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### **Cognitive Aptitude as a Predictor of Success In Associate Degree Nursing Programs**

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UNIVERSITY OF NORTHERN COLORADO

Greeley, Colorado

The Graduate School

COGNITIVE APTITUDE AS A PREDICTOR OF SUCCESS  
IN ASSOCIATE DEGREE NURSING PROGRAMS

A Dissertation Submitted in Partial Fulfillment  
of the Requirements of the Degree of  
Doctor of Philosophy

Nancy Brooks Leahy

College of Natural and Health Services  
School of Nursing  
Nursing Education

May 2021

This Dissertation by: Nancy Brooks Leahy

Entitled: *Cognitive Aptitude as a Predictor of Success in Associate Degree Nursing Programs*

has been approved as meeting the requirement for the Degree of Doctor of Philosophy in College of Natural and Health Sciences in School of Nursing, Program of Nursing Education

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## ABSTRACT

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Student success in nursing education is essential to supplement the healthcare workforce and sustain the delivery of safe and efficient nursing care. However, the loss of students who drop out or fail out of nursing programs is alarmingly high even though institutions have sought to identify the best candidates for admission to rigorous nursing curricula. While most nursing programs have used academic measures, such as grade point average or standardized testing to rank students for admission, these measures have not adequately captured the characteristics that students must possess to be successful. To further identify nonacademic attributes that enhance achievement, new criteria are being explored. This study tests a new model, the Nursing Cognitive Aptitude Model, or NCAM (Twidwell et al., 2018) as an organizational framework to examine the variables of prior academic performance, current knowledge, and critical thinking skills, for its ability to predict early student success in an associate degree nursing program. A convenience sample of 115 first semester nursing students completed two instruments, the Health Sciences Reasoning Test, and the Test of Essential Academic Skills. Student scores as well as both pre-nursing and nursing cumulative grade point averages were evaluated using regression analysis. The results were consistent with existing evidence that prior academic performance and current knowledge, as measured by composite scores on standardized testing,

were significantly related to student performance. However, overall critical thinking skill did not contribute to early success in nursing education. Thus, the combined composite scores of each variable included in the NCAM did not significantly predict nursing grade point average.

Additional inquiry with multisite designs and diverse student populations is needed to understand the role of pre-existing critical thinking skills in the educational process and to further evaluate the NCAM as a predictive model for student success.

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## **CHAPTER I**

### **INTRODUCTION**

Student attrition in nursing programs has impacted the number of graduating students who are eligible to transition to practice. This dissertation is a report of a prospective correlational study of three variables (critical thinking, pre-nursing grade point average, and pre-admission test scores) and the impact of these factors in predicting success of nursing students in the first semester of an associate degree program. This chapter presents a background of the study, describes its significance, and presents an overview of the methodology. The chapter concludes by noting the limitations and delimitations of the study and defining key terms.

#### **Background**

An increasing gap between the supply and demand of nurses has triggered a persistent global problem that will reach a critical tipping point over the next decade. The World Health Organization (WHO, 2016) reported that nurses, the largest segment of the workforce in healthcare, will reach a 7.6 million shortfall by 2030. Concurrently, the need for care will intensify as the population becomes older and as the burden of disease increases and becomes more complex. It is projected that by 2050, the percentage of the world's population over the age of 60 will double from 12% to 22% and this generation will require a level of care that further exacerbates the nursing shortage (WHO, 2016).

These trends in population demographics and the nursing shortage are relevant in the United States. According to the United States Bureau of Labor Statistics'

Employment Projections 2016-2026, registered nursing is one of the top occupations with expected growth through 2026, requiring a total workforce of 3.4 million. This 15% growth in the profession represents 438,100 new positions. In addition, the Bureau of Labor Statistics estimated that an additional 203,700 nurses would be needed each year through 2026 to replace retiring nurses (United States Department of Labor, Bureau of Labor Statistics, 2019). A survey conducted by the National Council of State Boards of Nursing confirmed this trend as 50.9% of the nursing workforce were reported to be over the age of 50 and expected to retire within the next 10 to 15 years (National Council of State Boards of Nursing [NCSBN], 2018).

The complex issues that surround nursing and impact the shortage at the bedside have been challenging to address and there have been efforts underway to better define both the etiology and scope of the problem. One solution to the lack of qualified RNs has been to increase the capacity of nursing programs to allow more students to enter the profession. However, nursing education is subject to state regulations and professional standards that limit the capacity of educational programs to admit more students.

The number of graduating pre-licensure candidates has been impacted by both nursing program enrollment capacity and the success of students. Barriers to expanding the size of nursing student cohorts include limited space available for clinical education, a growing shortage of qualified faculty, and a lack of classroom facilities (National League for Nursing [NLN], 2018a). These issues have created a bottleneck for potential students as qualified applicants are consistently turned away. According to the American Association of Colleges of Nursing (American Association of Colleges of Nursing [AACN], 2019a), baccalaureate and graduate nursing programs turned away 75,029 qualified applicants in 2018 due to an insufficient number of faculty, clinical sites, preceptors, classroom space and budgetary constraints. A recent survey

regarding faculty shortages, also produced by the AACN (Li et al., 2019), documents the current status of the shortage. The report shows that 56% ( $n = 488$ ) of schools have vacant full-time faculty positions while 15.8% ( $n = 138$ ) need additional faculty but do not have the resources to hire more. While the study assessed the faculty shortage in baccalaureate and graduate nursing programs, a similar trend was noted among associate degree programs. A recent study that focused on faculty openings in associate degree programs found that 75% of directors reported a faculty deficit (Oermann et al., 2015). In short, many underlying barriers exist that contribute to the sustainment or expansion of the nursing workforce and include both practice and educational issues. Regardless, these barriers are persistent and require that all possible solutions to the nursing shortage are examined.

One way to increase the overall number of nurses is to reduce attrition and improve progression and completion within the nursing education pipeline. Reducing attrition of students would improve graduation rates and increase the number of pre-licensure candidates. The education of nurses encompasses a resource-intensive process that requires experienced nursing faculty, clinical site availability, and the commitment of students to complete an academically rigorous program of study. Identifying students with the aptitude to succeed is an essential step to secure the number of qualified applicants needed to fill the current void of practicing nurses. There are numerous qualified applicants to programs who want to become nurses. Yet in 2018, baccalaureate programs turned away 29% of eligible applicants and associate degree programs turned away 38% (NLN, 2018a).

The competitive nature of the admission process implies that those who are selected are academically prepared for nursing education. However, the attrition of nursing students continues to be a persistent problem across all types of prelicensure educational settings (Olsen,



2017). While priority has been placed on establishing the baccalaureate degree as the educational level for entry into professional nursing practice, the availability of four-year education is limited by space and affordability. In the interim, strategic partnerships have evolved to provide seamless progression from associate to baccalaureate programs to enhance the educational level of the nursing workforce (AACN, n.d.). Therefore, the success of students in associate degree programs continues to be a strategic path for ameliorating the shortage. In 2019, there were almost equal numbers of prelicensure candidates who graduated from associate degree as compared with baccalaureate programs (84,794 and 84,298, respectively) who sat for the NCLEX-RN exam (NCSBN, 2019).

Globally, one third who begin nursing programs will drop out or fail out, even though they enter the major as motivated and academically qualified students (Fagan & Coffey, 2019; Mooring, 2016). The extraordinary rate of student attrition in nursing has generated a significant amount of research over the past several decades. Nursing scholars have reported attrition rates as high as 50% for students in baccalaureate programs and 47% in associate degree programs (Harris et al., 2014; Kubec, 2017). While attrition is recognized as a significant problem (Smith-Wacholz et al., 2019), the literature reporting specific large-scale attrition statistics is surprisingly sparse. Accrediting organizations or regulatory agencies do not routinely publish this information. As a result, determining the true scope of the problem is difficult and is further complicated by the variety of measurements used to define completion in academia. Terms such as retention, withdrawal, timely completion, discontinuation, persistence, and success rates are all found in the literature as associated terminology when discussing attrition (Hamshire et al., 2019).

While prevalence of the topic underscores the widespread and pervasive nature of problem, the complex, dynamic, and varied nature of attrition makes it difficult to define or measure. Moreover, there is so much variation in nursing curricula that identification of key precursors of attrition are challenging to identify on a meaningful scale. In a recent systematic review of attrition and curriculum design, it was reported that evidence from research is limited by overly small sample sizes, descriptive results, and a lack of focus on attrition as an outcome (Chan et al., 2018, p. 43). However, the review did reveal that attrition is related to factors such as course content and workload, clinical placement and experiences, and a disparity in the perception and reality of a nurse's role. These factors can be universal and can occur at any level of study; they are not confined to one specific point in a nursing curriculum.

The pressure to educate more nurses to help solve the nursing shortage has produced a sustained interest in finding solutions. Previous studies have focused on a list of academic and demographic variables as predictors of success on the national licensure exam (Barbe et al., 2018; Griffiths et al., 2018; Harris et al., 2014; Olsen, 2017; Robert, 2018). Perhaps since NCLEX-RN pass rates are common quality measures for regulatory and accreditation bodies, this variable has been extensively examined. But prior research does not adequately address the issue of attrition, or the incremental loss of students prior to program completion, which is limiting the numbers of students who progress to graduation and licensure. To improve student retention and reduce attrition, nursing programs are exploring the impact of admission criteria and trying to define the attributes of a candidate who will most likely succeed in a rigorous nursing curriculum (Harris et al., 2014; Mooring, 2016).

Attrition creates several problems that are difficult to resolve. Nursing curricula are regimented and sequential, which makes it difficult for students who stop out to restart a course

in a timely manner. Students who fail and need to repeat a course delay progression and are at increased risk of attrition once they resume their coursework. Moreover, nursing student attrition causes an increase in both the financial and emotional costs of education to the student and is a waste of academic resources for the institution as a failing student leaves an opening in that is not filled in the cohort model of education (Lewis, 2019). Dropping out of a clinical course creates a disadvantage for a student who may already be struggling with nursing content, the application of knowledge in clinical, or both.

It is essential that students who are selected for admission are academically prepared to be successful and possess the attributes needed to progress through a rigorous nursing program (Robert, 2018). Therefore, much attention has been paid to identifying the preadmission factors that could predict success. Most nursing program admission processes include a mix of criteria in the consideration of candidates. These typically include grades and standardized testing scores (Twidwell & Records, 2017; Wambuguh et al., 2016). In some programs, grades and standardized testing scores are encompassed in holistic admission procedures that have been adopted to provide a more diverse student population and eventually, a more diverse nursing workforce (Barbe et al., 2018; Glazer et al., 2016).

While many factors related to attrition have been studied, most research has been done in small, single-site samples and results have varied (Chan et al., 2018; Olsen, 2017). Recently published results can be grouped into two categories: demographic and academic factors. Demographic factors, such as gender, ethnicity, age, and socioeconomic characteristics have been explored but recent reviews of the literature reveal contradictory results (Olsen, 2017). Personal attributes and affective domains that influence success or failure have also been studied. These include characteristics such as learning styles, resilience and emotional intelligence, as

well as family and peer support (Fagan & Coffey, 2019). Research has also shown that students who underestimate the rigor, depth of knowledge, and legal implications of practice may drop out if they feel overwhelmed (Kukkonen et al., 2016). In addition to demographic variables, pre-admission academic factors of interest have also been studied with a focus on prior grades, subject specific grades, especially in science and math, and nursing-specific standardized test scores (Wambuguh et al., 2016). Yet, there are many dynamics that could influence attrition in nursing education that have not been examined.

The acquisition of critical thinking skills is an essential outcome of nursing education. The importance of critical thinking as a precursor to sound clinical judgment, is emphasized in most nursing programs. Nursing education organizations, including the NLN (2010) and AACN (2008), mention critical thinking skills in assumptions and outcome expectations for prelicensure students. However, critical thinking ability has not been typically used as metric in admission decisions. The use of “expanded cognitive aptitude” as a predictor for nursing student success is an emerging concept that has been presented in a new model, the Nursing Cognitive Aptitude Model, or NCAM (Twidwell et al., 2018). The NCAM includes three distinct variables as predictors for success. These include current scholastic knowledge, critical thinking ability, and prior academic performance. These three cognitive measures combine to create nursing cognitive aptitude, a potential predictor of academic success in baccalaureate degree nursing programs. While the NCAM has not been examined in associate degree populations, pre-licensure associate degree nursing students constitute the largest number of first-time NCLEX-RN examinees (NCSBN, 2019) and should be studied.

Moreover, community college students represent a diverse, nontraditional population of adult learners, many of whom are returning to college with a rich array of life experiences that

could influence the variables of success represented in the NCAM. According to current statistics, the number of nontraditional students has hit 8.9 million and is expected to increase by 14% by 2026, while at the same time traditional college enrollment is trending down (Barrington, 2020). According to the recent statistics, 38% of today's college students are older than 25, 58% work while in college, and 26% are raising children (Berman, 2017). The reduced cost and flexibility of a community college education is appealing to this new student demographic. With articulation agreements to four-year institutions for RN to BSN completion programs, community colleges offer another pathway to increasing the overall number of bachelors-prepared nurses. This project explored the use of the NCAM as a framework for admission criteria and examined its potential to predict student success in associate degree nursing programs.

### **The Problem Statement and Research Questions**

The purpose of this study was to determine the relationship of three specific cognitive aptitude measures to attrition of first semester associate degree nursing students from several programs located in a mid-Atlantic state. Using the Nursing Cognitive Aptitude Model as a framework (Twidwell et al., 2018), the investigator examined current scholastic knowledge (pre-admission standardized test scores), prior academic performance (pre-nursing GPA), and critical thinking ability as predictors of success. Success was measured by end-semester cumulative GPA of four specified nursing content course. This project sought to answer the following research questions:

- Q1     What is the relationship between pre-nursing critical thinking ability and end-semester nursing GPA in associate degree students?
- Q2     What is the relationship between prior academic performance and end-semester nursing GPA in associate degree students?

- Q3 What is the relationship between current scholastic knowledge and end-semester nursing GPA in associate degree students?
- Q4 Do the three expanded cognitive aptitude measures of the Nursing Cognitive Aptitude Model predict first semester attrition?

### **The Professional Significance of the Study**

The nursing profession is facing a significant global shortage of professional nurses in the next decade (WHO, 2016). The lack of nurses, the largest component of our healthcare workforce, places a strain on healthcare systems that can impact patient outcomes, overwhelm existing nursing staff, and create a burdensome work environment that precipitates more nurses choosing to leave the profession (Aiken et al., 2014; Blouin & Podjasek, 2019; Griffiths et al., 2018). While the shortage of nurses is not new, the large number of nurses required to offset a wave of retirements and fill the expanding roles of nurses creates a new urgency in solving the issue (United States Department of Labor, Bureau of Labor Statistics, 2019). The nursing shortage is dynamic and complex and will require a multi-faceted approach to resolve.

