reasoning, critical thinking, and analytical writing skills. These skills are not related to a specific field of study, rather they reflect skills that most closely mirror the kind of thinking required in graduate school programs ("The GRE Test," 2020).

- Healthcare Environment Variables: For the purposes of this study, healthcare environment referred to the employment environment that the nurse anesthesia program applicant identified as their workplace immediately prior to applying to the program.
- Health Sciences Reasoning Test (HSRT): The health sciences reasoning test measures high-stakes reasoning and decision-making processes and is specifically designed to assess the critical thinking skills of health science students and professionals. The assessment results are presented as an overall scale score, and as a set of individual scale scores for each of the five subareas: deduction, induction, analysis, inference, and evaluation ("Health Sciences Reasoning Test," 2018).
- Induction: Inductive reasoning relies on estimating likely outcomes. Decision making in contexts of uncertainty relies on inductive reasoning. Inductive decisions can be based on analogies, case studies, prior experience, statistical analyses, simulations, hypotheticals, trusted testimony, and patterns ("Measuring reasoning skills: Induction," 2018).
- Inference: Inference skills enable one to draw conclusions from reasons, evidence, observations, experiences, or values and beliefs. Using inference, one can predict the most likely consequences of the options. Inference enables one to see the logical consequences of assumptions ("Measuring reasoning skills: Inference," 2018).
- Institutional Review Board (IRB): The institutional review board, guided by ethical principles, is responsible for protecting the rights and welfare of humans who are involved in research of the university as subjects. The IRB monitors research to

ensure human subjects are protected from undue risk, deprivation of rights, and/or dignity ("Institutional Review Board," 2020).

- Intensive Care Unit (ICU): The ICU is a 24-hour critical care or life support intensive care unit. Healthcare providers who work in the ICU have extensive training in intensive care medicine. Typically, each nurse will monitor only one or two patients at a time ("Intensive Care Unit ", 2021).
- National Certification Examination (NCE): The certification examination administered to all newly graduated CRNA candidates by the National Board of Certification and Recertification for Nurse Anesthetists (NBCRNA). Passing this certification is required in order to be licensed to practice and will be one of the criteria used in this study to determine programmatic success ("National Certification Examination," 2019).
- Nontechnical Skills: The cognitive, social, and personal resource skills that complement technical skills. Behavioral markers identified into categories such as situational awareness, decision making, deduction, induction, analysis, inference, and evaluation (Facione & Gittens, 2016; O'Connor & Crichton, 2008).
- Program Retention: For the purposes of this study, program retention referred to a students' continuous enrollment in their program of study.
- Programmatic Success: For the purposes of this study, this construct was determined by one of two variables, dependent upon the research question. For research questions one and three, the nominal categorial variable, completion of the program yes or no, was used. For research question four, programmatic success was measured by students' NCE exam scores, both the students' first attempt scores and the final

passing score. Those students who did not successfully complete the program, or who were not able to pass the exam within five attempts were identified as having received a score of zero. Research question two did not include programmatic success as a variable.

- Science Grade Point Average (SGPA): For the purposes of this study, science grade point average referred to the average of the applicant's undergraduate science course grades based upon a 4.0 grading scale.
- Situational Awareness: A dynamic construct of the perception of the environment and outcomes that reflect critical task and performance of events (O'Connor & Crichton, 2008).
- Student Success: For the purpose of this study, student success referred to the student's ability to maintain continuous enrollment in the program and achieve programmatic success.
- Technical Skills: Any action, performed by a medical provider that involves direct patient care that impacts the patient's clinical outcome in a measurable way. Technical skills are a fundamental component of clinical instruction (Missen, McKenna, Beauchamp, & Larkins, 2016).

Methodological Assumptions

This study was conducted with the following assumptions:

- The number of respondents/participants was adequate for successful implementation of the research design.
- Data self-reported by participants was truthful and accurate.

- Participants performed on the HSRT assessment to the best of their abilities.
- The percentile rank related to the GRE scoring system as provided by Educational Testing Services were accurate.
- The percentile rank and raw score data as provided by Insight Assessment were accurate.

Delimitations of the Study

The delimitations of this study included admission data from the School of Nursing (SON) nurse anesthesia graduate program from 2014 through 2018. Participants for this study included candidates who applied to SON nurse anesthesia graduate program during this timeframe. Participants included candidates who were interviewed, offered a position, and started their program of study and were referred to as students. Study participants also included those candidates who were interviewed but failed to advance past the interview stage and were not accepted into the CRNA program.

For the purpose of creating a prediction model, both successful students and unsuccessful students were examined. Successful students were those students who completed their program of study within the prescribed timeframe and passed the NCE licensure/board exam. Unsuccessful students were those students who did not complete their program of study within the prescribed timeframe, and/or left prior to completion, and/or did not pass the NCE exam after five attempts.

Limitations

The following limitations were acknowledged for this study:

- Five cohorts of data were examined for three of the four research questions. Research question two only included two cohorts of data, cohorts 2017-19 and 2018-2020, as the HSRT was not incorporated into the admissions' criteria until 2017, thereby limiting the ability to generalize to larger populations.
- The accuracy of self-reported data by participants was beyond the investigator's control.
- Candidates may have had medical, mental, emotional issues, and/or other extenuating circumstances that may have prevented demonstration of their full potential on standardized assessments.
- There was no assumption that all Bachelor of Science in Nursing (BSN) prepared nurses received the same undergraduate preparation. Institutions, courses, and instructors utilize various methods to evaluate and grade students; therefore, how grades were earned and distributed cannot be controlled, so grade inflation cannot be discounted and prevented.
- Prior clinical experiences, identified as Healthcare Environment Variables, were components of the CRNA program application. The duration and type of professional experience was examined in this study as independent variables. However, the geographical location of employment, specific employer, and type of employment environment was not consistently captured and was not examined.

CHAPTER II

LITERATURE REVIEW

Nursing Programs' Admissions Criteria

Admissions criteria for both undergraduate and graduate nursing programs have traditionally included measurements associated with a candidate's academic success. These criteria include their cumulative grade point average (GPA), science GPA, and scores on standardized measures such as the American College Testing (ACT), Scholastic Assessment Test (SAT), and GRE (Beauvais et al., 2014; Burns, 2011; Conner, 2015; Grossbach & Kuncel, 2011; Ortega et al., 2013; Ross et al., 2013). In addition, to the academic measures, graduate nursing programs may include admissions requirements such as clinical nursing experience, letters of recommendation, and interviews (Burns, 2011; Hulse et al., 2007; Wong & Li, 2011). In an examination of the literature, El-Banna et al. (2015) found "very little empirical evidence examining whether clinical experience is related to better education outcomes" (El-Banna et al., 2015, p. 276). Yet, most graduate nursing programs require prior nursing experience as part of the admissions criteria, and for CRNA programs, a minimum of one year of critical care nursing experience is mandated (Burns, 2011).

An additional challenge of the advanced nursing admissions process is attempting to ascertain which candidates will be most likely to be clinically successful. Advanced nursing curriculums, such as nurse anesthesia, focus as much on "clinical education as they do on academic preparation, [candidates'] noncognitive and cognitive attributes are equally important"

(Collins, 2013, p. 467). However, there is a paucity of research regarding university admissions' ability to evaluate or predict clinical performance in nursing schools. Most processes fail to successfully identify clinically incompetent candidates or those who will be predisposed toward unsafe clinical behaviors prior to entering the clinical setting (Wong & Li, 2011). "There is limited existing research on graduate student selection to assist faculty" (Creech & Aplin-Kalisz, 2011, p. 404) with the decision making process. This may not be surprising given that the traditional admissions criteria are designed to support the selection process by helping to determine which students will be successful academically, not necessarily clinically.

There does not seem to be consensus regarding which admissions criteria are the most effective predictors of student success. Grossbach and Kuncel (2011) conducted a meta-analysis of 31 studies of undergraduate nursing programs that incorporated the ACT or SAT in their admissions process. The analysis found the SAT and ACT to be statistically significant predictors of student success on the National Council Licensure Examination for Registered Nurses exam (NCLEX-RN), a required exam all nurses must pass in order to become a licensed practitioner (Grossbach & Kuncel, 2011).