The impact of the nursing shortage extends beyond the bedside and into the classroom. Today, many nursing programs are trying to increase student admissions to help expand the ranks of practicing nurses. The profession attracts many qualified students, but a significant number are turned away due to a lack of resources (NLN, 2018b). Those admitted to nursing programs may discover that the program is more rigorous than expected (Kukkonen et al., 2016) and as many as 30% of students who start in a nursing program will leave prior to completion (Fagan & Coffey, 2019). Students who have begun the educational process and maintain the desire to become a nurse, but leave because of academic failure, are lost to the profession. Attrition significantly reduces the overall number of new nurses that transition to practice and help to fill the dwindling ranks.

This project adds to the scholarly research pertaining to nursing student attrition. One often overlooked population for research are nursing students in the community college population and this study helps to fill this gap. Despite the recommendation for the minimal entry level to practice be a baccalaureate degree (Institute of Medicine [IOM], 2011), community colleges produce approximately 50% of prelicensure candidates (NCSBN, 2018).

While many studies have focused on both demographic and academic variables as risk factors, the results are inconsistent (Hamshire et al., 2019; Olsen, 2017). Moreover, although critical thinking is a desired outcome in nursing education, pre-existing thinking skills have not been routinely assessed during the admission process (Twidwell et al., 2018). Nursing programs are tasked with admitting students who have the potential to succeed and the specific student attributes that contribute to success are still in question. If critical thinking skill is a significant predictor of success in the first semester, then an assessment of reasoning could be added to routine admission metrics. This may provide students who possess stronger critical thinking skills an enhanced opportunity for admission. Typically, students have been assessed by more limited cognitive aptitude testing, focused on GPA and pre-admission scores, which may have omitted students who could be successful.

### **Overview of Methodology**

A prospective correlational design was used to examine the association of cognitive aptitude skills and success in first semester nursing students. Multiple regression analysis was performed. The dependent variable, academic success in first semester, was measured by the cumulative GPA of four required nursing courses. The independent variables included critical thinking skill level, current scholastic knowledge, and prior academic performance. A convenience sample of first semester nursing students was obtained from several community

colleges. These colleges, located in a mid-Atlantic state, are attended by a diverse population of nontraditional students and are in urban, suburban, and rural areas. All 18 state community colleges have adopted a common nursing curriculum. Each of the 18 current nursing programs were invited to participate in the study. Programs with a planned incoming cohort for the fall 2020 and spring 2021 semesters and those programs that require the same pre-admission standardized test were selected. Students volunteered to complete a critical thinking exam near the beginning of the semester. These critical thinking scores were compared to pre-nursing data and end semester nursing course grades. Descriptive analysis was also performed to describe the study population.

### **Limitations**

This study was limited by both data collection time frame, student availability and participation, and specific program pre-admission testing. Data collection occurred close to the beginning of the first semester of nursing classes and a convenience sample included those students who chose to participate. The criteria to include programs with the same pre-admission standardized test excluded some students. The students were recruited from several community college settings but may not be representative of the overall community college population of nursing students. Since students self-selected to participate in the study as part of a convenience sample, it is unknown if the sampling method attracted students who possess cognitive skills that differentiate them from their peers who chose not to take part in the study.

### **Definition of Terms**

There are several terms used throughout this dissertation that may have ambiguous or broader meaning than used within the confines of the study. These terms were operationally defined to provide clarity and precision.



*Cognitive Reasoning.* Cognitive reasoning is “a complex cognitive process using both formal and informal processes to analyze and evaluate information required for implementing appropriate nursing actions” (Twidwell et al., 2018, p. 3).

*Critical Thinking.* Critical thinking is the demonstration of “higher-level thinking and discernment of thought, problem-solving skills, purposeful self-regulatory judgment, and metacognition” (Twidwell et al., 2018, p. 3). In this study, critical thinking aptitude will be measured by the Health Science Reasoning Test-Associate Degree version (HSRT-AD), a valid and reliable assessment of critical thinking skills.

*Current Scholastic Knowledge.* In this study, current scholastic knowledge was measured by a standardized nursing admission test that measures the cognitive aptitude of students and produces composite and subject-specific sub-scores. The scores can be used as criteria for meeting minimal requirements for nursing education and represent the knowledge gained from prerequisite, general education courses, such as math, science and English.

*End of First Semester GPA.* End of first semester GPA was defined as the average grade earned in the four first semester nursing courses (NSG 100, NSG 106, NSG 130, NSG 200) as calculated on a standard 4-point academic scale. Each course’s number of course credit hours was multiplied by the numerical equivalent of the letter grade earned (A = 4, B = 3, C = 2, D = 1, F = 0). These four numbers were added together and then divided by the total number of credit hours for the four courses to obtain the end of first semester GPA.

*Nursing Cognitive Aptitude.* Nursing cognitive aptitude is defined as “the degree to which the student demonstrates the capacity to learn and be successful in a nursing program” (Twidwell et al., 2018, p. 2). Nursing cognitive aptitude is a central construct of the Nursing Cognitive Aptitude Model and is comprised of three contributing, measurable

factors. These factors include current scholastic knowledge, prior academic performance, and critical thinking ability.

*Prior Academic Performance.* Prior academic performance was defined as the average grade earned in the five prerequisite courses (ENG 111, SDV 100, BIO 141, PSY 230, elective) as calculated on a standard 4-point academic scale. Each course's number of course credit hours were multiplied by the numerical equivalent of the letter grade earned (A = 4, B = 3, C = 2, D = 1, F = 0). These five products were added together and then divided by the total number of credit hours for the five courses to obtain the pre-nursing GPA.

*Student Academic Success.* In this study, end of 1<sup>st</sup> semester GPA was used to measure academic success and was defined as the average grade earned in the four first semester nursing courses (NSG 100, NSG 106, NSG 130, NSG 200) as calculated on a standard 4-point academic scale. Each course's number of course credit hours were multiplied by the numerical equivalent of the letter grade earned (A = 4, B = 3, C = 2, D = 1, F = 0). These four products were added together and then divided by the total number of credit hours for the four courses to obtain the first semester nursing GPA.

### **Organization of the Study**

This study examined the relationship and interaction of three expanded cognitive aptitude assessments to success of students in the first semester of associate degree nursing programs. Chapter II presents a comprehensive literature review of pertinent topics based on the NCAM as an organizing framework. Chapter III delineates the research design and methodology. The research instrument used to measure critical thinking, procedures followed, sampling technique and setting, as well as the planned statistical analysis is described.

## **CHAPTER II**

### **REVIEW OF THE LITERATURE**

There is a large body of knowledge related to many elements of student success in nursing education. With a global shortage of nurses predicted over the next decade (United States Department of Labor, Bureau of Labor Statistics, 2019), nursing programs are faced with providing more nurses to meet this need. As a result, nursing scholars have been examining sustainable methods to increase capacity in educational programs. One key to increasing the number of graduating students is to focus on identifying factors that lead to success. These factors include both academic and nonacademic characteristics that predict which students could succeed in a rigorous nursing educational program.

Despite the scope and magnitude of the nursing student attrition issue, most research conducted to date often presents conflicting or inconclusive results. Student attrition is complex and compounded by the contributory effects of the unique nature of each student's educational journey, personal experience, and underlying cognitive attributes. The use of a theoretical framework to examine the literature allows for a more focused approach to an exploration of the current evidence. In this chapter, the theoretical framework that underpins the proposed project will be used to structure the review. Therefore, the chapter begins with an explanation of the Nursing Cognitive Aptitude Model or NCAM (Twidwell et al., 2018), then proceeds with an exploration of the literature pertaining to its components: current scholastic knowledge, prior academic performance, critical thinking ability, nursing cognitive aptitude,

and student academic success. A discussion of current admission standards concludes the chapter.

### **Theoretical Framework**

A new conceptual model proposed by Twidwell et al. (2018) suggested that measuring expanded cognitive aptitudes of nursing program candidates can help predict student success. The Nursing Cognitive Aptitude Model, or NCAM), includes three contributing and measurable concepts - current scholastic knowledge, prior academic performance, and critical thinking - that comprise nursing cognitive aptitude. The authors theorize that nursing cognitive aptitude is a central latent attribute defined as “the degree to which the student demonstrates the capacity to learn and be successful in a nursing education program” (Twidwell et al., 2018, p. 331). The measurement of each component of nursing cognitive aptitude can be combined to provide a student profile that provides predictive value during the admission process.

The NCAM (Twidwell et al., 2018) serves as the theoretical framework for this study and organizes the remaining literature review. Each component of the model will be discussed and the current evidence to support each construct as an integral factor to success in nursing education will be reviewed. Because there are few studies that include all three components, a literature search for each construct and its relationship to success in nursing was employed and will be detailed in each section of the review.

Several additional models have been developed to help explain the problem of student attrition, retention and success in higher education. An early model developed by Tinto (1975), exhibits the multifactorial nature of persistence in general higher education settings and has served as a basis for more recent models of attrition. While Tinto’s model focuses on social and academic integration as central to retention, it also describes three pre-entry attributes (e.g.,

family background, skills and abilities, prior schooling) as contributing factors in establishing the intentions and goals that lead to success. These preexisting characteristics, or similar concepts, appear in several models developed to explain the issue of retention in nursing education, including the Nursing Universal Retention and Success (NURS) model (Jeffreys, 2015). Tinto's model has been cited and substantiated by studies related to the experience of many generic college students and their decisions to depart. Tinto provided the framework to support many early studies that identified attrition risk factors. These include the need for social support and faculty mentoring to decrease student feeling of isolation that can contribute to the decision to leave education (Fagan & Coffey, 2019). Tinto's model fails to recognize the impact of current social and economic norms that require many students to work, care for families, and juggle multiple roles in addition to that of student and, as a result, fails to include the complex factors specific to success in nursing education.

Jeffreys' (2015) Nursing Universal Retention and Success (NURS) model provides a more comprehensive view of the variables that are unique to student retention in nursing. Similar to Tinto, Jeffreys acknowledges the pre-existing characteristic that impact success but also delineates attributes valued by the profession. Concurrent outside factors, such as politics, economics, and nursing professional issues, as well as demographic factors, such as prior education or work experiences, language, or ethnicity, combine with affective characteristics that help to exemplify the unique experiences and challenges of a student nurse. Jeffreys' model also includes important environmental factors that may contribute to retention or attrition. Financial status and support, childcare, transportation, outside employment, and living arrangements are modern demands that impact student life. Jeffreys' model also includes factors related to professional integration, an issue like Tinto's beliefs about the importance of social and

academic integration. And finally, Jeffreys' model includes academic factors as a contributing characteristic to success. Study skills, study hours, attendance, class schedules, and academic services all play a role in academic outcomes, such as course grades cumulative GPA. While the NURS model captures many of the contributing factors related to success in nursing education, it does not focus on pre-existing cognitive attributes that may help to identify students who may be at greater risk for attrition. Additionally, many of the environmental factors identified by Jeffreys may be beyond the scope of academic services and therefore difficult to address or improve. Affective characteristics, such as self-efficacy or motivation, are more subjective in nature not routinely measured in nursing applicants; demographic variables are noted in the application process, but things like gender, race, age or family educational status are not items that can be scored, weighted or used in ranking during the admission procedure. Jeffreys' model demonstrates a comprehensive approach to recognizing the many issues that contribute to retention but cannot help in predicting who will be successful in a rigorous nursing program.

### **Prior Academic Performance**

Grades are given in the academic environment to provide feedback, instill motivation, and to benchmark the level of student achievement at the end of a course (Billings & Halstead, 2016). Additionally, grades are commonly used for administrative purposes that include admission, progression, graduation, awards, and scholarships. However, grades are also a source of controversy in nursing education as the ethical issues related to grading, such as bias or fear of poor student evaluations, and grade inflation, have come to light (Oermann & Gaberson, 2017). Grade inflation, an intentional increase in a grade without a significant improvement in performance, has diminished the meaning of grades through falsification or misrepresentation of an individual's ability (Elie, 2017).

Moreover, there is little consistency in grading scales across academic institutions. A recent study of grading scales in undergraduate nursing education programs in the state of New York found a wide variation in passing standards and grade distribution (Reynolds, 2015). Passing grades ranged from 70 percent to 85 percent, with a mean of 74.79 percent. Faculty differences were also noted with full time faculty assigning less As and more Bs than adjuncts, and tenured faculty awarding the least number of As and the greatest number of Cs as compared to their non-tenured colleagues. These inconsistencies illustrate current issues with the reliability of GPA as a true measure of academic success and describe the difficulty in using the GPA to interpret student achievement. Nevertheless, GPA continues to be an important metric in nursing education and a common variable in research in which both pre-program GPA and content-specific course work have been significantly correlated to success in nursing education.

A search was conducted of the CINAHL Plus with Full Text and Nursing and Allied Health ProQuest databases using the following terms in varied combinations: nursing, nursing education, grades AND admission, GPA AND admission, student AND success, attrition, predictor. The list was filtered to include full text articles in English and dissertations for a 10-year span, 2009 to 2019. A 10-year span was chosen to be consistent across all three constructs (i.e., prior academic performance, current scholastic knowledge, and critical thinking ability) and limited due to the frequent revision of standardized tests. Additional research studies were discovered as common references in the literature, and these were added to this review when relevant.

### **Pre-Program Cumulative Grades**

Most nursing programs use a combined number of metrics to rank students for admission (Liu et al., 2018). In an integrative review of 26 studies related to admission criteria and

programmatic success in associate degree nursing programs, Olsen (2017) discovered that all but one project included the measurement of GPA as an independent variable of success. Moreover, in a synthesis of findings, the author recommended the use of pre-program GPA in admission metrics to establish priority admission policies with evidence-based processes (Olsen, 2017). Similarly, baccalaureate programs in nursing also weight GPA heavily in the admission processes (Pitt et al., 2012).

Although pre-program cumulative grades are commonly used in the admissions process, the literature reveals conflicting results related to overall GPA and success. Some studies noted that pre-nursing cumulative GPA was a significant factor in students who succeed (Gilmore, 2008; Newton et al., 2007; Romeo, 2013) while other study results showed no significance (Beery, 2014; Dries, 2019; Trofino, 2013). Conflicting findings were documented in several integrative reviews examining studies of associate degree (Olsen, 2017), baccalaureate, and second-degree programs (Landry et al., 2010), and studies with traditional and nontraditional student samples in the United States (Olsen, 2017; Pitt et al., 2012) and abroad (Mooring, 2016).

### **Course-Specific Grades**

Research to support the use of grades in specific pre-nursing courses has also provided conflicting evidence. Anecdotally, grades in both science and math have been thought to be predictors for success in nursing because of the reasoning skills required, but the evidence to support this assertion is lacking (Maley & Rafferty, 2019). Some studies suggest that students with high grades in pathophysiology (Beery, 2014), anatomy and physiology (Gilmore, 2008; Higgins, 2005; Payne, 2011; Wambuguh et al., 2016), microbiology (Beery, 2014; Higgins, 2005; Muecke, 2008), and biology and chemistry (Bodman, 2012) are more likely to succeed in



nursing. In contrast, several studies found there was no relationship between these science courses and achievement in nursing education (Dries, 2019; Higgins, 2005; Jeffrey, 2007).