Burns (2011) examined the relationship between undergraduate GPA, science GPA, GRE scores, clinical experience, and graduate GPA among CRNA students. The findings indicated that a statistically significant positive relationship existed between a candidate's undergraduate GPA and their graduate GPA. There was also a statistically significant positive relationship between a candidate's science GPA and their graduate GPA, and between the candidate's overall GRE score and their graduate GPA. A negative correlation was found to exist between the students' number of years of critical care nursing experience and their academic success. However, of all of the variables examined, undergraduate GPA possessed the highest absolute

predictive value of student success, “GRE scores represented the independent variable with the smallest correlation and possessed little predictive value with academic progression” (Burns, 2011, p. 198). In other words, although predictive relationships existed between undergraduate GPA and GRE scores and graduate academic success, undergraduate GPA scores possessed the strongest predictive value.

Several studies of graduate nursing programs have suggested there is a predictive relationship between a student’s GRE score and his/her academic success (Benham & Hawley, 2015), while others have determined that the GRE serves little or no predictive purpose (Richard-Eaglin, 2017). The evidence-based review of admission criteria conducted by Ortega et al. (2013) found several studies suggesting that “GRE scores may help predict student success in graduate nursing programs” (p.185). However, other studies examined could only account for 5-8% of the variances in a student’s graduate GPA to his/her GRE scores, leading Ortega et al. (2013) to conclude that the potential barrier the GRE presented outweighed its predictive value. When studying the predictive value of the GRE for academic success of graduate nursing students, Suhayda et al. (2008) found that a candidate’s GRE score provided no additional value to the predictive model if the undergraduate GPA was 3.25 or higher and the BSN GPA was 3.0 or higher

The debates regarding the value of including the GRE as part of graduate nursing programs’ admissions criteria and the use of GRE scores as predictors of programmatic success are not new (Hulse et al., 2007). Katz et al. (2009) asked in their 2009 study, “What data exists related to applicant GRE scores and success in graduate school? If GRE scores are not strong predictors of student success, for what reasons are they being required?” (p. 369). Results from this study indicated the GRE was not an effective indicator of academic ability, as measured by

graduate GPA, nor of academic success, as measured by graduation rate. As a result of the study's findings and findings from similar studies, the authors' institution reevaluated the admissions criteria and replaced the GRE with holistic admissions materials designed to develop a more complete profile of a candidate's potential (Katz et al., 2009).

Student Success in Nursing Programs

Gaining admission to a nursing program is the first milestone students must achieve in order to successfully complete their program. Historically, as evident by traditional admissions criteria focused on students' academic skills, much of the research on academic success and persistence in a nursing programs has been focused on students' intellectual capabilities (Beauvais et al., 2014; Pitt et al., 2012). Today, literature is increasingly focused on the interaction of multiple variables and/or factors associated with student academic success and persistence. Factors such as students' personal characteristics, students' affective qualities, external environmental factors, and academic environmental factors have become more evident in the literature (Cipher, Urban, & Mancini, 2019; Jeffreys, 2015).

A 2012 interactive literature review of 44 studies identified various factors that impacted undergraduate nursing students' academic and clinical success, and attrition rates (Pitt et al., 2012). The meta-analysis grouped the multiple factors into four domains: demographic, academic, cognitive, and personality/behavioral. The demographic factors of age and gender were investigated in multiple studies. Findings of significance were not consistent across the studies. Investigations of the academic factors of prior academic performance, precollege GPA, and standardized test scores all had a significant positive impact upon students' undergraduate GPA. However, multiple studies found little or no impact of these same academic factors upon

students' program completion or attrition. With regards to personality and behavioral factors, self-efficacy was found to have a positive correlation with academic success, although there were challenges with this finding given that the lack of, "consistent [self-efficacy] measures are a limitation" (Pitt et al., 2012, p. 909). The authors state that critical thinking "necessitates further exploration" (Pitt et al., 2012, p. 909) as it was the only factor reviewed in this meta-analysis addressing nursing students' performance and attrition that had a consistently significant positive impact on both academic performance and attrition.

A significant gap in the literature exists with regards to the factors that impact student success in advanced nursing programs. Most studies associated with student success, academic progression, and persistence are focused on two year or four year degree level nursing students (Bossema et al., 2017; Burns, 2011; Cipher et al., 2019; Richard-Eaglin, 2017). In one of the few studies focused specifically on factors that contributed to student success in advanced nurse practitioner programs, Bossema et al. (2017) found that only two of the nine variables examined contributed to students' success: prior work setting and course grades. Being employed in a general health care environment was found to independently increase the probability of students' success by 22% as opposed to any of the other three settings identified: mental health, public health, or nursing home care.

For many students in advanced programs, several years can lapse between their previous nursing education and their advanced nursing program. For that reason, Bossema et al. (2017) decided, for the purpose of their study, undergraduate GPA would not be an accurate reflection of students' cognitive abilities, and instead chose to use the students' grades from their first semester literature study assignments as the independent variable of students' cognitive ability. The results of the study showed the higher the grade, the probability of success increased by

29%, and that the course grade was a predictor of student success. The course assignments required that students be adept in critical thinking, communication, and advanced research skills. The authors suggest that the development of an assessment that measures skills like those in the course could be a helpful tool in identifying successful students and those "at risk of failure" (Bossema et al., 2017, p. 73), thereby serving as an effective retention and student success strategy.

El-Banna et al. (2015) investigated the relationship between a nurse's prior clinical experience and his/her academic success in advanced nurse practitioner programs. No relationship was found between the number of years of clinical experience prior to entering the nurse practitioner program and academic success as measured by overall GPA, overall clinical GPA, ability to graduate with in four years, or whether students experienced any course failures. The authors did identify one exception. Those students with six or more years of clinical experience, prior to entering the program, had "substantially lower odds of graduating within four years" (El-Banna et al., 2015, p. 279) as compared to those students with fewer years of clinical experience.

Critical Thinking and Nursing

Jeffrey, Harris, and Sherman (2019) conducted a quality improvement study to determine the relationship between current admissions criteria and student success on the Canadian Practical Nurse Registration Exam. The purpose of the study was to provide recommendations to their administration regarding admissions practices based upon student success data. The resulting data indicated that academic factors such as the candidates' GPA and admissions test score, alone, could explain only a very low percent of the variance in students' success. "This

suggests that non-academic factors are contributory, and should be considered in admissions practices…and their relationship to student success" (Jeffrey et al., 2019, p. 69). In other words, additional variables, those not traditionally considered as part of the admissions process, may explain a larger percentage of the variance in students' academic performance and success than initially believed.

One nonacademic factor is critical thinking, "critical thinking is necessary in a discipline where individuals are faced with making life and death decisions daily" (Crouch, 2015, p. 45). Nursing is one such discipline. Advanced nursing involves caring for patients, especially acute and crucially ill patients, and requires the ability to rapidly collect relevant and appropriate data, distinguish and evaluate multiple lines of reasoning, and then act upon that information. The profession mandates that individuals be clinically and critically competent (Crouch, 2015).

In 2013, Ross et al. (2013) conducted a systematic literature review to determine if there was any consensus regarding the relationship between an individual's critical thinking skills, as measured by three different standardized assessment tools, and his/her academic success. The resulting analysis of 52 studies found a moderate positive correlation between critical thinking aptitude and academic success independent of the measures of academic success, the year, the type of the instrument, or the type of study. These data led the authors to conclude that critical thinking assessment could be a valuable admissions criteria and could be used to help determine those candidates most likely to be successful in the program, but also those more likely to struggle (Ross et al., 2013).

Benham and Hawley (2015) conducted a literature review of standardized instruments used to evaluate critical decision-making skills of candidates applying to graduate level healthcare programs. While the traditional admissions criteria, such as GPA and GRE scores,

may be predictive of students' academic success, those traditional admissions measures may not predict an applicant's ability to successfully engage in critical decision making. Advanced practice nursing "requires the ability to critically evaluate patient care situations and then re-evaluate the effect of the actions and correct if needed" (Benham & Hawley, 2015, p. 233). In their review, Benham and Hawley (2015) failed to identify any unique standardized instruments that were being used to assess critical thinking aptitude as an admissions component for graduate nursing programs.

The Health Science Reasoning Test as a Predictor of Success in Healthcare Professions

Although there may be discipline specific definitions of critical thinking, there is an overriding agreement that critical thinking is crucial to judgement and the decision making process (Facione, 1990). A frequently cited definition of critical thinking is one that was developed as a result of a Delphi study that included critical thinking experts from various disciplines from across the United States, and is the definition that informs this study (Facione, 1990). Numerous tools have been used to assess critical thinking aptitude in undergraduate nursing students over the past two plus decades. The most commonly used instrument, although not discipline specific, has been the California Critical Thinking Skills Test that was developed by Facione in the 1990's (Pitt et al., 2015). In 2011, the Health Science Reasoning Test (HSRT) was developed to measure critical thinking aptitude specifically among students in the healthcare professions. The HSRT assessment has reported content, construct, and criterion validity via numerous independent research studies ("Peer reviewed studies and student success," 2020). Highly correlated with the GRE, the HSRT has strong internal consistency ("Measuring Thinking Worldwide," 2018). The test content consists of a series of scenarios requiring the

participant to make decisions based on the presented information. The HSRT results consist of an overall scale score and five categorical scale scores. Based upon a participant's numerical score, the assessment provides a performance assessment ranging from not-manifested, moderate, strong, to superior ("Health science reasoning test: Reliability," 2020).

Strong critical thinking skills are essential for healthcare professionals due to the demanding, dynamic healthcare environment (Cox et al., 2013). In a 2015 study of 134 undergraduate nursing students, Pitt et al. (2015) found a significant relationship between nursing students' entry HSRT scores, academic success, and academic progression. Positive correlations were found between the students' HRST scores and all academic performance measures with the strongest relationships found between the students' course work and their analysis and deductive reasoning aptitudes. However, this study found no relationship between the students' entry HSRT scores and their clinical competence. The author suggests that the inclusion of the HSRT, prior to entry into a program, could prove to be useful in predicating student academic success and persistence (Pitt et al., 2015).

There is a gap in the literature with regards to exploring the relationship between the HSRT and graduate nursing students' academic success. The following four studies have explored the relationship between the HSRT and graduate healthcare admissions, student success, and persistence among doctor of pharmacy students and doctor of physical therapy students (Cox & McLaughlin, 2014; Cox et al., 2013; Huhn & Parrott, 2017; Kelsch & Friesner, 2014). In their 2013 study, Cox et al. (2013) raised the question if the correlations found between traditional academic measures such as, GRE and GPA scores, and students' academic success become invalid when trying to correlate the same academic measures with students' successful clinical performance, and if so then, "predicting both classroom success and clinical performance

may depend on a combination of traditional admissions criteria and measures of other qualities, such as critical thinking" (Cox et al., 2013, p. 2). The purpose of the study was to determine if a relationship existed between pharmacy students' performance on the HSRT, their Pharmacy College Admissions Test (PCAT) scores, and their undergraduate GPA. A significant positive relationship was found between students' HSRT scores and their PCAT scores, there was no relationship between their HRST scores and their GPA. After controlling for all other variables, HRST scores were significantly associated with the reading comprehension, verbal, and quantitative sections of the PCAT exam. One area that the authors conclude requires further investigation is the relationship between HSRT scores and student success in clinical environments (Cox et al., 2013, p. 4).

Cox and McLaughlin (2014) examined the relationship between pharmacy students' HSRT scores and their academic performance as measured by course grades in 37 courses. The authors expressed the hope to identify tools that could capture students' critical thinking aptitude thereby enabling colleges, at the point of admissions, to better identify qualified students capable of excelling and meeting the needs of 21st century healthcare. Findings of this study indicated students' HSRT scores were significantly correlated with 24% of the courses examined. The most significant relationships, although weak, were found in the applied courses. The authors offered one possible explanation for the weak correlations. The majority of the courses examined were traditional lecture format curriculums and were based upon teaching strategies not as effective at fostering critical thinking as other problem-based, experiential learning teaching strategies (Cox & McLaughlin, 2014).

Kelsch and Friesner (2014) also examined pharmacy students' admissions criteria in relation to their HSRT scores. Specific to this study's inquiry was the question whether the

HSRT provided additional unique information to the admissions process when evaluating potential candidates, and "if there is unique information contained in critical thinking test scores, to what extent does it affect who is accepted into the program and which students are declined admissions" (Kelsch & Friesner, 2014, p. 2). Study results indicated students' HSRT scores did not significantly affect admissions decisions for most of the applicants. This finding may have been related to the fact the study also found HSRT scores to be largely redundant with PCAT scores, with the correlation between the two scores at nearly 50%. The authors' concluded the HSRT was an effective assessment of critical thinking aptitude and could be an effective part of an admissions process, provided the instrument's usefulness was not mitigated by redundancies.

In their retrospective analysis of four cohorts of physical therapy students, Huhn and Parrott (2017) sought to identify the variables that could help predict student success, as measured by students' scores on the National Physical Therapy Examination (NPTE). GRE scores and GPA were already known to be correlated with student success on the NPTE, but those measures "account for less than 50% of the variance in student performance on the NPTE" (Huhn & Parrott, 2017, p. 7). A literature review provided limited evidence the predictability of the academic variables increased when a measure of critical thinking skills was introduced, and "a paucity of research related to the HSRT as an admissions decisions tool" (Huhn & Parrott, 2017, p. 8) resulted in the following foci for their study: To determine the relationship between HSRT scores, NPTE scores, and other academic admissions criteria, and to develop a tool based upon a predictive model that would enhance admissions decisions (Huhn & Parrott, 2017).

Findings indicated all variables were significantly correlated with students' NPTE scores. HSRT scores had a moderate positive relationship. The study results also determined the HSRT did contribute to predicting students' NPTE scores. The model, when including the HSRT,

showed a significant improvement over the model without the HSRT. These findings "support the notion the HSRT accounts for an additional portion of the unexplained variance in NPTE scores" (Huhn & Parrott, 2017, p. 11). The authors were able to utilize the results from the modeling to create a tool to be used in admissions decision making. The tool enables admissions committees to determine the minimum HSRT score needed for a candidate to successfully pass the NPTE given differing GRE and undergraduate GPA scores. This tool provides admissions faculty the opportunity to make admissions decisions based upon more than the traditional academic measures. The authors stressed further work "could enhance understanding of the role of the HSRT in predicting success across programs" (Huhn & Parrott, 2017, p. 12). As noted in the other studies reviewed (Cox et al., 2013, Cox & McLaughlin, 2014, Kelsch & Friesner, 2014, Pitt et al., 2015), Huhn and Parrott (2017) investigated the relationship(s) between the HSRT, program admissions, and academic success variables of students pursuing health related professions.

This study was designed to add to the knowledge base regarding the role students' HSRT scores and other admissions criteria had in predicting students' likelihood of success in advanced nursing programs, specifically nurse anesthetist programs. Student programmatic success included both completion of the program within the prescribed timeframe and successful passing of the NCE in the first attempt. Development of a model focused on identifying candidates' potential for programmatic success adds tremendous support to the admissions process, especially when evaluating candidates whose traditional academic admissions qualifications such as GPA or GRE scores, may be marginal or borderline.

CHAPTER III

METHODOLOGY

Description of Population and Sample

The population for this study included individuals who provided application data to University of Tennessee at Chattanooga's (UTC) School of Nursing (SON) CRNA graduate program between the years 2014 and 2018. From the population of individuals who submitted application data to the CRNA graduate program, the study participant sample included:

- Candidates who were interviewed, offered a position, and started the CRNA program.
- Candidates who were interviewed but failed to advance past the interview stage and were not offered a position in the graduate CRNA program.
- Students who successfully completed the CRNA program between the years 2016 and 2020.
- Students who enrolled in the CRNA program and did not successfully complete the program

Identification and Classification of Variables

The various independent and dependent variables examined within this study have been identified as related to each unique research question (see Appendix A). The students' programmatic success and admission status were the proposed dependent variables. Proposed independent variables included HSRT scores, GRE scores, GPA scores, work experiences, and

time away from academia. Attribute variables included cohort membership, gender, ethnicity, age, and veteran status.