Research on math courses as a predictor of success in nursing school has also been mixed. While some studies show a relationship (Chen & Voyles, 2013; Domiano, 2018; Higgins, 2005; Knauss & Wilson, 2013; Trofino, 2013), others do not (Gilmore, 2008; Robert, 2018; Wolkowitz & Kelley, 2010). Even within math subjects, specific courses may not be consistently linked to achievement. A recent study (Maley & Rafferty, 2019) compared program completion to individual math course grades and found that while calculus and precalculus were predictive of success, algebra, trigonometry, or statistics grades, had no effect on graduation.

### **Summary**

While most research has been retrospective and compared single grades or combined GPA to end of program measures of success, such as on-time program completion, graduation, and passing NCLEX-RN on the first attempt, few have used success in the initial courses of the nursing curriculum as an outcome variable. With attrition reducing the overall number of graduating nurses, identifying and defining attributes of students who are likely to persist through the early part of a nursing curriculum is important. Jeffrey (2015) reported that students who fail, drop out, or withdraw and then reenter a nursing program are at greater risk of attrition. Examination of early program success in relation to pre-established predictors, such as GPA, represents a significant gap in the current literature.

Only a few dissertations have explored early program success and its relationship to pre-admission grades. In a small, single-site study of associate degree students ( $n = 78$ ), Luna (2014) found that the final course grades at the end of the first semester in nursing were moderately correlated with the pre-nursing grades in science ( $r = .447, p < .001$ ), English ( $r = .329, p <$

.007), math ( $r = .297, p < .023$ ), when analyzed using the Pearson Product Correlation. In a retrospective study of 539 associate degree students who had failed a nursing course, Dries (2019) noted that students were most likely to fail the first semester nursing course, nursing fundamentals. Moreover, students who failed a course in the second or third semester were most likely to be academically dismissed. Using logistic regression analysis, Dries (2019) discovered there was a statistically significant correlation between the final course grade in fundamentals and program completion ( $r = 0.300, p < .01$ ). More research related to first semester success and program completion may illuminate the importance of grades in the first semester of nursing.

A gap in the literature exists when evaluating pre-nursing courses, both individual and cumulative course grades, to early success in nursing. Most research has focused on end of program outcomes as a measure of success, which ignores potentially valuable data from non-completers. This approach has also left unexamined the impact of GPA, a common admission criterion, on early success in nursing education.

### **Current Scholastic Knowledge**

Scholastic ability is commonly measured through standardized testing, which is thought to offset the variability of GPA (Olsen, 2017). While some nursing programs admit students as freshmen, many require that students meet the college standard for admission, complete initial general education courses for several semesters, and then submit a separate application for nursing. Therefore, admission criteria are inconsistent with some students entering nursing education directly from secondary school and others applying to nursing after one or more semesters of college level coursework. Standardized testing provides an objective, comparable measure between students and can help to sort and rank applicants who may have varied academic backgrounds. Although admission committees rely on different criteria, most use a

general examination for college, such as the Scholastic Achievement Test (SAT) or the American College Testing (ACT) exams, and many require a specific nursing aptitude exam. There are several tests designed to predict success in nursing.

### **Standardized Admission Testing**

Pre-admission standardized testing specific to nursing may help to identify students with the cognitive aptitude for success. There are several tests that are specifically tailored to nursing students, but each contains variations that prevent easy comparison. In a recent literature review, Olsen (2017) noted that while each exam has been studied in its relation to academic success, research to compare one or more exams was lacking. The most common general standardized entrance exams in the United States include the Scholastic Achievement Test (SAT), the American College Test (ACT), and the Collegiate Assessment of Academic Proficiency (CAAP). However, nursing education also has profession-specific tests which include the Health Education Systems Incorporated Admission Assessment (HESI A<sup>2</sup>), the Test of Essential Academic Skills (TEAS), and the NLN Pre-Admission Exam (PAX-RN), which are commonly used in admission metrics (Twidwell & Records, 2017). The proposed project focuses on the standardized exams for nursing, which are required for the population of the proposed study. Therefore, the current literature regarding the use of each pre-admission nursing exam and the evidence pertaining to the ability of each exam to predict success will be discussed in greater detail.

A search was conducted of the CINAHL Plus with Full Text and Nursing and Allied Health ProQuest databases using the following terms in varied combinations: nursing, nursing education, entrance AND exam, student AND success, attrition, predictor, Health Education Systems Inc. (HESI), Test of Essential Academic Skills (TEAS), and Pre-Admission

Examination for Registered Nurses (PAX-RN). The list was filtered to include full text articles in English and dissertations for a 10-year span, 2009 to 2019. A 10-year span was chosen to include data from the most recent versions of each standardized examination. Additional research studies were discovered as common references in the literature, and these were added to this review.

### ***Health Education Systems Incorporated Admission Assessment (HESI A<sup>2</sup>)***

The HESI Admission Assessment Exam is formulated to measure academic knowledge in English, math and science. The results give a composite score as well as eight subset scores: math, reading, grammar, vocabulary, anatomy & physiology, biology, physics, and chemistry (HESI Exam, 2021). There have been several studies that concentrated on end-program outcomes, especially NCLEX-RN licensure and the use of another test product, the HESI A<sup>2</sup> Exit Exam. However, a few focused on the use of the HESI A<sup>2</sup> to predict early academic success during the first semester or first year of nursing education. These studies were conducted at single institutions, in either associate degree or baccalaureate programs, with the purpose of curricular evaluation or to inform admission policy decision. The results cannot be generalized to broader populations.

Some research has been conducted to investigate the potential of the HESI A<sup>2</sup> exam to identify students who are likely to experience early academic success. HESI A<sup>2</sup> composite scores were found to significantly correlate with course grades accrued in the first semester of AD programs in several studies. Knauss and Wilson (2013) found a significant correlation ( $r = .532$ ,  $p < .01$ ;  $r = .455$ ,  $p < .01$ ) in two first-semester course grades and HESI A<sup>2</sup> composite scores in a sample of 157 students. Chen and Voyles (2013) found similar results in their study of 513 community college nursing students. Their report showed a positive correlation between the HESI A<sup>2</sup> composite scores and all three first semester course grades ( $t = 6.394$ ,  $p < .01$ ).

Additionally, two dissertation studies examined the use of HESI A<sup>2</sup> scores in relation to early success in associate degree nursing programs. Bodman (2012) completed a retrospective dissertation study in which 263 associate degree nursing students' HESI A<sup>2</sup> scores and course grades were evaluated for a correlation to success through the curriculum to graduation. The author found that there is a significant correlation in the composite HESI A<sup>2</sup> score and the grades earned, as well as program completion. Discriminant function analysis revealed that the HESI A<sup>2</sup> biology sub score successfully classified those who passed or failed Nursing 1 (87.1%). The HESI A<sup>2</sup> composite score was also able to accurately classify success in Nursing 2 (66.1%), Nursing 3 (64.7%), and Nursing 4 (66.7%). In contrast, a doctoral study by Hilke-Lampe (2014) using logistical regression analysis ( $n = 133$ ) found that HESI A<sup>2</sup> scores were not reliable predictors in determining who would pass or fail four first semester courses.

Research conducted in baccalaureate education has shown comparable results (Underwood et al., 2013). These authors noted that the composite A<sup>2</sup> scores significantly correlated ( $p < .01$ ) with final course grades in three first-semester nursing courses ( $n = 184$ ) and that A<sup>2</sup> scores increased as course grades increased. A retrospective study by Hinderer et al. (2014) found that HESI A<sup>2</sup> scores were positively correlated with overall GPA but noted scores had no predictive value regarding timely progression. The authors considered timely progression as completion of the nursing major in four contiguous full-time semesters without stopping out or dropping out (Hinderer et al., 2014). While this implies that some attrition was noted, specific correlation to first semester or first year attrition was not addressed.

It is surprising to note that most studies found in the literature were published in the early part of the past decade and used retrospective data collected several years prior to publication. There were no studies related to HESI A<sup>2</sup> and early program success during the past five years.

However, the previous studies were consistent in providing evidence that the HESI A<sup>2</sup> correlates with success in both baccalaureate and associate degree nursing programs.

### ***National League for Nursing Pre-Admission Test (PAX-RN)***

The National League for Nursing (NLN) offers another common nursing pre-admission test, the PAX-RN. The PAX-RN provides a mechanism to compare students' academic ability in basic verbal, math and science skills. According to the information available from the NLN (2015), the verbal section assesses word knowledge, reading comprehension, and critical thinking.

Published research using the PAX-RN is limited. An unpublished paper and conference presentation by Levine and Bellefleur (2011) reported that in a small study of 45 students in an associate degree program, the PAX-RN composite and verbal scores were significantly higher in students who were successful in the first semester. Using the Pearson Product Correlation, the authors compared scores of students who passed the first semester and those who did not. Significant differences were found in Verbal Ability raw score ( $r = -2.461, p < .05$ ) and the Composite raw score ( $r = -2.198, p < .05$ ). The usefulness of the study results is limited by its small size and emphasis on a minority sample. A study conducted in 2015 (Manieri et al.) found that the PAX-RN was not an effective predictor. Moreover, the PAX-RN was updated in 2015 to include current nursing knowledge and multiple format questions and no recent studies were discovered.

### ***Test of Essential Academic Skills (TEAS)***

The TEAS test is another common nursing pre-admission examination and like HESI A<sup>2</sup>, it's scores have been used in a significant number of research studies. The TEAS results include an overall adjusted individual score (normalized) as well as four component scores: reading,

English and language use, math, and science (Assessment Technologies Incorporated [ATI], 2020). Unlike the HESI or PAX-RN, the TEAS test also assigns an academic preparedness category to each result with each category is designated by a cut score. The purpose of defining academic categories is to assist nursing programs in assessing the overall profile of applicants and accepted cohorts. ATI suggests that each program establish individual cut scores for their unique student population (Bremner et al., 2014). Regardless of cut score designation, there have been several studies that compare TEAS scores to both early and end of program success as well as component sub scores.

There have been three published projects that have examined TEAS scores; all had a different focus and utilized the same data set. The first study (Bremner et al., 2014) was completed in a baccalaureate setting with a large sample ( $n = 474$ ) gathered from four consecutive cohorts. Using five admission variables, including the composite TEAS score, the authors compared the test results to three outcome measures (nursing GPA, program completion, success on NCLEX-RN). Statistical analysis on the data set sought to determine a correlation between combined variables and each outcome measure by using logistic regression techniques.

However, a cut score for the overall TEAS result was determined by identifying the median composite TEAS score (TEAS = 82%) over the four years in which data were collected. To simplify data analysis, students with a score below 82 were coded with a 0 while students with a score of 82 or above were coded with a 1. A score of 82 placed students in the Advanced category when designated by the academic preparedness scale created by ATI. The Advanced category range established for the TEAS is quite broad with a range of 78 to 90.6%. With a cutoff score for the Advanced category set at 82% for this sample, some students who scored between 78% to 82% were coded as lower performing students. This departure from the

recommended designation was reversed once the final study results were examined. An overall range of composite TEAS scores was reported as 61% to 98% for this sample (Bremner et al., 2014).

The authors reported that of the 511 students who entered the program, only 474 completed the first semester and took an additional ATI exam, RN Fundamentals of Nursing. Some of the students who were not accounted for may have withdrawn from the program for poor performance; this could influence the data and confound the results. Logistic regression analysis found a statistically significant impact of TEAS scores on predicting the score of the ATI RN Fundamentals Exam ( $\chi^2_1 = 8.343, p = 0.0039$ ). The authors concluded that no threshold value clearly differentiated the successful from the unsuccessful students because of a significant overlap in initial TEAS and Fundamentals test scores. A final cut score of 78% was chosen for the program as it provided a balance between sensitivity and specificity; the use of this threshold allowed students to be identified if they would be successful (83.8%) or unsuccessful (26.6%) at the end of the semester. The final cut score determined by the authors coincided with the recommend cut scores for Advanced Proficiency by ATI. In sum, the TEAS test scores were significant in predicting first semester success (as measured by the ATI RN Fundamentals exam) when a composite cut score of 82% was used in analysis. However, the use of a single site in this study is a limitation that prevents the generalization of results.

Using the same data as the Bremner et al. (2014) study, Wambuguh et al. (2016) focused on the outcome of program completion using a correlational logistic regression approach to compare TEAS scores to the outcomes of graduation and NCLEX-RN success. The results showed that a student with a pre-admission TEAS score of greater than 82% had an 8% greater probability of graduating and 9% greater possibility of passing NCLEX-RN. Students with a



TEAS score of 82% or higher increase the odds of graduation by 2.14 ( $p = .01$ ; Wambuguh et al., 2016).

The last published study that used the Bremner et al. (2014) data is of interest because of the analysis of significant predictors for nontraditional students. In this project, Van Hofwegen et al. (2019) pulled data for students who were military veterans ( $n = 55$ ) to profile the characteristics of this unique population and identify their success in nursing education. The student veteran population consisted of 57% men, 43% women and only 39% Caucasian; age ranged from 22-62 with 65% of the students between 26 and 40. Again, logistic regression was used to analyze the correlation of TEAS score to program completion, graduate and NCLEX-RN success. Unlike the Wambuguh et al. (2016) study, the results revealed that the two predictors (TEAS and pre-admission GPA) had no effect on graduation (chi-square = 1.04,  $p = .05$ ), or passing the NCLEX-RN (chi-square = 2.77,  $p = .25$ ). No analysis of the ATI RN Fundamentals exam and the TEAS were discussed. Although the difference in results may be due to a smaller sample size, the TEAS score was not a predictor in this nontraditional population.

A more recent study used similar variables to the Bremner et al. (2014) research. Liu et al. (2018) evaluated prediction accuracy using the composite score and the incremental analysis of component sub scores of entrance TEAS exam and compared this data to the ATI RN Fundamentals score. The goal of the project was to determine if one component score or a combination of component scores provided the best evidence. The authors used a large sample ( $n = 6,405$ ) from 204 programs across 35 states. Among the participants, 3,149 were from associate degree programs, while 3,253 were from baccalaureate programs. Hierarchical regression was used to examine the relationship between predictor sets (TEAS component scores) and outcome variables (ATI RN Fundamental exam score). Analysis began with a pairwise correlation

coefficient between the RN fundamentals score and each component score. The highest correlation component (science) was added first and then the other components were added in order of significance, and each step was evaluated using regression analysis. While the science predictor variable was the most statistically significant in accounting for variance (14.7%), all subsequently added variables (reading, English, then math) were also significant. The results of linear regression analysis for the composite TEAS score and the RN fundamentals score showed that the composite score significantly predicted success in the total sample of both associate and baccalaureate students ( $\beta = .431$ ,  $t_{6400} = 38.354$ ,  $p < .001$ ) as well as the individual program types. The composite TEAS score also explained a significant amount of variance in the RN Fundamentals scores ( $R^2 = .431$ ,  $F_{6400} = 1463.381$ ,  $p < .001$ ; Liu et al., 2018). The authors concluded that while their research was congruent with previous studies that showed the science component sub score to be the most significant, the additive value of each component score was also significant. This finding suggests that students who are successful early in a nursing program must have a broad range of skill and knowledge and a higher value should be placed on the composite score when students are evaluated for admission (Liu et al., 2018).