Research Design

The research design for this study was based upon a certain philosophical paradigm and research methodology. This study was based upon a postpositivism theory of knowledge that reflects philosophical assumptions often associated with a quantitative research design. A postpositivist worldview is based on determination, reductionism, detailed observation, and measurement of select variables and the testing of theories, regarding the relationship(s) of said variables that are continually refined (Creswell, 2003). This study was nonexperimental and incorporated an associational research approach, one that enabled the examination of potential relationships between variables with the specific purpose of identifying associations, rather than causes, that enabled the development of a predictive model (Gliner, Morgan, & Leech, 2009). The research methodology was strictly quantitative in nature.

Research question one investigated the predictive nature of an accepted student's HSRT score and his/her success in the CRNA program: Is a Certified Registered Nurse Anesthetist student's critical thinking aptitude, as measured by the health sciences reasoning test, a valid predictor of programmatic success as measured by the student's completion of their program of study within the prescribed timeframe? The criterion or dependent variable was successful completion of the graduate program of study within the prescribed timeframe. Successful program completion was a nominal categorical variable and was not measured in months. For this research question completion within the prescribed timeframe was coded as successful or unsuccessful. The predictor or independent variable was the student's HSRT overall scale score,

which was an interval or continuous variable. Therefore, for this research question a dichotomous condition existed with the dependent variable, yes, the student completed within the prescribed timeframe, or no, the student did not complete within the time frame. The appropriate statistic to investigate research question one was a logistic regression analysis (Field, 2013).

Research question two was predictive in nature and designed to investigate any relationship between candidates' HSRT scores and admissions status: Is a Certified Registered Nurse Anesthetist candidate's critical thinking aptitude, as measured by the health sciences reasoning test, a predictor of admissions status? This research question investigated only the student data from cohorts 2017-19 and 2018-2020 as these cohorts incorporated the HSRT as part of the admissions process. The criterion or dependent variable was reflected as the candidate's admissions status. A candidate was identified as either accepted, wait-listed, or denied. Acceptance status was based upon the candidate's total interview score out of a possible 80 points. At the conclusion of all interviews, candidates were ranked by interview scores and the top 30 candidates were offered acceptance, the next five were placed on the wait list, and the remainder were denied acceptance. The dependent variable for this research question was nominal with three variable levels.

The predictor or independent variable was the candidate's HSRT score, as reported by quartile and was therefore also a nominal or categorical variable. A candidate's HSRT score was a component of their overall admissions interview score. All candidates who were invited for interviews were required to take the HSRT assessment. Each candidate was awarded points, based upon their HSRT score, which were added to their interview score. The awarded points accounted for 1.25% to 6.25% of the candidate's interview score depending upon the HSRT quartile in which they scored. Given that both the dependent and independent variables were

nominal, the appropriate statistic for this research question was a Pearson chi-square (Field, 2013).

Research question three was designed to investigate if any relationship existed between the inclusion of the HSRT in the admissions process and a Certified Registered Nurse Anesthetist students' programmatic success: Is the inclusion of the health sciences reasoning test, as an element of a candidate's admissions status, a predictor for Certified Registered Nurse Anesthetist programmatic success? The criterion or dependent variable was a single nominal variable reflected as yes or no, did the student complete the program within the prescribed timeframe? There were two predictor or independent variables, the students' HSRT quartile and their cohort membership, both were nominal variables. The appropriate statistic for this research question was a Loglinear analysis (Field, 2013).

Research question four was predictive and designed to investigate any relationship between one or more variables and programmatic success: Can a predictive model for Certified Registered Nurse Anesthetist students' programmatic success, as measured by students' NCE exam scores, be developed based upon one or more variables? First-time NCE pass rates are important programmatic success indicators. The Council on Accreditation of Nurse Anesthesia Education Programs (Coates & Matthews, 2018) has set a benchmark requirement of 80% of each cohort will pass the NCE on the first attempt ("Accreditation policies and procedures," 2020). Therefore, research question four was split into two parts. Research question four A examined the predictive model using students' first attempt NCE scores. Research question four B examined the predictive model using students' final NCE score. There were multiple predictor variables which were interval variables, including HSRT, GRE, BSN, and undergraduate science GPA scores, students' pre-enrollment work duration, and time away from academia, as well as

attribute variables. Therefore, the appropriate statistic for this research question was a multiple regression (Field, 2013).

Data Collection

This study utilized existing data from admissions materials from the School of Nursing CRNA graduate program applications from 2014-2018. Data from student cohorts entering and successfully completing the CRNA programs from 2014-2020; included self-reported data, such as personal demographic attribute variables, and third-party verified data, such as undergraduate and graduate grade point averages, GRE scores, HSRT scores, and NCE scores.

Data for applicants not accepted into the School of Nursing CRNA programs from 2014-2018 included the same self-reported and third-party verified data associated with the application process but did not include data associated with enrollment in and/or completion of the CRNA program. NCE exam score data was not included for those individuals not accepted into the program. All data utilized were secondary data that was collected by the institution as part of the application, admission, enrollment, graduation, and/or accreditation processes.

Admissions data that was used for this research was collected from CRNA candidates' program and graduate application files via Radius, the institution's online application management system. The following data was collected from the associated assessment providers. The Education Testing Services provided the percentile rank score and the raw GRE score data for each CRNA candidate in this study. The HSRT raw scores, normed percentile ranked scores, and quartiles for each CRNA candidate interviewed, cohorts 2017-19 and 2018-20, and for admitted students 2014-2016, in this study was provided by Insight Assessment. To quantify candidates' academic success prior to application to the CRNA program, each candidate's

official transcripts was used to determine his/her BSN GPA, undergraduate Science GPA, and master's degree GPA, if appropriate. Students' academic status and successful completion of the CRNA program was determined via the university student information system, Banner. Graduates' NCE results were accessed via the NBCRNA report. This report provided each study participant's total NCE score, their first time pass rate status, and the national average score for the year in which the test was administered.

Procedure

The following were the data collection procedures. The primary investigator submitted an Institutional Review Board (IRB) Form 104(d)4 to the University of Tennessee at Chattanooga Institutional Review Board for review and approval. IRB approval was received on November 24, 2020 IRB # 20-161. Data collection and entry of existing data into a comprehensive database occurred after receipt of IRB approval. All personal identifiers were removed, and unique identification codes were assigned to each student's data. All data were stored in a secure and locked facility with only the primary investigator having access. Strict confidentiality was maintained. All IRB protocols and guidelines were strictly maintained throughout the study. Data analysis was conducted utilizing the statistical software, Statistical Package for the Social Sciences (SPSS) version 27.

Data Analysis

Associational inferential statistics were utilized; bivariate and multiple linear regression analyses were conducted to determine predictive relationships. Bivariate linear regression examined the relationship between a predictor variable and criterion variable. Multiple

correlations analysis was conducted to determine the relationship between the criterion variable and multiple predictor variables (Hinkle, Wiersma, & Jurs, 2003). The multiple regression to be conducted was referred to as a backward solution or a simultaneous multiple regression in which all predictor variables are entered in the regression model and then deleted if determined not to contribute to the model (Gliner et al., 2009; Hinkle et al., 2003). The least squares fit was used to determine the best linear combination of variables.

CHAPTER IV

RESULTS

This chapter presents the statistical testing that was conducted and the associated results. The purpose of this study was to investigate the relationship between one or more variables and Certified Registered Nurse Anesthesia program candidates' likelihood of program admission, retention, and programmatic success. This investigation consisted of two components. The first component investigated whether candidates' critical thinking aptitude, as measured by the HSRT, had any impact upon admissions status or programmatic success.

- RQ1: Is a Certified Registered Nurse Anesthetist student's critical thinking aptitude, as measured by the health sciences reasoning test, a predictor of programmatic success as measured by the student's completion of their program of study within the prescribed timeframe?
- RQ2: For those candidates in cohorts 17-19 and 18-20 only: Is a Certified Registered Nurse Anesthetist candidate's critical thinking aptitude, as measured by the health sciences reasoning test, a predictor of a candidate's admissions status?
- RQ3: Is the inclusion of the health sciences reasoning test, as an element of a candidate's admissions status, a predictor for Certified Registered Nurse Anesthetist programmatic success?