The use of the TEAS test and its value in predicting both early and end-program success has been widely examined and discussed in the literature. In the past decade, both published work (Bremner et al., 2014; Trofino, 2013; Van Hofwegen et al., 2019; Wambugh et al., 2016; Wolkowitz & Kelley, 2010), and unpublished doctoral research (Luna, 2014), have consistently reported its value in predicting achievement. Both composite and component sub scores have been demonstrated to predict success in nursing. No studies were discovered that showed a negative association between TEAS score and achievement as measured by the ATI RN Fundamentals exam, end of program GPA, program completion or NCLEX-RN success.

## Summary

The current literature supports the use of standardized testing as a pre-admission measure in nursing programs. However, most research has focused on end of program outcomes or compared initial and subsequent standardized test scores to first or second semester success. Notably, no studies have examined the impact of pre-nursing exam scores and early grades at the end of the first semester. While grades are not a standardized means of assessment and much variation exists among grading scales and faculty differences in assessment (Oermann & Gaberson, 2017), grades are the common outcome that dictate progression and are available to faculty for free. The three tests discussed in this review are proprietary and may be offered by independent vendors or publishing companies that offer discounts for a packaged series of tests. Not all learning environments have access to ongoing assessment of knowledge competency through standardized testing. For those programs, the ability to evaluate grades compared to an admission test as an early outcome measure would be beneficial.

With several tests available, there have been few articles that look at the overall ability of each to predict success. A study by Manieri et al. (2015) compared the three admission tests discussed in this review. Using logistic regression, the authors concluded that only the HESI A<sup>2</sup> ( $p < .000$ ) and the TEAS ( $p < .004$ ) tests were predictive of success in an associate program. The HESI A<sup>2</sup> explained 15.9% of the variance of success while the TEAS explained less at 5.9% (Manieri et al., 2015). A recent integrative review (Twidwell & Records, 2017) of articles related to admission criterion also suggested that the HESI A<sup>2</sup> was the best predictor of success. In conclusion, the use of a standardized admission exam as a metric for nursing program admission may help in reducing attrition by identifying the strongest candidates for a rigorous curriculum. However, most previous research uses samples from single sites which creates a limitation in

generalization of results. This study included several institutions within a common curriculum and provided a more diverse population of students from both urban, suburban and rural settings.

### **Critical Thinking Ability**

Along with prior academic achievement and current scholastic knowledge, critical thinking ability is the third construct of the Nursing Cognitive Aptitude Model, or NCAM (Twidwell et al., 2018). Critical thinking has been defined as a mode of thinking that is self-directed, self-disciplined, self-monitored and self-corrective (The Foundation for Critical Thinking, n.d.). In nursing, the concept of critical thinking has been extensively used in both research and education and has been considered an integral part of safe nursing practice although it has not been well defined (Von Colln-Applying & Giuliano, 2017). In the literature, the terms clinical judgment, problem solving, decision making, diagnostic thinking, and critical thinking, have been used interchangeably (Papp et al., 2014; Tanner, 2006).

The early work published in the APA Delphi Report (P. A. Facione, 1990) provided a stimulus for further study and refinement of the concept of critical thinking. The report described a list of dispositions associated with critical thinking: inquisitive, systematic, analytical, truth-seeking, open-minded, and confident in reasoning. A list of core skills was also identified: analysis, interpretation, self-regulation, inference, explanation and evaluation. These skills and dispositions were used to create new tools for measuring critical thinking and its conceptual precursors. The California Critical Thinking Disposition Inventory, The California Critical Thinking Skills Test, and the Health Sciences Reasoning Test, are three assessment tools designed from the attributes defined in the APA Delphi Report (P. A. Facione, 1990).

A multidisciplinary task force was charged with creating a consensus statement that captured the complex nature of critical thinking as well as delineated the stages in which a

critical thinker evolves (Papp et al., 2014). The group built on existing frameworks developed by the Foundation for Critical Thinking (n.d.) and was influenced by the work of Dreyfus (stages of expertise) and Kegan (model of identify development). The task force developed a definition that implies that an individual must possess the ability to apply higher order cognitive skills as well as the disposition to be deliberate about thinking. These two attributes combined lead to action that is logical and appropriate. Because the end result of critical thinking is safe and reasoned action, an individual must possess both the disposition to be a critical thinker, as well as the willingness to act.

The work of the task force mirrors the current science and impacts the way in which we can evaluate students for critical thinking skills. The group concluded that critical thinking ability exists more on a continuum than as progressive steps. These milestones create a fluid matrix of attributes that are classified into five delineated stages. Individual critical thinking ability can fluctuate, and learners can both improve and regress. Devolved thinking generally occurs with high levels of stress, emotionally taxing situations, or other negatively charged situations that are complex, novel or create a personal or psychological threat (Papp et al., 2014).

In this section, the literature that supports critical thinking as an essential attribute in nursing for safe patient outcomes and its role in nursing program success will be explored. Additionally, instruments that measure critical thinking will also be discussed. A search was conducted of the CINAHL Plus with Full Text and Nursing and Allied Health ProQuest databases using the following terms in varied combinations: nursing, nursing education, critical thinking, critical thinking AND success, predictor, attrition, retention, critical thinking measurement, HSRT, CCTDI, CCTDI, ATI CTE. The list was filtered to include full text articles in English and dissertations for a ten-year span, 2009 to 2019. A 10-year span was chosen to

provide consistency with the other topics discussed in the review. Additional research studies were discovered as common references in the literature, and these were added to this review if relevant.

### **Critical Thinking in Nursing**

Critical thinking has been tied to enhanced clinical decision making in practice and has become an important focus in nursing education. Critical thinking is recognized as a key competency by the NLN (2010) as an essential component of nursing judgment. According to the outcomes and competencies established for each level of nursing education, critical thinking is needed to identify, evaluate and use evidence to guide decisions. In addition, clinical judgment is defined as a process of observing, interpreting, responding and reflecting within the realm of nursing's knowledge and perspective (NLN, 2010). Beyond thinking critically, the nurse should employ critical appraisal of research evidence to guide practice in the evolving and complex science of healthcare (NLN, 2010; Sharples et al., 2017).

The AACN (2019b) includes critical thinking in several of its new domains as part of an update in the AACN Essentials competencies for nursing graduates. While not a stand-alone competency, critical thinking is incorporated as clinical judgement in Domain 1: Knowledge for Nursing Practice, as evidenced informed care in Domain 2: Person-Centered Care, and as self-reflection and acquisition of expertise in Domain 10: Personal, Professional, and Leadership Development. The new Essentials make the importance of methods of thought more explicit in nursing care as compared to the current version (AACN, 2008).

Most recently, the National Council of State Boards of Nursing introduced a clinical judgment model (Dickison et al., 2019). Abbreviated as the NCSBN-CJM, the model was designed to provide a framework for nurse educators when teaching clinical judgment to both

prelicensure students and in continuing education programs. Based on foundational theoretical constructs (Intuitive-Humanistic Model, Dual Process Reasoning Theory, and the Information-Processing Model), the NCSBN-CJM includes four layers of cognitive operations that allow educators to design and evaluate learning activities based on specific cognitive tasks. Citing the lack of meaningful data related to students' ability to make appropriate clinical judgments, the NCSBN stated that the model is preferable to standardized tests or multiple-choice assessments which often fail to capture the complexity of health care decisions. The model provides a framework from which several components of decision-making could be measured in a more authentic way and opens the door for novel assessment techniques, such as fidelity-based clinical simulation (Dickison et al., 2019). Clearly, the NCSBN, the NLN, and the AACN recognize the importance of critical thinking and clinical judgment, which has been exemplified through the recent work in new academic standards and models for new methods for creating and assessing complex, situation-based learning.

There have been numerous studies that sought to show the impact of critical thinking ability in nursing, but the results have been contradictory. In an integrated review of research on the correlation between critical thinking ability and clinical decision-making in nursing, the authors noted deficiencies in the quality of studies and the evidence presented (Lee et al., 2017). Lee et al. (2017) reported that of the 222 studies found during the literature search that spanned 1980-2015, only nine met the standards for inclusion based on the Quality Assessment and Validity Tool. Of these nine studies, four reported a positive relationship between critical thinking and clinical decision-making and five showed no statistical significance. A lack of solid study design and appropriate instrumentation were cited as the reason for inconsistent results. Therefore, the authors recommend that future quantitative studies include larger sample size

determined by power analysis. Larger samples would allow improved detection of significant correlations and a multi-factorial analysis. Additionally, Lee et al. (2017) recommended that critical thinking measurement tools should have evidence of validity and reliability, specifically tailored to the healthcare population.

### **Critical Thinking in Nursing Education**

Like the results related to critical thinking and clinical decision-making in nursing, the literature contains contradictory evidence related to the thinking ability of nursing students and success in academia. The synthesis of results is made difficult by the variety of testing options. Moreover, the purpose of each study placed most of the emphasis on either enhancing thinking skills through specific teaching strategies (e.g., problem-based learning or simulation) or comparing critical thinking assessment scores to end of program success. The following section will discuss the instruments found in the literature as well as the evidence presented in the associated research.

#### ***Measurement Instruments of Critical Thinking in Nursing Education***

The measurement of clinical judgment in students and practicing nurses should be assessed through multiple measures (N. C. Facione et al., 1994). Since the APA Delphi Report was published (P. A. Facione, 1990), several instruments have been developed to measure both critical thinking aptitude and skill. As noted in the integrative review by Lee et al. (Landry et al., 2010), few studies have employed valid and reliable instruments. However, the measurement tools created out of the APA Delphi report have been used for several decades and provide a viable option for research.



The synthesis of research related to nursing students and critical thinking is made more challenging by the varied instruments and methodology, as well as the diversity in study purpose. To consolidate the available evidence related to critical thinking assessment and culturally diverse students, Sommers (2018) published a literature review in which 38 international studies were identified that assessed critical thinking in nursing students from 2010-2016. Of the total, 13 studies used unspecified or faculty developed instruments, 4 used the HESI exam, 1 used the Kaplan test, 7 used the CCTDI, 4 used the CCTST, 1 used the CCTDI and the CCST, 5 used the HSRT, and 3 studies used lesser-known tests-the Critical Thinking Scale, the InterEd CT Nursing Instrument, and the CT Domain of Authentic Assessment Rubric. While the review focused on assessing critical thinking within a context of different cultures, the work by Sommers (2018) exemplifies the lack of clarity and the need for further research that employs valid and reliable tools and expands beyond small samples and single-site studies. Additionally, Sommers (2018) noted that the number of theoretical frameworks, varied definitions of the study constructs made the current science of the topic difficult to determine.

Sommers' (2018) findings were consistent with this literature review. There were a variety of research methods and instruments used in measuring critical thinking and comparing this variable to end of program success. However, this project focuses specifically on the early success in nursing education and its relationship to baseline critical thinking ability. Therefore, the following instruments and their use in research that is limited to early academic progression or retention will be discussed.

**California Critical Thinking Disposition Inventory (CCTDI).** The CCTDI builds off the APA Delphi Report (P. A. Facione, 1990) consensus definition of critical thinking as both a cognitive skill and personality attribute as a basis for measuring critical thinking disposition.

Moreover, the authors of the CCTDI recognized the significance of having a disposition to value and use critical thinking in addition to the aptitude of being a critical thinker. To measure this construct, N. C. Facione et al. (1994) created a measurement tool that evaluated the critical thinking disposition and its seven subscales: inquisitiveness, systematicity, analyticity, truth-seeking, open-mindedness, self-consciousness, and maturity. The CCTDI is designed for use in general adult populations and asks the test taker to make a reasoned decision to agree or disagree with statements regarding “common opinions, beliefs, values, expectations, and perceptions that relate to the reflective formation of reasoned judgments” (Insight Assessment, 2019a, para. 2). Internal consistency reliability for the individual scales included in any of the mindset measures range from .71 to .80, with the alpha for the overall instrument repowered to be a minimum of 0.80. Insight Assessment (2019a), a division of California Academic Press, sells the instrument for institutional and research use and recommends that the CCTDI be administered with a companion test, the California Critical Thinking Skills Test (CCTST) to allow simultaneous assessment of both critical thinking disposition and baseline skill.

There have been several studies in the past decade that have used the CCTDI to compare critical thinking skills to several different predictor and outcome variables. Research has been completed using the CCTDI as an early predictor of success in pharmacy (Comer et al., 2019), dental (Whitney et al., 2016) and physical therapy students (Domenech & Watkins, 2015), but little work has been done in nursing outside of measuring critical thinking change as a result of specific teaching strategies (Carter et al., 2015). No studies were found that examined CCTDI scores in relationship to first semester nursing student success.

Of the numerous studies reviewed, only a few focused on the relationship of critical thinking skill to early program success or retention. In a study that compared first ( $n = 237$ ) and

third year students ( $n = 215$ ) in Ireland (Noone & Seery, 2018), the results showed that overall CCTDI scores were higher at the beginning of the nursing program than measured in the third year. These results were also noted in previous, older studies of baccalaureate students (McCarthy et al., 1999; Stewart & Dempsey, 2005). Meade-Searing and Carter-Kookan (2016) studied 96 baccalaureate students and showed that there were no meaningful relationships between CCTDI scores and any outcome measures assessed (e.g., first year science grades, HESI Pharmacology or Exit Exam scores, or cumulative GPA).

Clearly, the CCTDI has been used in nursing education research, but it most often is included as a companion instrument to the CCTST and is rarely used alone. Perhaps the disposition to develop critical thinking is stagnant or slow to change during the educational process and therefore difficult to detect. However, there has been some discussion in the literature that the overall reliability of the instrument may be in question with some studies reporting alpha coefficients as low as .53, .67, and .75 (Carter et al., 2015). As a result, use of the test as a single measure of critical thinking is limited.

**California Critical Thinking Skills Test (CCTST).** The CCTST is an additional test offered by Insight Assessment (2019b) and developed from the APA Delphi Study (P. A. Facione, 1990). While the CCTDI measures an individual's aptitude to become a critical thinker, the CCTST measures the core cognitive skills required to form reflective and purposeful judgments: overall reasoning skill, interpretation, evaluation, explanation, inference, deduction, and induction. Like the CCTDI, the test is discipline neutral and leveled for both undergraduate and graduate students (Insight Assessment, 2019a). Data collected over that past 25 years is reported to meet the standard for strong internal consistency (reliability) for the entire instrument

and has been measure by the KR-20 coefficient with ranges from .77 to .83. Factor loading for subscale items range from .300 to .770.

There have been several studies in the past decade that have used the CCTST to compare critical thinking skills to several different predictor and outcome variables. However, these studies have done little to inform the science related to retention. In an extensive systematic review of articles prior to 2011 of health care professional students, Brudvig et al. (2013) discovered only 10 nursing studies that met the inclusion criteria by using McDermid's Evaluation Guidelines for Rating of the Quality of an Intervention Study and all that met this criterion were conducted between 1999 and 2003. Of these 10 studies, six used the CCTST, but none focused on early academic success. The evidence since this review was also sparse and indicated a need for additional, well-designed research. No studies were found in this review that compared the CCTST to first semester outcomes.