The second component of this study investigated the development of a predictive model to identify factors that were most likely to predict CRNA students' programmatic success as measured by success on the NCE exam.

- RQ4: Can a predictive model for Certified Registered Nurse Anesthetist students' programmatic success, as defined by NCE exam scores, be developed based upon one or more variables?

The HSRT as a Predictor of On-Time Program Completion

Research question one investigated the predictive nature of an accepted student's HSRT score and his/her success in the CRNA program, as measured by on-time program completion. A backward step method logistic regression was conducted (Field, 2013) utilizing students' HSRT percentage scale scores as the predictive variable and the dichotomous dependent variable, yes, the student completed within the prescribed timeframe, or no, the student did not complete within the time frame. The linear model of students' HSRT percentile scores as predictors of on-time program completion indicated no significant association ($p = .078$) as demonstrated by the model summary as seen in Table 1. The distance from one, as depicted in both the Cox and Snell and Nagelkerke tests, further confirms that the variable, HSRT percentage score, was not a coefficient of determination in this model (Field, 2013). The indication of significance ($p = .03$) with the Hosmer and Lemeshow goodness of fit test suggests that there is the potential for a better model (Field, 2013).

Table 1 Coefficients of the Model HSRT Percentile Scores Predict On-Time Program Completion

		95% CI for Odds Ratio		
	b	Lower	Odds	Upper
Constant	-.79			
HSRT percent	-.02	.962	.982	1.002

Note. $x^2(7) = 15.55$, $p = .03$ (Homer & Lemeshow) .03 (Cox & Snell) .05 (Nagelkerke). Model $x^2(1) = 3.104$, $p = .078$.

The HSRT as a Predictor of Admissions Status

Research question two investigated if CRNA program candidates' HSRT quartile scores, were predictors of admissions status, admitted, wait listed, or denied, for cohorts 17-19 or 18-20. For this research question, both the dependent and independent variables were nominal, or categorical, therefore a Pearson chi-square analysis was conducted. No statistically significant association between a CRNA program candidate's HSRT score and his/her admissions status was found $x^2 (9) = 8.829$, $p = .453$.

The Inclusion of the HSRT as an Admissions Component to Predict Programmatic Success

Research question three investigated whether the inclusion of the HSRT as an admissions data element was predictive of programmatic success. Of the five cohorts of students in this study, three program cohorts did not have HSRT scores included as part of the admissions considerations and two did include HSRT scores. All three variables included in this research

question were nominal. The dependent variable was defined as completed on-time, yes or no. The independent variables were the student's HSRT quartile score and whether HSRT scores were incorporated in the admissions process, yes or no. Therefore, a Hierarchical Loglinear analysis was conducted (Field, 2013).

The three-way loglinear analysis produced a final model that revealed partial associations between two of the variables, on-time completion and the HSRT quartile scores (see Table 2). The likelihood ratio of this model was $x^2(0) = 0$, $p = 1$. This indicated that the highest-order interaction (complete on-time x HSRT Quartile) was significant: $x^2(15) = 133.281$, $p = .000$ (see Table 3).

Table 2 Two-way Association Between On-Time Completion and HSRT Quartile

						95% Confidence Interval	
Effect	Parameter	Estimate	Std. Error	Z	Sig.	Lower Bound	Upper Bound
Complete on time x HSRT as Quartile	1	-.546	.266	-2.055	**.040***	-1.066	-.025
	2	.282	.339	.834	.404	-.381	.946
	3	-.038	.212	-.181	.856	-.455	.378
Complete on time	1	.828	.153	5.409	**.000****	.528	1.128
HSRT as Quartile	1	-.445	.266	-1.674	.094	-.965	.076
	2	-.589	.339	-1.741	.082	-1.253	.074
	3	.544	.212	2.562	**.010***	.128	.960

* $p < .05$ ** $p < .001$

Table 3 K-Way and Higher-Order Effects

			Likelihood Ratio		Pearson		Number of Iterations
	K	df	Chi-Square	Sig.	Chi-Square	Sig.	
K-way and Higher Order Effects[a]	1	15	123.509	.000	133.281	**.000****	0
	2	10	10.622	.388	11.240	.339	2
	3	3	1.581	.664	1.302	.729	3
K-way Effects[b]	1	5	112.887	.000	122.041	**.000****	0
	2	7	9.040	.250	9.937	.192	0
	3	3	1.581	.664	1.302	.729	0

a. Tests that k-way and higher order effects are zero. *b.* Tests that k-way effects are zero.
***p*< .001

The Development of a Predictive Model: First Attempt NCE Scores

Two variations of a predictive model of programmatic success were investigated. In both models, the dependent variable was students' NCE scores. Model A included students' first NCE attempt scores and Model B included the students' final passing NCE score. All other variables remained constant across both models. Independent variables included the students' HSRT and GRE scores, BSN and SCI GPAs, time away from school, as measured in years since BSN completion, and time working in the intensive care unit (ICU), as measured in months at the time of entry into UTC's CRNA program. A multiple regression analysis was conducted for both Model A and Model B.

For Model A, statistically significant correlations were found between all variables. The strongest correlations were not associated with the predictive model (ICU time x away from school $r = .497$, $p = .000$; HSRT x GRE $r = .488$, $p = .000$; SCI GPA x BSN GPA $r = .387$, $p = .000$). Two of the six independent variables, time away from school and ICU time, demonstrated

moderate negatively correlations with students' NCE scores, r = -.287, p = .001 and r = -.232, p = .008 respectively. Three independent variables were moderate to weakly positively correlated with students' first attempt NCE scores, HSRT percentile scores (r = .257, p = .004), BSN GPA (r = .197, p = .02), and GRE Scores (r = .184, p = .028).

The fit of the regression model for Model A was statistically significant as depicted in the model summary (see Table 4) and the analysis of variance (ANOVA). A backwards hierarchical regression was conducted, meaning the first regression model included all predictor variables and then for each subsequent model a variable was removed. The R^2 values demonstrate the proportion of variance explained by each model. Each subsequent regression demonstrates how much change in variability was accounted for by each of the predictors, in Model A the variance percentages ranged from 12% to 16.9% (Δ 4.9%) with an adjusted R^2 value of 10.3 to 11.9 (Δ 1.6). The ANOVA analysis (see Table 5) demonstrates that the predictive model provided a statistically significant (p <.01) method of predicting CRNA students' programmatic success, as measured by their NCE first attempt scores, as compared to not using the predictive model. The assumption errors of independence was met as the Durbin-Watson statistic was close to the number two (1.854), and between the numbers one and three (Field, 2013).

Table 4 Model Summary: Predictive Model of CRNA Students' Programmatic Success as Measured by First Attempt NCE Scores

					Change Statistics					
Model	R	R^2	Adjusted R^2	SE	R^2 Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.411[a]	.169	.119	127.258	.169	3.414	6	101	**.004****	
2	.405[b]	.164	.123	126.960	**-.004****	.524	1	101	.471	
3	.395[c]	.156	.123	126.976	**-.008****	1.025	1	102	.314	
4	.377[d]	.142	.117	127.403	**-.014***	1.701	1	103	.195	
5	.346[e]	**.120**	.103	128.429	**-.022***	2.698	1	104	.103	1.854

a. Predictors: (Constant), SCI GPA, Time away from school -=Years, GRE Total Score, BSN GPA, Time in ICU before interview -MONTHS, HSRT Percentage. *b.* Predictors: (Constant), SCI GPA, Time away from school -=Years, BSN GPA, Time in ICU before interview -MONTHS, HSRT Percentage. *c.* Predictors: (Constant), Time away from school -=Years, BSN GPA, Time in ICU before interview -MONTHS, HSRT Percentage. *d.* Predictors: (Constant), Time away from school -=Years, BSN GPA, HSRT Percentage. *e*. Predictors: (Constant), Time away from school -=Years, HSRT Percentage. Dependent Variable: NCE First attempt