**Health Sciences Reasoning Test (HSRT).** The Health Sciences Reasoning Test (HSRT) is a form of the college level California Critical Thinking Skills Test (CCTST) designed for testing health sciences professionals and students in health science programs. The test is also available in a version specifically created for associate degree students, the HSRT-AD. The HSRT and HSRT-AD differ from the CCTST in the content of item questions. While the CCTST uses everyday situations when assessing critical thinking skills, the HSRT uses questions based within the context of a health sciences workplace. According to Insight Assessment (2019c), no health science knowledge is required to successfully answer the questions. However, using a health sciences context is more relevant to test takers who may be more engaged in the content and may perform better as the topic is perceived as relevant. The HSRT includes multiple choice questions that range in difficulty. The test must be completed within 50 minutes. The scores

reported include an overall critical thinking skill score, as well as sub scores for important constructs: analysis, interpretation, inference, evaluation, explanation, induction, deduction, and numeracy. There are three version of the instrument that have been scaled for specific populations such as associate degree students, undergraduate baccalaureate students, and graduate health sciences students.

In a recent Australian study (Hunter et al., 2014), a descriptive cross-sectional design was used to evaluate the critical thinking skills of students ( $n = 277$ ) at each level of the curriculum and to compare the results to demographic data. Using the domains of the HSRT, the authors found that in each domain, mean scores increased with each year of study. However, no examination of first year student data to other variables were done.

**Assessment Technologies Institute Critical Thinking Exam (ATI CTE).** The ATI CTE does not appear in the literature as a commonly used assessment for critical thinking. However, the ATI CTE is offered as a companion test to the commonly used ATI TEAS exam and there are a few studies that include its use. There are no reliability standards reported for this exam on the host website and all statistical information related to the test was gleaned from recent dissertation documents. Like the CCTST and the CCTDI, the test is based on the APA Delphi Report (P. A. Facione, 1990) is reported to have a standardized item alpha of .70 for all items for first-time examinees as well as a construct validity established by content experts (Belim, 2019; Porter, 2018). The test includes 40 items that have been vetted by nursing content experts. There are six subscales reported: interpretation, analysis, evaluation, inference, explanation, self-regulation. The only published research using the ATI CTE showed mixed results, with a study by Lyons (2008) showing no predictive value of the test and another by

Ukpabi (2008) that showed a positive correlational between an increase in ATI CTE and NCLEX-RN success ( $p = .008$ ).

While formally published research using the ATI CTE is scant over the past decade, the test has been used to assess student critical thinking in several recent doctoral projects. Porter (2018) compared 550 associate degree student results from the CTE to program completion and NCLEX-RN success while controlling for the variables of preadmission TEAS score and nursing course cumulative GPA. Using logistic regression, analysis of the data showed no predictive value of the ATI CTE to program success ( $p = .189$ ) while both GPA ( $p = .004$ ) and entrance TEAS scores ( $p = .004$ ) were statistically significant. Similarly, another small dissertation study by Kastler (2017), found there was no statistical significance when using the ATI CTE alone to predict NCLEX success ( $n = 143$ ).

In another doctoral project, Belim (2019) examined the final grades for the first semester students ( $n = 166$ ) in the course, Fundamentals of Nursing, and compared the grades to both the TEAS and the CTE scores using simple linear regression analysis to assess for a relationship. A statistically significant regression equation was reported,  $F(1, 165) = 27.99, p < .001$  with an  $R^2$  of .146 (Belim, 2019). In sum, while the ATI CTE exam did not predict program success in one study, it was a significant predictor of first semester success in another. These findings are consistent with the mixed results reported in the literature related to other critical thinking assessment exams.

## **Summary**

This review revealed a gap in evidence pertaining to the use of critical thinking assessments to evaluate or predict early academic success. While several studies have employed one of the four common critical thinking tests (CCTDI, CCTDI, HSRT, ATI CTE), most have

compared these variables to end of program outcomes such as on-time completion or first-attempt NCLEX-RN pass rates, and have not considered critical thinking as a variable that could impact attrition. This study addressed this gap by comparing select entrance requirements and critical thinking ability to the first semester academic measure of cumulative nursing GPA.

### **Summary**

The impact of attrition in nursing education has sparked research in identifying the factors that are most predictive of success in nursing education. However, the multifaceted nature of this issue has created a large body of knowledge with inquiry reported on many different aspects of student success. To focus on the variables essential to this project, the literature review was guided by the theoretical framework of the Nursing Cognitive Aptitude Model, or NCAM (Twidwell et al., 2018). The NCAM is unique as it includes critical thinking ability, along with prior academic success and current scholastic knowledge to formulate Nursing Cognitive Aptitude, a suggested precursor to success in nursing education. Each variable of the NCAM was explored and the current evidence to support the use of each factor was substantiated by the literature. A lack of sound methodological processes, sample size, and poor instrument reliability and validity have limited the usefulness of many study results. Moreover, current research has focused on end of program outcomes and has neglected to address early academic success and attrition.

Studies evaluated in this review have included several common limitations. The prevalence of small, single-site samples as well as the use of multiple tools creates a barrier to both interpretation and generalization of current evidence. Additionally, previous studies have relied on the evaluation of primarily academic and demographic measures and have examined data by use of bivariate statistical methods. Evidence pertaining to predictive variables related to

success in nursing education could be strengthened by multivariate analyses that examine variables that are closely aligned with theory (Olsen, 2017).

This study spanned across several institutions and compared students in a standard, state-wide curriculum by using the consistent preadmission exams, preadmission course grades, and cumulative first semester grades, and critical thinking test scores. Examining the potential for a critical thinking test to predict attrition in students when compared to other admission factors may provide another important metric for admission policy decisions. Despite the significance of critical thinking and the development of clinical judgment in nursing, a gap in the literature exists that focuses on the impact of critical thinking ability as a predictor of success. Additionally, this study used multivariate analyses which allowed a more comprehensive evaluation of multiple, co-existing variables that impact student attrition.



## **CHAPTER III**

### **METHODOLOGY**

A prospective correlational research design was used to determine the association of critical thinking skills and success in first semester nursing students who attended select community colleges in a mid-Atlantic state. This chapter describes the methods that were used in completing the study and includes a discussion of the research design, setting and sample, the research instrument, data collection, and the plan for statistical analysis.

#### **Methods**

##### **Design of the Study**

A prospective correlational research design was used to determine the association of cognitive aptitude skills and success in first semester nursing students. A prospective design was chosen to allow data collection as the semester progresses. This process prevented the loss of student grade data in the event of course withdrawal, which would have resulted in removal of all student data from the learning management system. A correlational method was advantageous for this study as this design allowed for an examination of the relationships among variables. A correlational design revealed the strength of a relationship, but will not determine causality (Grove et al., 2013).

##### **Setting**

The setting for the study was community college nursing programs in one mid-Atlantic region. This community college system had 23 college campus sites, 18 of which have nursing programs. Each college was established to serve a unique district and may be situated in urban,

suburban, or rural areas. The system had a current enrollment of 241,000 students, which encompassed 57% of undergraduates in the state (Virginia Community College System [VCCS], 2019). Students who attend each community college are diverse and most are considered nontraditional. According to the National Center for Education Statistics (n.d.), nontraditional students are those that meet one of the following characteristics: delayed enrollment into postsecondary education, attends college part-time, works full time, is financially independent for financial aid purposes, has dependents other than a spouse, is a single parent, or does not possess a high school diploma. Cohorts are comprised of first-time college students and second-degree or second-career students and represent many socio economic and ethnic backgrounds. The most recent statistics related to cohort diversity shows that 45% of students identify as non-white and 21% are first-generation college students. While an average of 37% of community college students in the state receive financial aid, this percentage ranges from 26.5 - 59.9% at individual institutions (Virginia Community College System, 2019).

All students, regardless of the campus site, were accepted into the nursing program through a competitive application process which required success in the pre-nursing curriculum, a minimum GPA of at least 2.5, and satisfactory scores on a pre-nursing standardized test. Once admitted to the program, the students progress through a common, concept-based curriculum over four semesters. Each program required the same nursing courses in the prescribed sequence. There is a total of 23 community college nursing programs in the common curriculum. However, programs are given the flexibility to administer any pre-admission standardized test. Therefore, participant programs were limited those that required a common test with the goal to have three to five programs would be selected to participate in the study.

## **Participants**

A convenience sample of first-semester nursing students was used. Inclusion criteria for this study included: students who were enrolled in the first semester of an associate degree nursing program during the spring and fall 2020 semesters, students who consented to participate, and students who completed the HSRT-AD prior to the end of the data collection period. Exclusion criteria included any student who completed the HSRT-AD but did not provide demographic information, particularly an accurate name that would permit linking the student to the HSRT-AD results and to pre-admission data and nursing course grades. An a priori power analysis using G\*Power3 (Faul et al., 2007) for linear multiple regression revealed that for input parameters for an effect size of 0.10, an alpha probability error of 0.05, a power of 0.80 and three predictors, the critical F was 2.69 with a required sample size of 114. To compensate for loss of up to 30% of participants over the data collection period, a total number of 148 students were needed.

## **Recruiting Sites for Participation**

Once participating programs were identified, available licenses for access to the study instrument were distributed so that the final sample would represent a mixture of students from each site. At a minimum, the plan was for 2 participating sites with 74 students from each. As the number of sites increased, the number of students participating from each site would be decreased.

The original plans for recruiting program participation evolved as participant recruitment waned. Initially there were administrators from four nursing programs who volunteered to participate. However, two of the programs were delayed by the IRB process at their institutions. A third program had five students who joined the study and completed the HSRT-AD, but the

additional data required (e.g., pre-admission data and nursing course grades) were not obtained. The data for these students were excluded from the study. Therefore, the sample used for this study was recruited from one nursing program and drawn from two different cohorts who were admitted in spring 2020 and fall 2020 semesters.

### **Recruitment and Informed Consent**

Students were recruited through the college Office of Institutional Evaluation (OIE) after approval of the study through both the researcher's university IRB process and the nursing program's institution. The OIE contacted each student through the college's email and informed them of the opportunity to participate. An attachment to the email included information related to the purpose of the study, the consent process, confidentiality of the data collected, and how the data would be stored, analyzed, and reported (see Appendix A). This document also included information related to the student's rights and stated that student participation was confidential, voluntary, and did not impact course grades or program standing. Furthermore, students could withdraw from the study at any time.

All state community college nursing programs and were initially invited to participate in the study. An informational letter (Appendix B) was sent to nursing deans and directors to give an overview of the project, elicit interest in participation, and determine current pre-admission tests used for admission. Interested programs offering the same pre-admission test were selected for the study to prevent confounding factors created by different exams. The recruitment announcement with consent (Appendix A) included all elements required for informed consent.

Advantages to subjects included insight into personal critical thinking skills. The results could be useful to determine areas of strengths and weaknesses in critical thinking and to identify specific reasoning skills that could be improved. The test report included an overall categorical

interpretation of the results (superior, strong, moderate, weak, not manifested) as well as quantitative scores that measured the student's performance against national percentiles (Insight Assessment, 2019c). Individual participation in the study was optional, students could opt out of the study at any time, and course status or course points were not be impacted by participation. Students received a link to the study tool and completed the test online at any time during the testing window. Only the student and the primary investigator (PI) had access to the results. However, students could choose to share results with an academic advisor or nursing faculty member. There were no direct risks to students anticipated. However, students with prior issues of test anxiety could experience an indirect risk of stress. No reports of stress or unanticipated outcomes were reported. Students were provided contact information for their college disabilities support services specialist should this issue arise.

### **Instrumentation**

The independent variables included critical thinking skill level (Health Sciences Reasoning Test-AD scores), prior academic performance (prerequisite GPA), and current scholastic knowledge (pre-admission test score). The dependent variable, academic success in first semester, was measured by the cumulative GPA of four required nursing courses. Each variable is discussed along with its measurement and analysis, below.

#### ***Critical Thinking Ability: Health Sciences Reasoning Test-Associate Degree***

The Health Sciences Reasoning Test (HSRT) is based on the APA Delphi Consensus Definition of Critical Thinking (P. A. Facione, 1990), a seminal document produced by a multidisciplinary team of researchers who worked to define critical thinking, its core components, and its role in education. In use since 2006, the HSRT was developed to specifically

measure critical thinking skills in the health sciences for students in post-secondary education. As use of the tool has grown, the HSRT has been adapted to include a version for undergraduate and graduate level students, as well as a version, the HSRT-AD, calibrated for use in certificate and two-year programs.

The HSRT-AD contains 40 multiple choice questions and is administered online over 45-55 minutes. If a documented disability exists, arrangements can be made for individual students to have extended time. A proctored environment is preferred. No specialized health science knowledge is necessary. The test is set at a Flesch-Kincaid reading grade level of 8.6 or lower. Each question requires the student to make an accurate and complete interpretation of the question, examine the information presented, and reason to the best answer among the options provided (Insight Assessment, 2019c).

**Sub-Score Categories.** Each subcategory assesses a distinct reasoning skill required for reflective judgment. There are six sub scores reported: analysis, inference, evaluation, induction, deduction, and numeracy. The HSRT-AD user manual defines each category as described below (Insight Assessment, 2019c).

***Analysis.*** Analytical reasoning skills enable people to identify assumptions, rationales, and claims and examine the interaction of each to form an argument. People who possess strong analytical skills notice patterns and details and can more easily gain insight to complex issues.

***Inference.*** Inference skills allow formation of conclusions from both evidence and rationales. Inference contributes to thoughtful suggestions or hypotheses, but also involves attention to consequences of action.

***Evaluation.*** Evaluative reasoning skills enable assessment of credibility of sources of information and support determination of strengths and weaknesses. This allows careful consideration of the reliability of information as well as the conclusions drawn.

***Induction.*** Skills in induction are required when making decisions when uncertainty exists. Inductive reasoning relies on hypotheticals, probability and recognition of patterns and leads to a confident and reasonable decision, even when all the facts are not known.

***Deduction.*** The skill of deduction relies on precise or logical progression from assumptions to beliefs to conclusion. It is based on a defined set of rules, values, policies and procedures and terminology.

***Numeracy.*** Numeracy skills are needed to apply concepts related to numbers, measures, or mathematical techniques in order to interpret or evaluation information. Numeracy refers to the ability to use data or make decisions based on quantitative reasoning. It requires understanding or how quantitative data is collected, manipulated and portrayed visually in graphs, charts and diagrams.

### ***Composite Scores***

Composite scores provide an overview of the test taker's strength in "reasoning skills to form reflective judgments about what to believe or what to do" (Insight Assessment, 2019c, p. 5). This overall score combines each sub score to provide a prediction of the capacity for success in educational or work settings which require complex thinking and problem solving. The composite scores range from 50 to 100 and have been divided into five distinct qualitative descriptors: Superior (93-100), Strong (82-92), Moderate (74-81), Weak (63-73), and Not Manifested (50-62). A high composite score requires balanced ability in all subcategories. Each test report gives the corresponding national percentile score compared other HSRT-AD test

takers and overall percentage and percentages for each subcategory. The test administrator chooses the group to which the scores will be benchmarked. For example, in the proposed study an appropriate benchmark would be to students in associate degree nursing programs nationally. In addition, mean percentile scores for the group can also be examined against national statistics.

### ***Procedures for Estimating Validity and Reliability***

There is evidence in the literature that higher-order cognitive skills, such as critical thinking, can be accurately measured when valid and reliable measurement tools are used.