*p< .05 **p < .01

Table 5 ANOVA Analysis: Predictive Model of CRNA Students' Programmatic Success as Measured by First Attempt NCE Scores

Model		Sum of Squares	df	Mean Square	F	Sig.**
1	Regression	331701.416	6	55283.569	3.414	**.004**[b]
	Residual	1635649.797	101	16194.552		
	Total	1967351.213	107			
2	Regression	323218.583	5	64643.717	4.010	**.002**[c]
	Residual	1644132.630	102	16118.947		
	Total	1967351.213	107			
3	Regression	306692.074	4	76673.019	4.756	**.001**[d]
	Residual	1660659.139	103	16122.904		
	Total	1967351.213	107			
4	Regression	279272.543	3	93090.848	5.735	**.001**[e]
	Residual	1688078.670	104	16231.526		
	Total	1967351.213	107			
5	Regression	235476.198	2	117738.099	7.138	**.001**[f]
	Residual	1731875.015	105	16494.048		
	Total	1967351.213	107			

Dependent Variable: NCE First attempt. b. Predictors: (Constant), SCI GPA, Time away from school -=Years, GRE Total Score, BSN GPA, Time in ICU before interview -MONTHS, HSRT Percentage. c. Predictors: (Constant), SCI GPA, Time away from school -=Years, BSN GPA, Time in ICU before interview -MONTHS, HSRT Percentage. d. Predictors: (Constant), Time away from school -=Years, BSN GPA, Time in ICU before interview -MONTHS, HSRT Percentage. e. Predictors: (Constant), Time away from school -=Years, BSN GPA, HSRT Percentage. f. Predictors: (Constant), Time away from school -=Years, HSRT Percentage

** $p < .01$

When examining the coefficients, the average variance inflation factor (VIF) was very close to one (1.23), and the average tolerance statistic was above 0.2 (.825), thus "confirming that there [was] no collinearity within this data" (Field, 2013 p. 342). The regression analysis for Model A indicated there were two variables with statistically significant ($p < .05$) predictive relationships with the outcome variable, if all other predictor variables were held constant. Those variables were time away from school (β_i = -.239, $t(104) = -2.554$, $p = .012$) and HSRT percentage scores (β_i =.199, $t(105) = 2.102$, p =.038).

The Development of a Predictive Model: Final NCE Scores

Model B included the students' final passing NCE scores as the outcome, or dependent, variable. A multiple regression analysis was conducted. Statistically significant correlations were found between all variables. As with Model A, the strongest relationships were between variables not associated with the predictive model. Model B's correlations varied only slightly from Model A (ICU time x away from school r = .497, p = .000; HSRT x GRE r = .496, p = .000; SCI GPA x BSN GPA r = .389, p = .000). Additionally, a moderate negative correlation between HSRT scores and away from school was identified (r = -.242, p =.006). Two of the six independent variables were found to have a slightly weaker moderate negative correlation with students' final NCE scores than was found in Model A's first attempt NCE scores, time away from school (r = -.270, p = .002) and ICU time (r = -.205, p = .016). Two additional independent variables indicated a weak positive correlation with students' final NCE scores, HSRT percentile scores (r = .216, p = .012) and BSN GPA (r = .174, p = .035).

The fit of the regression model for Model B was statistically significant as depicted in the model summary (Table 6) and ANOVA analysis. A backwards hierarchical regression was conducted, meaning that the first regression model included all predictor variables and then for each subsequent model a variable was removed. The R^2 values demonstrate the proportion of variance explained by each model. Each subsequent regression demonstrates how much change in variability was accounted for by each of the predictors. In Model B both the variance and range of variance were smaller than in Model A, with an R^2 range of 9.9 to 12.9 (Δ 3.0) and an adjusted R^2 range of 8.2 to 7.7 (Δ -0.5).

Table 6 Model Summary: Predictive Model of CRNA Students' Programmatic Success as Measured by Passing NCE Scores

					Change Statistics					
Model	R	R^2	Adjusted R^2	SE	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.359[a]	.129	.077	129.53	.129	2.51	6	102	**.026***	
2	.356[b]	.127	.085	129.01	**-.002****	.176	1	102	.676	
3	.352[c]	.124	.090	128.60	**-.003****	.343	1	103	.560	
4	.340[d]	.115	.090	128.62	**-.009****	1.03	1	104	.313	
5	.315[e]	.099	.082	129.18	**-.016***	1.94	1	105	.167	1.99

a. Predictors: (Constant), SCI GPA, Time away from school -=Years, GRE Total Score, BSN GPA, Time in ICU before interview -MONTHS, HSRT Percentage. b. Predictors: (Constant), SCI GPA, Time away from school -=Years, BSN GPA, Time in ICU before interview -MONTHS, HSRT Percentage. c. Predictors: (Constant), Time away from school -=Years, BSN GPA, Time in ICU before interview -MONTHS, HSRT Percentage. d. Predictors: (Constant), Time away from school -=Years, BSN GPA, HSRT Percentage. e. Predictors: (Constant), Time away from school -=Years, HSRT Percentage. Dependent Variable: NCE First attempt
*$p < .05$ **$p < .01$

The ANOVA analysis (see Table 7) demonstrates that Model B also provided a statistically significant ($p < .05$) method of predicting CRNA students' programmatic success, as measured by their passing NCE scores, as compared to not using the predictive model. The assumption errors of independence was met as the Durbin-Watson statistic was very close to the number two (1.993), and between the numbers one and three (Field, 2013). As was the case with Model A, when examining the coefficients, the average VIF (1.165) was very close to the number one, and the average tolerance statistic was above 0.2 (.825), thus "confirming that there [was] no collinearity within this data" (Field, 2013 p. 342). The regression analysis for Model B indicated that there was only one variable that had a statistically significant ($p < .01$) predictive

relationship with the outcome variable, if all other predictor variables were held constant. That independent variable was time away from school (β_i = -.263, t(106) = -2.847, p = .005).

Table 7 ANOVA Analysis: Predictive Model of CRNA Students' Programmatic Success as Measured by Passing NCE Scores

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	252380.893	6	42063.482	2.507	**.026**[b] *
	Residual	1711315.657	102	16777.604		
	Total	1963696.550	108			
2	Regression	249430.456	5	49886.091	2.997	**.014**[c] *
	Residual	1714266.095	103	16643.360		
	Total	1963696.550	108			
3	Regression	243725.949	4	60931.487	3.684	**.008**[d] **
	Residual	1719970.601	104	16538.179		
	Total	1963696.550	108			
4	Regression	226717.247	3	75572.416	4.568	**.005**[e] **
	Residual	1736979.304	105	16542.660		
	Total	1963696.550	108			
5	Regression	194708.485	2	97354.242	5.834	**.004**[f] **
	Residual	1768988.066	106	16688.567		
	Total	1963696.550	108			

a. Dependent Variable: NCE First attempt. b. Predictors: (Constant), SCI GPA, Time away from school -=Years, GRE Total Score, BSN GPA, Time in ICU before interview -MONTHS, HSRT Percentage. c. Predictors: (Constant), SCI GPA, Time away from school -=Years, BSN GPA, Time in ICU before interview -MONTHS, HSRT Percentage. d. Predictors: (Constant), Time away from school -=Years, BSN GPA, Time in ICU before interview -MONTHS, HSRT Percentage. e. Predictors: (Constant), Time away from school -=Years, BSN GPA, HSRT Percentage. f. Predictors: (Constant), Time away from school -=Years, HSRT Percentage
* p < .05 ** p < .01

The research design developed for this study enabled the successful investigation of each of the four research questions presented via the various statistical analysis identified in this chapter. The findings from this study indicated that the predictor variable, HSRT percentage

score, was not a significant predictor of students' on-time completion nor was it a significant predictor of their admissions status. However, when HSRT scores were converted into quartile ranks, a statistically significant association was revealed between HSRT quartile scores and student on-time completion. Additionally, the results of this study seemed to indicate that yes, the development of a statistically significant ($p < .01$) predictive model comprised of multiple variables was possible. When all other predictor variables were held constant, two independent variables indicated statistically significant ($p < .05$) predictive relationships with the outcome variable, programmatic success as measured by NCE exam scores. Those two variables were students' time away from school and his/her HSRT percentage scores. The next chapter will further summarize the findings and discuss the implications of those findings along with addressing potential future study.