**Validity.** In the literature, validity encompasses several different types and subtypes of overlapping and interrelated measures. According to Grove et al. (2013), construct validity is created by the evidence provided by the measurement of varied characteristics. These include content validity, factor analysis, divergent and convergent validity, validity from contrasting groups, and validity of prediction. Content validity refers to the ability of the tool to measure the components of the intended construct and can be obtained from the literature, representatives of the target population, and content experts (Grove et al., 2013).

The HSRT-AD is based on the critical thinking components as identified by experts in the American Psychological Association Delphi study (P. A. Facione, 1990). Insight Assessment, the test administrator, reports that initial validation was achieved in collaboration with health science educators and professionals through case control methodologies. The test items for critical thinking have been curated for several decades and maintained and updated by experts in decision science, statistics, psychometrics and measurement, and critical thinking (Insight Assessment, 2019d). In addition, an independent study by Huhn et al. (2011) supported content validity. The investigators compared expert and novice performance on the HSRT and found that experts earned significantly higher scores than novice students. Huhn et al. (2011) reported that



“experts ( $n = 73$ ) had a higher total HSRT score (mean 24.06, SD 3.92) than the novices ( $n = 79$ ) (mean 22.49, SD 3.2), with the difference being statistically significant  $t(148) = 2.67, p = 0.008$ ” (p. 181). The authors determined that HSRT total score discriminated between expert and novice critical-thinking skills, therefore establishing construct validity.

Predictive validity of the instrument has also been assessed through peer-reviewed independent research. Several longitudinal or pretest-posttest studies using the HSRT or its companion critical thinking tests have shown that strength in critical thinking skills serves as a predictor for attrition, retention, and increased knowledge development as demonstrated by standardized testing.

The HSRT-AD is scaled to accurately measure the construct and sub-constructs of critical thinking in associate degree health sciences students (Insight Assessment, 2020). However, because validity is sample-specific, it should be estimated each time the instrument is used. In the current study, validity was established through the research design and methodology. The HSRT-AD was specifically chosen as the research instrument as it aligned best with the student population and discipline. It was created for the associate degree, health science student. All participants in this study were associate degree students who were in the nursing major.

**Reliability.** Internal consistency reliability of the HSRT-AD has been evaluated by the Kuder Richardson statistic (KR-20). The KR-20 falls within the range of .77-.83 in all forms of the reasoning tests for graduate, undergraduate, and technical or community college settings. However, the KR-20 underestimates the reliability of a test when there are less than 50 items, or the content is not homogenous. Factor loading for items range from .300 to .770 in published reports (Huhn et al., 2011; Insight Assessment, 2020). The reliability for the current study was estimated as .80 by G\*Power3 analysis (Faul et al., 2007).

## **Prior Academic Performance**

### ***Grade Point Average (GPA)***

Academic aptitude is a common measure of success. Admission metrics may include overall cumulative GPA, or give weight to specific content courses, such as math or science. In a recent integrative review of admission factors for associate degree nursing programs, Olsen (2017) found that most of the 26 studies included in the review considered some aspect of academic performance in admission decisions. While recognized as a common criterion, GPA represents academic habits and does not adequately reflect knowledge comprehension. As a result, nursing programs generally use a mix of metrics for academic performance which may include GPA calculated from all or specific courses, as well as standardized testing. Olsen (2017) reports strong evidence of AD nursing program success in students with higher pre-admission GPA as well as higher grades in science.

Progression is also tied to academic performance and is stipulated by program policy and grading scale. In the study population, all students' grades are determined by a standard grading scale that was established when the common curriculum was developed. Pre-admission GPA may be influenced when courses are transferred in from institutions outside of the community college system. However, end of first semester grade point averages were consistent as nursing programs across the community college system offered the same four first semester courses and have identical grading scales. Regardless of uniform grading scales and policies, some variation is likely to exist as the expectations among individual programs and faculty may occur.

**Pre-Admission Grade Point Average.** The pre-admission GPA, an independent variable, was calculated using the mathematical average of a 4-point grading scale. Grades were awarded with A equal to 4 points, B equal to 3 points, and C equal to 2 points. Students must

earn a minimum of C in each of 5 prerequisite courses to be eligible for admission to a nursing program and the average pre-admission GPA of the courses must be a least 2.5. The prerequisite courses total 14 academic credits.

**First-Semester Grade Point Average.** The first semester GPA, the dependent variable, was calculated using the mathematical average of a 4-point grading scale. There are four nursing courses required in the first semester of the common curriculum. The total number of credits for nursing courses is 10, although some students take a total of 14 credits to complete general science requirements.

Students must earn at least a C in all courses to progress to the subsequent semester. Students are enrolled in a fundamentals of nursing course that includes a clinical component. An unsatisfactory clinical grade, regardless of didactic grade, will require that students to repeat the entire course. The final letter grade of clinically unsatisfactory students depends on total course points. A student passing the didactic portion of the course but failing the clinical portion of the course will receive a D. A student failing both the didactic and clinical portions of the course will receive an F. Students with a D or an F in any nursing course are required to repeat the course before continuing to the second semester of the program. Therefore, success at the end of the first semester was determined by didactic grade for each course, clinical satisfactory grade, and continued maintenance of at least a 2.0 cumulative GPA.

### **Current Scholastic Knowledge**

#### ***Pre-Admission Tests***

The use of standardized pre-admission testing provides an objective process for assessing the current knowledge of potential nursing students and along with GPA, is a common admission criterion. While GPA may be indicative of study habits, standardized pre-admission test scores

provide information related to knowledge attainment in subjects needed for nursing education (Olsen, 2017). There are several tests available for measuring the academic foundational information required for a nursing curriculum. All nursing programs within the state's community college system may use one of the following: Health Education Systems, Inc. Admission Assessment (HESI A<sup>2</sup>), Kaplan Admissions Test, and the Test of Essential Academic Skills (ATI TEAS). For this study, participant programs administered the current version of the TEAS test as a pre-admission requirement.

### ***Test of Essential Academic Skills***

The Assessment Technologies Institute's (ATI, 2020) Test of Essential Academic Skills, or ATI TEAS, is a common pre-admission, standardized test for nursing. The timed test is composed of 150 questions divided into 4 content areas. Developed by content experts, the assessment contains 47 reading, 32 mathematics, 47 science, and 24 English and language usage items. The purpose of the test is to evaluate a candidate's overall preparedness for a health science program. Therefore, ATI recommended that the score for the entire assessment be used for admission decisions. While sub scores are reported, ATI (2020) asserted that these scores were "not equated scores and are not comparable across candidates or administrations" (p. 5). Sub content area scores are intended to identify areas where students may need additional study. The TEAS test has been shown to be valid in predicting success in a nursing program (Bremner et al., 2014; Manieri et al., 2015; Underwood et al., 2013; Wambuguh et al., 2016; Wolkowitz & Kelley, 2010). Moreover, several studies have found significant relationship between sub score categories and early program success (Higgins, 2005; Trofino, 2013; Wolkowitz & Kelley, 2010).

**Sub-Score Categories.** There are four content area domains evaluated by the ATI TEAS. Each category is described below and the number of items in each domain are identified.

**Reading.** According to ATI (2020), the reading content area focuses on the assessment of functional literacy skills and is divided into three domains: key ideas and details, craft and structure, integration of knowledge and ideas. The 47 items in this category require that students read and interpret complex text and graphs, evaluate the purpose and point of view, interpret the meaning of words and phrases, distinguish between fact and opinion, recognize bias, and compare and contrast different sources to evaluate as argument or draw conclusions.

**English and Language Usage.** The ATI TEAS exam includes 24 questions related to the use of English and general language competency. This section evaluates the skill of vocabulary acquisition, knowledge of language and the conventions of standard English, including spelling, punctuation and sentence structure. Additionally, students are challenged to apply basic elements of writing to enhance clarity, organize a well-developed paragraph, and distinguish between formal and informal language (ATI, 2020).

**Mathematics.** The math content area assesses basic math skills including algebra (fractions, decimals, percentages) and numerical operations (addition, subtraction, multiplication, division). Additionally, students are required to interpret and evaluate information in tables, charts and graphs, explain the relationship between variables and calculate geometric equations. While students may use a calculator during the exam, the questions are written at a level for which a calculator is not necessary to correctly determine the answer (ATI, 2020).

**Science.** The science portion of the test contains questions that include content related to human anatomy and physiology, life and physical sciences, and scientific reasoning. Test items require general knowledge of organ systems, immune and endocrine response, macromolecule

systems, principles of hereditary, atomic structure, properties of substances, and chemical reactions. In addition, students must use scientific reasoning to explain relationships, processes and analyze the design of a scientific investigation (ATI, 2020).

### ***Composite Scores***

The composite score reported by ATI is the total score, which is the percentage of items answered correctly on the whole test and represents a comprehensive description of student performance. Normative data, means and percentile ranks, are also reported and are grouped by type of institution and compared nationwide. Furthermore, the composite score is also reported as a criterion-referenced category, the academic preparedness level. The academic preparedness categories are based on cut scores established by ATI and based on the adjusted percent correct total score. This specification allows the student to assess their relative standing and interpret their individual proficiency in descriptive terms of academic preparedness for a nursing program: Developmental, Basic, Proficient, Advanced, and Exemplary. While some institutions require a cut score for admission using the minimum academic preparedness level, many consider the ATI TEAS without a cut score in an admission formula design in which the test is weighted along with other criteria (ATI, 2020).

**Reliability.** The reliability coefficients and standard errors of measurement are reported for each content area as well as the total score. Assessment Technologies Institute (ATI, 2020) reports a reliability index of 0.96 for the total score and slightly lower content area indices: math, 0.69; English and language usage, 0.70; reading, 0.82; science, 0.88.

**Validity.** Content and predictive validity evidence are reported by ATI (2020). Content validity is established through the test construction process. Qualified item writers are selected and trained to ensure alignment of items to an established test blueprint. Next, a test development

team evaluates questions to ensure that each item meets standard specifications related to content alignment and distribution, and cognitive complexity. Questions are also evaluated for bias in content and language related to gender and diversity. Once approved, items are presented as an unscored pretest section of the currently administered TEAS. This process allows for statistical analysis and potential revision prior to use in a scored version of the exam.

Predictive validity was established through examining student performance on subsequent ATI examinations. In a recent analysis, ATI (2020) reported a positive and moderate correlation (0.41) between scores on the ATI TEAS and the RN Fundamentals test, which was usually administered during the first year of a nursing program. This correlation indicated that the ATI TEAS was a good indicator of early program success (ATI, 2020).

### **Threats to Internal and External Validity**

#### ***Threats to Internal Validity***

Internal validity “is defined as the extent to which the results of the study can be attributed to the action of the independent variables and not something else” (Wood & Ross-Kerr, 2011, p. 120). In correlational research designs, internal validity must focus on selection of the sample and reliability testing of the data collection instruments. In this project, several threats to internal validity exist. Using a convenience sample gives little control over subject selection. Students volunteered to participate and the impact of self-selection on the dependent variable is unknown. Another potential threat to internal validity is posed by sample size. The accuracy of correlational research design is impacted by the size of the sample. Larger samples produce more precise results and low participation will impact both the accuracy of the findings which highlights the importance of effective recruitment plans.

According to Wood and Ross-Kerr (2011), correlational designs were appropriate when a conceptual framework existed, previous research has been completed on each variable, and each could be measured numerically. In this study, the dependent and all independent variables were numerical and have been used extensively in either educational or nursing research. The measurements used for all independent variables required no manipulation and each variable was represented by a reliable measure based on previous research, which helped to lessen the threats to internal validity.

### ***Threats to External Validity***

External validity refers to the degree to which the findings are generalizable to the target population (Wood & Ross-Kerr, 2011). Because this study employed a convenience sample, the results only apply to the sample obtained as nonprobability sampling techniques do not allow generalization to a larger population.

## **Data Collection Procedures**

### **Processes**

Data collection began once approval had been obtained from the University of Northern Colorado Institutional Review Board and from each participating community college. All participating faculty, including the PI who is a faculty member in this community college system, maintain knowledge and compliance with student privacy policies (FERPA) through mandated annual training provided by the state community college system. The PI adhered to the policies required for each institution to seek permission to conduct research with students. Contact by email with participating programs occurred 4 to 6 weeks prior to the planned start of data collection and included an introduction to the purpose of the study, explanation of the study instrument and its data, and a description of both faculty and student responsibilities for



participation (Appendix B). The student recruitment announcement and consent form were also provided for review (Appendix A).

The faculty at participating sites were asked to post the announcement on the course learning management system, send the announcement via email, or facilitate a short presentation onsite during student orientation. The course faculty of each college were not informed of student participation. All student questions about the study or testing process were directed to the PI via email or phone. The PI's contact information was available to faculty and participants during the research process and was included on the cover letter.

When students received the study announcement and all elements of a written informed consent, they also received a link to the study's measurement tool (HSRT-AD). By clicking on the link, participants were able to complete the test once online. Repetition of testing was prevented by the host site as each student was screened during test registration. When registering for the HSRT-AD, demographic data were collected. The HSRT-AD was available several weeks prior to the start of the nursing program and for up to the first eight weeks of the semester. Eight weeks was chosen as a reasonable amount of time to achieve the desired sample size.

Once the testing period closed, the HSRT-AD data were available from the testing provider as an Excel spreadsheet for initial analysis. Students had immediate access to their personal results which could be printed or saved electronically for further reference. Only the PI had access to the data collated by the testing service. The course faculty of each college were not informed of student participation. Additional information was added to the spread sheet by the investigator during on-site visits or virtual communication with participating colleges. These on-site visits were coordinated with the program's Nursing Admissions Committee Chairman who provided access to application data, including pre-admission GPA, and ATI TEAS scores and

sub scores. End of semester GPA was not collected until final course grades had been entered. This process protected the identity of participating students from first semester faculty and ensured that involvement in the study did not impact subjects' course grades or program standing. If a student informed their course faculty that they planned to withdraw from one or more nursing courses, faculty were asked to record course grade data up to the time of withdrawal. There were no participants who withdrew from the study.

Students who participated were entered into a random drawing for a small gift acknowledging their participation. Eight 25-dollar gift cards were awarded randomly to participants who received the electronic gift card via email. Once a student's name was selected, it was removed from the pool and only the remaining participants were eligible for subsequent drawings which were distributed over the data collection period.

### **Consent Process**

This project qualified as an Exempt Category 2 study according to the criteria cited by the University of Northern Colorado Office of Research, Procedures for Research Involving Human Participants. A request to waive the requirement for the investigator to obtain a signed consent was submitted to the Institutional Review Board (IRB) and was approved (Appendix C). Participants received a cover letter that contained all elements of an informed consent document, which was retained by the participant rather than signed and returned. The cover letter, included in the recruitment email, included the following statement as required by the IRB, "completion of the survey and/or return of the questionnaire indicates consent to participate in the study." Any disclosure of testing results outside of the research would not place subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability,

educational advancement, or reputation. Participants could withdraw from the study at any time and participation or nonparticipation had no influence on course grades or program standing.

### **Data Handling**

All data were maintained by the testing vendor on a secure, web-based platform. The PI had the only access to the data through a password protected log in. The confidentiality of participants was maintained by assigning each student a numerical code. A summary group report was provided to participating colleges and included statistical data of composite scores and sub scores for each assessment category: analysis, inference, evaluation, induction, deduction, numeracy. A sample individual report (Appendix D) and group report (Appendix E) are included in the appendix. A sample individual report for the ATI TEAS is also included (Appendix F).

After reviewing the final participants' information, several students had taken the HSRT-AD more than once or used fictitious names to register for the test anonymously. Duplicate results were removed, and the first attempt was used for analysis. Results with fictitious names were also omitted.

### **Data Analysis**

Applying statistics to data allows the researcher to understand more about the sample and draw conclusions (Kellar & Kelvin, 2013). The following portion of this chapter describes the statistical analysis of the demographic data and the inferential analysis of each research question. Analysis of data were conducted with the use of the statistical program, IBM SPSS version 26.

### **Demographics**

Demographic data were examined using descriptive analysis. Demographic information included age, gender, ethnicity, and prior academic and work experience, and college program

site. Frequency distribution were examined by creating histograms for each data point (age, gender, ethnicity, college experience, program site). Measures of central tendency, including mode, median and mean were assessed. Additionally, measures of dispersion were also examined by determining the range, interquartile range, and standard deviation and variance. Fischer's measure of skewness of and Fischer's measure of kurtosis were used to determine specific distribution attributes.

### **Demographics of the Study Sample**

There were 115 students in the final sample. There were 75 students who were admitted to the nursing program in spring 2020 and 40 students who were admitted in fall 2020. Both cohorts were admitted using the same admission criteria and were combined to determine the demographic data. The sample consisted of participants whose age ranged from 18-66 years ( $M = 27$ ,  $SD = 7.9$ ). Most students were female (80%,  $n = 92$ ) and Caucasian (69%,  $n = 79$ ). The majority indicated that they did not have a previous college degree (61%,  $n = 70$ ) or previous healthcare experience (57%,  $n = 65$ ). See Table 1 for detailed demographics for the sample.

Table 1

*Demographics of Participants*

Variable	Number ( <i>n</i> = 115)	Percentage
Gender		
Female	92	80.0
Male	23	20.0
Ethnicity		
Black	30	26.1
Caucasian	79	68.7
Hispanic	1	0.9
Asian	2	0.7
Not Disclosed	3	2.6
Previous Degree		
Yes	50	43.5
No	65	56.5
Previous Healthcare		
Yes	45	39.1
No	70	60.9

### **Descriptive Analysis of Study Variables**

Descriptive analysis was also used to examine the frequency distribution, measures of central tendency, and measures of dispersion for each study variable. This included the independent variables of pre-admission GPA, pre-admission test scores and sub scores, and HSRT-AD scores and sub scores and the dependent variable of first semester cumulative nursing

GPA. Multiple regression analysis was performed as it best examined the effect of multiple independent variables on the dependent variable.

### **Inferential Analysis of Research Questions**

Inferential statistics were used to examine each study question. Standard linear regression allowed comparison of each independent variable to the dependent variable, while multivariate linear regression allowed comparison of the unique, simultaneous effects of several combined variables on the dependent variable. According to Kellar and Kelvin (2013), the assumptions for linear regression should be assessed and include:

1. The sample must be representative of the population to which the inference will be made.
2. The dependent variable is normally distributed overall and for each value of the independent variables.
3. For every value of X, the distribution of Y must have equal variability (homoscedasticity).
4. The relationship of X and Y must be linear.
5. Independent variables are not strongly intercorrelated (multicollinearity). (p. 341)

Assumptions were tested both before and after analysis began. The dependent variable was assessed for normal distribution. Scatter diagrams were used to visualize relationships and recognize outliers. Bivariate correlations were examined for multicollinearity, which may inflate the predictive validity of the results. This was mitigated by combining variables with a correlation of 0.70 or greater (Grove et al., 2013). Regression diagnostics were employed to evaluate residuals and included an assessment for normal distribution and homoscedasticity.

***Research Question 1***

- Q1 What is the relationship between pre-nursing critical thinking ability and end-semester nursing GPA in associate degree students?

This question was answered by using the HSRT-AD composite score as the measure of critical thinking for each student and comparing it to their cumulative nursing course GPA earned at the end of the first semester. The sub score identified in each category of the test was also be compared to the end semester GPA. Standard linear regression was used to evaluate the association of each value to the GPA.

***Research Question 2***

- Q2 What is the relationship between prior academic performance and end-semester nursing GPA in associate degree students?

This question was answered by using pre-admission curricular GPA to measure prior academic performance for each student and comparing it to their cumulative nursing course GPA earned at the end of the first semester. Standard linear regression was used to evaluate the association of these two variables.

***Research Question 3***

- Q3 What is the relationship between current scholastic knowledge and end-semester nursing GPA in associate degree students?

This question was answered by using composite pre-admission test scores (ATI TEAS) to measure current scholastic knowledge for each student and comparing it to their cumulative nursing course GPA earned at the end of the first semester. The sub score identified in each category of the test was also be compared to the end semester GPA. Standard linear regression was used to evaluate the association of each value to the GPA.

**Research Question 4**

- Q4 Do the expanded cognitive aptitude measures of the Nursing Cognitive Aptitude Model predict success in the first semester of an associate degree nursing program?

The analysis of this question tested the components of the Nursing Cognitive Aptitude Model (NCAM) and assessed their influence on student success. Multivariate linear regression was used to compare select, influential variables included in NCAM (critical thinking ability, current scholastic knowledge, prior academic performance) to student performance (GPA) at the end of the first semester of nursing.

**Summary**

This chapter described the methods that were used in completing this study and included a discussion of the design, the study setting, participant recruitment, and a summary of sample characteristics. The research instruments (e.g., ATI TEAS and HSRT-AD) were described, and the computation of both pre-nursing and first semester nursing GPA were discussed. The data analysis plan for each research question was delineated.

In the next chapter, the results of the study are presented. Detailed processes for the statistical analysis and decision processes during data analysis are presented. An analysis of each research question is presented.



## **CHAPTER IV**

### **RESULTS**

This study examined the variables of critical thinking, pre-nursing grade point average, and pre-admission test scores and the impact of these factors in predicting the success of nursing students in the first semester of an associate degree program. This chapter is organized in terms of the four research questions presented in Chapter I. The study first examined each variable in relation to end-semester grade point average, then combined the variables to explore the ability of the framework, the Nursing Cognitive Aptitude Model, to predict student attrition. Based on the initial results, select sub-categorical measures of content-specific pre-admission testing and components of critical thinking, were also explored to determine their predictive value.

#### **Inferential Analysis of Study Questions**

Inferential statistics were used to examine each study question. Bivariate logistic regression allowed comparison of each independent variable to the dependent variable, while multivariate logistic regression allowed comparison of the unique, simultaneous effects of several combined variables on the dependent variable. According to Kellar and Kelvin (2013), the assumptions for linear regression should be assessed and include:

1. The sample must be representative of the population to which the inference will be made.
2. The dependent variable is normally distributed overall and for each value of the independent variables.

3. For every value of X, the distribution of Y must have equal variability (homoscedasticity).
4. The relationship of X and Y must be linear.
5. Independent variables are not strongly intercorrelated (multicollinearity). (p. 341)

Assumptions were tested both before and after analysis began. The dependent variable, nursing first semester cumulative GPA, was assessed for normal distribution. Scatter diagrams were used to visualize relationships between variables and recognize outliers. Bivariate correlations were examined for multicollinearity, which may inflate the predictive validity of the results. This was mitigated by combining variables with a correlation of 0.65 or greater (Grove et al., 2013). Regression diagnostics were employed to evaluate residuals and included an assessment for normal distribution and homoscedasticity.

For this study, an a priori power analysis using G\*Power3 (Faul et al., 2007) for linear multiple regression revealed that for input parameters for an effect size of 0.10, an alpha probability error of 0.05, a power of 0.80 and three predictors, the critical F was 2.69 with a required sample size of 114. The initial plan anticipated up to 30% attrition of participants which meant that 148 student participants would be needed. However, no attrition was noted, and the final sample size achieved was sufficient at 115.

### **Testing for Multiple Regression**

All research questions were analyzed using standard multiple regression. The appropriateness of this analysis was determined by first examining the assumptions associated with regression. The minimum sample size required for using multiple regression, normality of the dependent variable, potential issues with homoscedasticity, and the linearity of the relationship between the independent and dependent variables were assessed using the variables

from Research Question 1. Research Question 1 had the most independent variables and, therefore, would result in the most conservative requirements.

To examine sample size assumptions, the  $N > 50 + 8m$  formula where  $m$  was the number of independent variables was used. There were 6 independent variables for Research Question 1, resulting in a minimum required sample size of 98 [calculated as  $50 + (8 \times 6)$ ]. The minimum required sample size was less than the achieved sample size of 115. This assumption was not violated.

The normality of the dependent variable was assessed. First semester cumulative grade point average results indicated that the variable was not normally distributed ( $p < 0.001$ ). This result is not surprising given that the dependent variable is grade point average and the admission process to nursing programs is selective. There were no other violations within the assumptions for regression. According to Tabachnick et al. (2007), non-normal distributions within the dependent variable that are problematic would also result in violations of other assumptions. As no other major violations were noted, transformation was not performed.

The results also indicated that there were no issues with homoscedasticity. This indicates that the data were evenly dispersed above and below the regression line and reflects an equal variance of both variables (Grove et al., 2013). The relationships between independent variables with each other and between each independent variable with the dependent variable were linear. Finally, the results of correlation analysis indicated that there were some issues with multicollinearity as many of the variables were correlated above the upper threshold,  $r > .70$  (Tabachnick et al., 2007). Combined or dropped variables cannot reliably determine or predict changes in the dependent variable (Tabachnick et al., 2007). However, intercorrelated variables

were dropped and assessed for significant changes in the dependent variable, but no significant difference was noted. These issues were not significant enough to halt further analyses.

### Research Question 1

What is the relationship between pre-nursing critical thinking ability and end-semester nursing GPA in associate degree students? This question was answered by using the HSRT-AD composite score as the measure of critical thinking for each student and comparing it to their cumulative nursing course GPA earned at the end of the first semester. The sub score identified in each category of the test was also compared to the end of semester GPA. The frequency distribution for the GPA and the composite and sub-category scores for HSRT-AD are shown in Table 2.

Table 2

<i>Characteristics of Sample: Grade Point Average and Health Science Reasoning Test Scores</i>					
	<i>M</i>	<i>Mdn</i>	<i>SD</i>	Minimum	Maximum
Cumulative Nursing GPA	3.16	3.3	0.86	0.0	4.0
HSRT-AD Score-Composite	78.80	80.0	5.90	63.0	94.0
Analysis Score	76.49	75.0	6.97	61.0	93.0
Inference Score	76.59	75.0	7.86	57.0	93.0
Evaluation Score	80.61	82.0	7.75	61.0	96.0
Induction Score	79.50	81.0	6.69	61.0	94.0
Deduction Score	78.01	76.0	6.54	65.0	94.0
Numeracy Score	74.54	75.0	7.73	57.0	96.0

This research question was assessed using a standard multiple regression process previously described. The results of the regression analysis indicated that the model was not

significant,  $F(6, 108) = 1.752, p = 0.116$ . The model explained 4% of the variance ( $R^2 = 0.038$ ). While the model was not significant, there was one variable that significantly predicted changes in the nursing grade point average (Table 3). Numeracy indeed did predict changes in the dependent variable. None of the other variables significantly contributed to the outcomes.

The independent variables that did not significantly impact the dependent variable were dropped from the analysis and the standard multiple regression was repeated. The results indicated that the revised model was significant,  $F(1, 113) = 7.624, p < 0.01$  and explained 6% of the variance ( $R^2 = 0.055$ ). While the model was significant, the results suggested that numeracy only explained a small amount of variance in the dependent variable ( $b = 0.251, p = 0.007$ ). The null hypothesis was rejected, and the alternate hypothesis was partially accepted as the model did significantly predict changes in the dependent variable. The scores on Numeracy were included in the final regression associated with Research Question 4.

Table 3

*Regression Results--Health Science Reasoning Test and Strength of Prediction on Nursing Grade Point Average*

	<i>B</i>	<i>SE</i>	$\beta$	<i>t</i>	<i>p</i>
Analysis	0.00	0.02	0.01	0.06	0.96
Inference	0.01	0.02	0.11	0.51	0.61
Evaluation	-0.02	0.02	-0.14	-0.63	0.53
Induction	0.02	0.03	0.14	0.55	0.59
Deduction	-0.03	0.03	-0.23	-0.85	0.40
Numeracy	0.04	0.02	0.37	2.03	0.05

## Research Question 2

What is the relationship between prior academic performance and end-semester nursing GPA in associate degree students? This question was answered by using pre-admission curricular GPA to measure prior academic performance for each student and comparing it to their cumulative nursing course GPA earned at the end of the first semester. The frequency distribution of the sample's cumulative pre-nursing and first semester nursing GPA are noted in Table 4.

Table 4

*Characteristics of Sample: Pre-Nursing Grade Point Average and Cumulative Nursing Grade Point Average*

	<i>M</i>	<i>Mdn</i>	<i>SD</i>	Minimum	Maximum
Pre-Nursing GPA	3.38	3.43	0.39	2.57	4.00
Cumulative Nursing GPA	3.16	3.30	0.86	0.00	4.00

The results indicated that the model was significant,  $F(1, 113) = 4.659, p < 0.05$  and explained 3% of the variance ( $R^2 = 0.031$ ). However, there was little to no variance explained in the dependent variable and the strength of prediction associated with prior academic performance was not strong ( $b = 0.199, p = 0.033$ ). As such, the null hypothesis was rejected, and the alternate hypothesis was partially accepted that the model did significantly predict changes in the dependent variable. Scores of prior academic performances (pre-nursing cumulative GPA) were included in the final regression associated with Research Question 4.

## Research Question 3

What is the relationship between current scholastic knowledge and end-semester nursing GPA in associate degree students? This question was answered by using composite pre-

admission test scores to measure current scholastic knowledge for each student and comparing it to their cumulative nursing course GPA earned at the end of the first semester. The frequency distribution of student GPA and both composite and content category scores for the ATI TEAS are shown in Table 5.

Table 5

*Characteristics of the Sample: Cumulative Nursing Grade Point Average and Test of Essential Academic Skill Scores*

	<i>M</i>	<i>Mdn</i>	<i>SD</i>	Minimum	Maximum	
Cumulative Nursing GPA	3.16	3.30	0.86	0.00	4.0	
ATI TEAS Score Composite	85.50	88.00	8.36	66.0	99.0	
ATI TEAS Sub Scores	Reading	80.26	82.00	14.38	45.0	99.0
	Math	88.28	93.00	11.33	54.0	99.0
	Science	77.61	77.00	13.13	48.0	99.0
	Language	75.53	79.00	16.01	46.0	99.0

The sub score identified in each category of the test was compared to the end of semester GPA and analyzed using a standard multiple regression process as previously described.