CHAPTER V

DISCUSSION AND CONCLUSIONS

The research presented in this study addressed identified gaps in the literature with regards to graduate nursing programs. Specifically, the role an individual's critical thinking aptitude may play in his/her success in graduate nursing programs and what relationships may exist between critical thinking and one or more variables and a graduate nursing program candidate's admission, retention, and programmatic success were examined. Lastly, this study asked the question, if relationships do exist, can a statistically significant predictive model of programmatic success be developed?

The population for this study included individuals who provided application data to University of Tennessee at Chattanooga's (UTC) School of Nursing (SON) CRNA program between the years 2014 and 2018. The study participant sample included those candidates who were interviewed, offered a position, and started the CRNA program, and those candidates who were interviewed, yet failed to advance past the interview stage. Subsets of the sample population included students who enrolled and successfully completed the CRNA program between the years 2016 and 2020 and students who enrolled and did not complete the program.

This study was nonexperimental, utilized existing data from admissions materials, included self-reported data such as personal demographic attribute variables, and third-party verified data such as undergraduate and graduate grade point averages, GRE scores, HSRT scores, and NCE scores. The methodology was strictly quantitative in nature. The associational

research design enabled the examination of relationships between variables, rather than causation, thus enabling the development of a predictive model (Gliner et al., 2009).

The findings from this study may seem mixed when examining the results in relation to research questions one, two, and three. Research question one investigated the predictive nature of an accepted student's HSRT score and his/her success in the CRNA program, as measured by on-time program completion. The linear model of students' HSRT percentile scores as predictors of on-time program completion indicated no significant association (p = .078). Research question two investigated if CRNA program candidates' HSRT quartile scores were predictors of admissions status for cohorts 17-19 or 18-20. No statistically significant association between a CRNA program candidate's HSRT score and his/her admissions status was found (x^2 (9) = 8.829, p = .453). Research question three investigated whether the inclusion of the HSRT as an admissions data element was predictive of programmatic success. The three-way loglinear analysis produced a final model that revealed partial associations between two of the variables, on-time completion and the HSRT quartile scores. The likelihood ratio of this model was (x^2(0) = 0, p = 1). This indicated that the highest-order interaction, complete on-time x HSRT Quartile, was significant (x^2 (15) = 133.281, p = .000).

The findings related to research question four indicate that yes, critical thinking aptitude does impact programmatic success and yes, the development of a statistically significant (p < .01) predictive model for CRNA students' programmatic success, as measured by NCE exam scores, is possible. Research question four investigated two variations of a predictive model of programmatic success. In both models, the dependent variable was students' NCE scores. Model A included students' first NCE attempt scores and Model B included the students' final passing NCE score. The use of a student's NCE score also indirectly indicated a student's overall

academic/programmatic success since only students who successfully completed a CRNA program were eligible to sit for the NCE examination. The independent variables included HSRT and GRE scores, BSN and SCI GPAs, time away from school and time working in ICUs prior to enrolling in the graduate program.

Relationship of the Current Study to Prior Research

This study lends support to many of the studies reviewed in Chapter Two, yielding similar findings. This study found a statistically significant positive correlation between students' HSRT and GRE scores (r = .496, p = .000) which lends further support to the HSRT authors' statement that the assessment is highly correlated with the GRE ("Health science reasoning test: Reliability," 2020). The current study lends additional support to the Kelsch and Friesner (2014) and Cox et al. (2013) findings of strong positive correlations between students' HSRT scores and their PCAT admissions assessment scores. The moderate negative correlation found in this study between the amount of time working in ICUs and academic success (r = -.232, p = .008) mirror those of Burns (2011) study where a negative correlation was found to exist between the number of years of critical care nursing experience and students' academic success. The current study also lends further support to El-Banna et al. (2015) findings that those students with six or more years of clinical experience were significantly less likely to be academically successful.

This study's findings that HSRT scores, when examined as percentile scores, were not statistically significant predictor of candidates' admissions status (x^2 (9) = 8.829, p = .453) or of on-time program completion (p = .078), lends support to Kelsch and Friesner (2014) findings that the inclusion of HSRT scores as part of the admissions process added little significance to the admissions decisions. The current study's findings seem to contradict the Pitt et al. (2015)

findings in which positive correlations were found between the undergraduate nursing students' HRST scores and academic performance measures. However, in the current study, when students' HSRT scores were converted to quartile scores, the HSRT was found to be a statistically significant predictor of on-time completion (x^2 (15) = 133.281, p = .000).

The current study's weak to moderate positive correlations between students' HSRT scores and their NCE scores, lends additional support to the Huhn and Parrott (2017) study's findings of a moderate positive relationship between HSRT scores and NPTE scores. Huhn and Parrott also found HSRT scores to be a contributing factor in predicting students' academic success. As was the case in the current study, the inclusion of the HSRT in predictive modeling significantly improved the models' strength.

Researcher's Insights

Based upon the findings of this study alone, it would be inappropriate to identify specific types of preparation, skills, personal characteristics, and/or attributes that students must possess in order to be academically successful in CRNA programs. The multitude of independent and situational variables that are present in any one academic setting at any one time would make such a proclamation not only invalid but unhelpful. What is valid is to examine some of the commonalities and trends across the literature in light of the current study's findings. The following insights are those that the author believes could help inform implications for practice and recommendations for future research.

- A student's age does not seem to be a significant factor in relation to academic success.

- The amount of time an individual is away from the academic environment is significant and seems to have a negative impact upon the ability to be successful in a CRNA program.
- Work experience in an intensive care environment is an important, and required, preparation criterion before starting a CRNA program, however, too much time seems to have a negative effect. The longer a candidate is employed in an ICU environment, before enrolling in a program, the less likely they are to successfully complete that CRNA program.
- A statistically significant negative relationship exists between both the amount of time a student is away from school prior to starting a CRNA program and their NCE scores, and the length of time they are employed in an ICU and their NCE scores.
- Critical thinking aptitude does play a role in a student's academic success and in his/her ability to successfully pass the required certification examination (NCE). A statistically significant positive correlation exists between HSRT scores, and a student's on-time completion and NCE scores.
- Critical thinking aptitude, as measured by the HSRT, when included as part of a predictive model provides a statistically significant (p <.01) method of predicting CRNA students' programmatic success, accounting for 12% of the model's variability.
- GRE scores and BSN GPA are found to have a weak positive relationship with a students' NCE scores and account for 4.9% of the predictive model's variability.

Implications for Practice

The findings from one study of MSN level CRNA program candidates, program students, and program graduates is not the basis for any generalizations. However, this study, and other studies with similar findings, seem to suggest that an individual's academic success may be impacted by external and/or internal factors that are beyond the control of the student and/or the institution. The current study's findings bring into focus some of these factors and the possible implications for future practice, admissions criteria, and candidate selection considerations.

- Spending a required amount of time in the ICU, getting a chance to mature and grow as a practitioner in a critical care environment, is a long-held requirement and expectation of the profession. Although as this study found, extended employment time may have a negative effect upon an individual's ability to be successful in a graduate program.
- Many CRNA programs and their institutions require traditional measurements associated with academic success such as GRE scores and BSN and SCI GPA. This study and many others have found that these criteria provide little if any predictive value with regards to academic progression and/or success.
- Critical thinking aptitude does seem to have an impact upon academic success. The higher the candidates' HSRT scores, the more likely they are to complete the program on time and achieve NCE scores that are both above the first time pass rate cut score and above the national mean score.

Recommendations for Further Research

Additional research seems warranted surrounding the issues of time away from the academic environment and the amount of time spent in the work environment. The current study

found that students who were identified as having worked for extended periods of time in the ICU and/or spent many years away from school exhibited academic struggles and often academic failure. An important consideration for such future research is the recognition that the amount of time away from school and the amount of time in the work environment are not necessarily the same thing. Many nurses continue their academic studies while working. For example, a CRNA candidate might have six years of ICU experience but be less than 12 months removed from the academic environment as having just completed a BSN degree immediately prior to applying to a CRNA program.

Another area of continued investigation would be that of CRNA program admissions criteria and the development of programmatic success predictive models. Although found to be statistically significant in predicting programmatic success, the model developed in the current study accounted for only 16.9% of the variance of students in the MSN level program. As the CRNA profession moves to the DNP programmatic model, additional study is warranted into what additional components may be required of candidates and what factors may serve as valid predictors of success. Given that the current study reaffirmed the minimal impact of a candidates' GRE and/or GPA upon predicting academic success, accounting for only 4.9% of the model's ability to predict programmatic success, this research could provide valuable insights.

This study lends support to the body of knowledge identifying specific non-traditional variables' impact upon a candidate's likelihood of academic success in graduate nursing programs. This study determined statistically significant predictive modeling, used to determine the likelihood of academic success in CRNA programs, should include critical thinking aptitude, length of time employed in an intensive care environment prior to program application, and length of time away from school prior to enrolling in graduate programs, in addition to

traditional admissions variables, such as GRE scores and BSN GPA. Additional study is warranted to determine if these and/or additional factors continue to serve as valid predictors of student programmatic success as the profession transitions to DNP-CRNA programs.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL

THE UNIVERSITY OF TENNESSEE
CHATTANOOGA

Institutional Review Board
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TO: Marclyn D Porter **IRB # 20-161**
Dr. Elizabeth Crawford

FROM: David Deardorff, Interim Director of Research Integrity
Dr. Susan Davidson, IRB Committee Chair

DATE: 11/24/2020

SUBJECT: IRB #20-161: Creating a Predictive Model of Student Success in Certified Registered Nurse Anesthetist Graduate Programs

Thank you for submitting your application for exemption to The University of Tennessee at Chattanooga Institutional Review Board. Your proposal was evaluated in light of the federal regulations that govern the protection of human subjects.

Specifically, 45 CFR 46.104(d) identifies studies that are exempt from IRB oversight. The UTC IRB Chairperson or his/her designee has determined that your proposed project falls within the category described in the following subsection of this policy:

46.104(d)(4)(ii): Secondary research for which consent is not required: use of identifiable information or identifiable biospecimen that have been or will be collected for some other 'primary' or 'initial' activity, and information is recorded so subject cannot readily be identified (directly or indirectly/linked); investigator does not contact subjects and will not re-identify the subjects

Even though your project is exempt from further IRB review, the research must be conducted according to the proposal submitted to the UTC IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit an Application for Changes, Annual Review, or Project Termination/Completion form to the UTC IRB. Please be aware that changes to the research protocol may prevent the research from qualifying for exempt review and require submission of a new IRB application or other materials to the UTC IRB.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite our best intent, unforeseen circumstances or events may arise during the research. If an unexpected

situation or adverse event happens during your investigation, please notify the UTC IRB as soon as possible. Once notified, we will ask for a complete explanation of the event and your response. Other actions also may be required depending on the nature of the event.

Please refer to the protocol number denoted above in all communication or correspondence related to your application and this approval.

For additional information, please consult our web page http://www.utc.edu/irb or email instrb@utc.edu.

Best wishes for a successful research project.

APPENDIX B

VARIABLES ANALYSIS

RQ1: Is a Certified Registered Nurse Anesthetist candidate's critical thinking aptitude, as measured by the Health Sciences Reasoning Test, a valid predictor of programmatic success as measured by the student's completion of their program of study within the prescribed timeframe? Statistic: Logistic Regression			
Type	Variable Labels	Levels of Variables	Scale
Dependent Variable	Completion of Program of Study within timeframe	1=Yes, within prescribed timeframe, 2= NO	Nominal
Independent Variable	HSRT (Health Sciences Reasoning Test)	Overall scale score	Interval
RQ2: For cohorts 2017-19 and 2018-2020 only. Is a Certified Registered Nurse Anesthetist candidate's critical thinking aptitude, as measured by the Health Sciences Reasoning Test, a valid predictor of admissions status? Statistic: Pearson chi-square			
Type	Variable Labels	Levels of Variables	Scale
Dependent Variable	Admissions Status	1=Admitted, 2=Wait listed, 3=Denied	Nominal
Independent Variable	HSRT	Scores reported in nationally normed quartiles and classification of manifestation: 4=superior, 3=strong, 2=moderate, 1=not manifested	Nominal
RQ3: Is the inclusion of the Health Sciences Reasoning Test, as an element of a candidate's admissions status, a predictor for Certified Registered Nurse Anesthetist programmatic success? Statistic: Loglinear analysis			
Type	Variable Labels	Levels of Variables	Scale
Dependent Variable	Completion of Program of Study within timeframe	1=Yes, within prescribed timeframe, 2= NO	Nominal
Independent Variables	HSRT	Scores reported in nationally normed quartiles and classification of manifestation: 4=superior, 3=strong, 2=moderate, 1=not manifested	Nominal
	SRNA Cohort	1=14-16 Cohort 2=15-17 Cohort 3=16-18 Cohort 4=17-19 Cohort 5=18-20 Cohort	Nominal

RQ4: Can a predictive model for Certified Registered Nurse Anesthetist students' programmatic success, as measured by NCE exam scores, be developed based upon one or more variables? **RQ4A: Can a predictive model for Certified Registered Nurse Anesthetist students' programmatic success, as measured by students' first attempt NCE exam score, be developed based upon one or more variables?** **RQ4B: Can a predictive model for Certified Registered Nurse Anesthetist students' programmatic success, as measured by students' final passing NCE exam score, be developed based upon one or more variables?** **Statistic: Regression**			
Type	Variable Labels	Levels of Variables	Scale
Dependent Variables			
	NCE exam scores	Overall score (0-600)	Interval
Independent Variables	HSRT (Health Sciences Reasoning Test)	Overall scale score	Interval
	GRE Total Score	Reported on a 260-340 scale	Interval
	PRE-program BSN GPA	0.0-4.0	Interval
	Pre-Program SCI GPA	0.0-4.0	Interval
	Work experience duration	Time employed in ICU months	Interval
	Time away from Academia	Time since last enrolled as a student in years	Interval
Attribute Variables	Labels	Levels	Scale
	SRNA Cohort	1=14-16 Cohort 2=15-17 Cohort 3=16-18 Cohort 4=17-19 Cohort 5=18-20 Cohort	Nominal
	Gender	1=Female 2=Male 3=Other	Nominal
	Ethnicity	1=AA, 2=Asian, 3=Native peoples, 4=Hispanic, 5= White, 6=multi-racial, 7=other	Nominal
	Veteran Status	1=Active Duty	Nominal

		2=Military Veteran (retired) 3=Reservist 4=Not a Veteran 5=Other	
	Health Care Environment	1= Flight Nurse, 2= CVICU, 3=MICU, 4=SICU, 5=Neuro, 6=PICU, 7=float, 8=General, 9=Other	Nominal
	Post-Master	1=Yes, 2-No	Nominal

VITA

Marclyn D. Porter (Marcy) was born in Indianapolis, IN, to the parents of Sue and Byram Dickes. She is the eldest of three children and has a younger sister and brother. She attended Crow Island Elementary School, Skokie Middle School, Washburne Jr. High School, and graduated from New Trier East High School, all of which are in Winnetka, Illinois. Her 3rd grade teacher, Ms. Condos, was not only her life-long favorite teacher, but served as Marcy's inspiration to pursue a career as an educator. Marcy completed the Bachelor of Science degree in May 1983 in Elementary Education from Peabody College at Vanderbilt University, after switching majors from pre-law to education to follow her true passion. Marcy has fulfilled her dream of being an educator by working with children and adults in public and private Pre-K-12 settings, non-profit educational foundations, arts organizations, and in higher education settings. Marcy pursued and was awarded a Reading Specialist degree in 1985 and completed a Master of Education in Educational Leadership from the University of Tennessee at Chattanooga in May 2007. Marcy is continuing her education in educational leadership by pursing an EdD degree at the University of Tennessee at Chattanooga.