The results indicated that the model was significant,  $F(4, 110) = 5.402, p < 0.01$ . The model explained 13% of the variance ( $R^2 = 0.134$ ) and there were several variables (e.g., math and language scores) that more significantly predicted changes in the dependent variable (Table 6). No other variables significantly contributed to the outcome. The independent variables that did not significantly impact the dependent variable were deleted and the standard multiple regression analysis was repeated. The results indicated that the revised model was significant,  $F(2, 112) = 9.879, p < 0.001$ . The revised model explained 14% of the variance ( $R^2 = 0.135$ ). The results

suggested that Language scores ( $b = 0.287, p = 0.002$ ) uniquely contributed to changes in the dependent variable, while Math scores ( $b = 0.202, p = 0.026$ ) approached significance.

Therefore, the null hypothesis was rejected, and the alternate hypothesis was accepted that the revised model did significantly predict changes in the dependent variable. Math and Language scores were included in the final regression associated with Research Question 4.

Table 6

*Regression Results--Test of Essential Academic Skill and Strength of Prediction on Nursing Grade Point Average*

	<i>B</i>	<i>SE</i>	$\beta$	<i>t</i>	<i>p</i>
Reading	0.00	0.01	0.06	0.063	0.53
Math	0.01	0.01	0.19	1.96	0.05
Science	0.01	0.01	0.11	1.24	0.22
Language	0.01	0.01	0.26	2.79	0.01

#### **Research Question 4**

Do the expanded cognitive aptitude measures of the Nursing Cognitive Aptitude Model predict success in first semester of an associate degree nursing program? This research question was analyzed using a standard multiple regression with scores on the measures of numeracy (HSRT-AD sub score), prior academic performance (pre-nursing GPA), and Math and Language scores (TEAS sub scores) were included in the model. These variables were selected based on their enhanced ability to predict changes in the dependent variable.

The results indicated that the model was significant,  $F(4, 110) = 5.693, p < 0.001$ . The model explained 14% of the variance ( $R^2 = 0.141$ ). While the model was significant (see Table



7), scores on measures of Language were the only independent variable that predicted changes in the dependent variable. None of the other variables significantly contributed to the outcomes.

As a result, the independent variable of numeracy was deleted, and the multiple regression was repeated. The results indicated that the revised model was significant,  $F(3, 111) = 7.301, p < 0.001$ . This model explained 14% of the variance ( $R^2 = 0.142$ ). While the revised model was significant, the results suggested that Language scores ( $b = 0.276, p = 0.003$ ) continued to uniquely contribute to changes in the dependent variable, while Math scores ( $b = 0.178, p = 0.053$ ) approached significance. The null hypothesis was rejected, and the alternate hypothesis was accepted that the revised model did significantly predict changes in the dependent variable.

Table 7

*Regression Results--Health Sciences Reasoning Test and Strength of Prediction on Nursing Grade Point Average*

	<i>B</i>	<i>SE</i>	$\beta$	<i>t</i>	<i>p</i>
Numeracy	0.01	0.01	0.09	0.94	0.35
Prerequisite	0.25	0.19	0.12	1.35	0.18
Math	0.01	0.01	0.15	1.49	0.14
Language	0.01	0.01	0.26	2.77	0.01

### Summary

The data analysis results indicated support for each of the research questions tested. However, a closer examination of these results suggested that only a few of the variables significantly contributed to predictive changes in the dependent variable, the GPA after the first semester in nursing school. Select components or sub scores of the variables included in the

Nursing Cognitive Aptitude Model (Twidwell et al., 2018) were tested for their potential to predict success and the findings of this study only partially supported the framework. Pre-admission GPA and Language component and composite TEAS scores were predictive of first semester nursing GPA but only explained a small amount of the variance. The Math component sub score approached significance. The composite HSRT-AD scores did not predict first semester GPA, but the sub score for Numeracy was significant. When these significant variables were analyzed by regression in question four, the TEAS subcategories of Math and Language scores were the two independent variables that contributed to the most variance of the GPA after the first semester of nursing school, with Language being the most significant and Math approaching significance.

In the next chapter, the interpretation of the findings and the relationship to current research are discussed. The implications of findings inform admission processes for nurse educators and will provide the basis for admission metrics recommendations. Suggestions for additional research are proposed.

## **CHAPTER V**

### **CONCLUSIONS AND RECOMMENDATIONS**

This study was conducted to explore the ability of the Nursing Cognitive Assessment Model (Twidwell et al., 2018) to predict student outcomes at the conclusion of the first semester of an associate degree nursing program. Each component of the model was evaluated for a correlation to the cumulative student grade point average (GPA) of nursing courses. Pre-admission standardized test composite and sub scores, pre-admission GPA, and results of a critical thinking assessment were analyzed. This chapter includes a discussion of the findings in relation to prior research in admission criteria and student success in nursing. Additionally, recommendations for further research within the context of nursing program admission standards are discussed.

#### **Summary of the Study**

Student attrition in nursing educational programs is a complex and persistent problem that has a significant impact on the number of graduating, and subsequently, practicing nurses. As many as one third of students who begin nursing programs will fail or drop out (Fagan & Coffey, 2019; Mooring, 2016) and some researchers have reported attrition rates are high as 50% (Harris et al., 2014; Kubec, 2017). To improve retention, it is essential that students who are selected for admission to nursing programs are successful in completing the educational and regulatory requirements for practice (Robert, 2018). To improve student retention and reduce attrition, many nursing programs are exploring the impact of admission criteria and trying to define the attributes of candidates who are likely to be successful. While recently published

studies have focused on demographic and academic factors, the results are contradictory (Olsen, 2017). Additionally, studies that focus on the role of personal attributes and affective domains have also revealed mixed outcomes related to learning styles, resilience, emotional intelligence, and the impact of family and peer support (Fagan & Coffey, 201

Most programs utilize multiple admission criteria in consideration of candidates (Liu et al., 2018). These criteria may include cumulative GPA, grades in subject-specific courses, and an array of standardized testing, or a more holistic approach comprised of personal statements and interviews (Barbe et al., 2018; Glazer et al., 2016; Twidwell & Records, 2017; Wambuguh et al., 2016). Unfortunately, attrition across all types of programs with various approaches to the admission process remains alarmingly high (Smith-Wacholz et al., 2019).

To resolve high attrition rates and improve success in nursing education, emphasis has been placed on the identification of characteristics that define a successful student. While many factors have been explored, the dynamic and complex nature of nursing education presents many variables that have yet to be examined. Critical thinking skill is an essential characteristic of competent nursing practice and a desired outcome of nursing education (AACN, 2008; NLN, 2010). However, critical thinking ability has not been included in the typical metrics for nursing admission decisions. A model, the Nursing Cognitive Aptitude Model or NCAM (Twidwell et al., 2018), has been proposed to include three measure of cognitive aptitude that combine to predict student success in nursing. The NCAM provided the framework for this study and helped define the independent variables of interest: current scholastic knowledge (ATI TEAS scores), prior academic performance (pre-nursing GPA), and critical thinking ability (HSRT-AD scores). Both composite and component scores of the ATI TEAS and HSRT-AD were examined in

relation to success, which was measured by end-semester cumulative GPA of four specified nursing content courses.

This study explored four research questions to determine the ability of the NCAM to predict student success. The first research question, “What is the relationship between pre-nursing critical thinking ability and end-semester nursing GPA in associate degree students?” examined critical thinking. The HSRT-AD critical thinking instrument was used to measure both overall critical thinking skill and the component variables of analysis, inference, evaluation, induction, deduction, and numeracy. The data for this question demonstrated a statistically significant relationship between the content sub score of Numeracy and GPA. The composite and other sub scores of the HSRT-AD were not significant.

The second research question asked, “What is the relationship between prior academic performance and end-semester nursing GPA in associate degree students?” The data obtained in response to this question demonstrated that pre-nursing GPA did significantly predict first semester nursing GPA. However, the strength of prediction associated with prior academic performance was not strong.

The third research question asked, “What is the relationship between current scholastic knowledge and end-semester nursing GPA in associate degree students?” Current scholastic knowledge, measured by the composite score of the ATI TEAS pre-admission test, was significant in predicting GPA but only explained a small amount of the variance. When component scores were analyzed, additional variables were identified as predictive. Sub scores on Language and Math did significantly predict changes in the dependent variable.

The fourth and final question asked, “Do the three expanded cognitive aptitude measures of the Nursing Cognitive Aptitude Model predict first semester attrition?” Analysis of the

influence of both composite and component elements of each variable of the NCAM informed the selection of variables to answer the final research question. A revised model included the most significant variables in predicting GPA. For critical thinking ability, the sub score for Numeracy from the HSRT-AD was used. For current scholastic knowledge, the sub scores for the categories of Language and Math on the ATI TEAS were selected. These influential predictors were combined with pre-nursing GPA for analysis. The results indicated that the revised model was significant. However, there were several variables that did and some that did not predict changes in GPA. Initially, Language scores were the only significant variable. However, as independent variables were removed for subsequent regression analysis, the results suggested that Math and Language scores uniquely contributed to changes in the dependent variable, Language was most predictive. Neither HSRT-AD Numeracy scores nor pre-admission GPA, when combined with the other components of the revised model, were predictive of cumulative nursing GPA at the end of the first semester.

### **Discussion of the Findings**

The goal of this research study was to evaluate the elements of the NCAM (Twidwell et al., 2018) and examine the ability of these composite and component variables to predict GPA at the end of the first semester of an association degree nursing program. In the review of the literature, many studies have been conducted to identify the attributes of students who are most likely to succeed in a rigorous nursing curriculum. Most research of student success in nursing has focused on academic aptitude (Olsen, 2017; Pitt et al., 2012; Wolkowitz & Kelley, 2010), demographic variables (Higgins, 2005; Hilke-Lampe, 2014; Jeffreys, 2007; Payne, 2011), personal factors such as self-efficacy (Payne, 2011), anxiety and commitment (Hopkins, 2008), or socioeconomic factors (Barbe et al., 2018; Hilke-Lampe, 2014). Despite this notable body of

literature, a gap exists related to the role of critical thinking skill to initial success as a nursing student. Critical thinking is a desired outcome of nursing education and an essential attribute in safe nursing practice (AACN, 2008; NLN, 2010), however, the influence of critical thinking and initial success in nursing education has not been explored. Therefore, understanding the impact of pre-existing critical thinking skills on academic achievement, both independently and in combination with traditional admission criteria, may be important to identifying students who are most likely to succeed in nursing.

### **Research Question 1**

Research Question 1 compared critical thinking skill to nursing cumulative GPA at the end of the first semester of a nursing program. The purpose of testing this research question was to determine if there was a difference in student success, as measured by GPA, in relation to critical thinking skill as measured by the instrument, HSRT-AD. The HSRT-AD included both an overall, or composite score, as well as individual score for specific attributes of critical thinking: analysis, inference, evaluation, induction, deduction, and numeracy. In this study, the composite critical thinking score was not significant in predicting cumulative GPA at the end of the first semester. Few studies have published results of composite HSRT-AD scores in relation to predictors for success and none have examined the instrument scores in relation to first semester nursing students. However, there is some evidence to suggest that composite scores for novice nursing students are low and increase over time. An Australian research team (Hunter et al., 2014) investigated total HSRT scores of undergraduate nursing students across a three-year curriculum. Findings indicated that composite scores were the lowest for the first-year students, who had significantly lower mean scores than upper-class cohorts. Although the researchers did not evaluate the critical thinking score for its effect on retention or attrition, the results of this

study suggest that the timing of critical thinking skill measurement is significant. Additional research that utilizes a longitudinal design to examine both critical thinking skill and attrition across a nursing curriculum may provide a better understanding of how critical thinking changes as students progress and may help to identify a potential link between these variables.

The sub content score for numeracy was the only variable of significance as a predictor in the change of GPA. This finding is consistent with some previous research showing the importance of mathematical proficiency in the success of nursing students (Olsen, 2017). While many studies have evaluated the role of math competency in nursing school success, the results have been mixed. Several studies have shown a significant relationship between math course grades and GPA or program completion (Chen & Voyles, 2013; Domiano, 2018; Higgins, 2005; Trofino, 2013), while others have not (Gilmore, 2008; Robert, 2018; Wolkowitz & Kelley, 2010). Some scholars have attributed this inconsistency to the array of college courses offered to meet the math requirements which makes it difficult to compare studies across settings (Maley & Rafferty, 2019). To date, studies that examine the relationship of the HSRT-AD numeracy sub score and first semester GPA or program progression or completion have not been done. More research is needed on math competency, including clinically-based numeracy skills required for safe nursing practice, and its relationship to success in nursing education.

### **Research Question 2**

Research Question 2 compared the pre-nursing curricular GPA to the first semester nursing GPA. The findings for this research question demonstrated that pre-nursing GPA was significant in predicting first semester GPA, but that the strength of prediction was not strong. Because nursing programs offer admission through a competitive process, most programs accept students with GPAs on the higher end of the scale. In the nursing program from which the



sample of this study was obtained, the minimum GPA required for admission is 2.5 and students must earn a C or higher in all prerequisite courses. If students repeat a course because of failure, only the higher grade is calculated in the preadmission curricular GPA. Additionally, a passing grade in this nursing program is a cumulative course percentage of 80%. The participating community college employs a 5-point grading scale in which each letter grade is represented by a whole number and no additional partial points are given based on a student's actual percentage within the established scale. As a result, the range of GPAs used to calculate the means was narrow and the possible combination of values was limited by the small number of courses in both the prerequisite GPA ( $n = 5$ ) and first semester of nursing ( $n = 4$ ). In sum, analysis of this research question provided a significant statistical relationship for the GPAs, but closer examination of the data revealed limitations inherent in calculating cumulative GPAs within nursing programs. As a result, there was little variance in nursing GPA and the strength of predictions associated with prior academic performance was not strong.

Prerequisite GPA is a common academic factor used to evaluate candidates for admission to nursing programs. In a recent integrative review of 26 studies related to associate degree admission criteria and programmatic success, Olsen (2017) reported that all but one study included GPA as a variable of interest. Both preprogram college GPA and high school GPA or rank, were examined and compared to program completion. None of the studies identified in the Olsen review compared first semester cumulative GPA to pre-admission GPA. Findings from the integrative review related to preadmission cumulative GPAs and nursing program completion are mixed. Ten programs reported a significant relationship between either high school or college preadmission GPA and successful program completion and of these, seven reported a significant positive relationship. In other studies, investigators reported a significant positive relationship

between preprogram cumulative grades and program completion (Gilmore, 2008; Luna, 2014; Muecke, 2008; Payne, 2011; Preston, 2007; Shelton, 2012). Rogers (2009) noted a significant relationship between high school GPA and program completion. Studies by Beery (2014), Jackson (2010), and Jeffrey (2007) found no significant relationship between preprogram cumulative GPA and program completion. While the study completed by Luna (2014) reported that pre-nursing cumulative GPA and program completion had a significant relationship, this relationship was insignificant when the model was controlled for the variable of composite ATI TEAS scores. In sum, the Olsen (2017) review revealed an important overview of the current literature and reported that 7 of 10 studies showed a significant relationship between academic performance prior to nursing and program success.

The results of this dissertation study were similar to the prevalent findings noted by Olsen (2017), in that pre-nursing GPA, as a measure of prior academic success, is a significant factor in predicting program completion. However, unlike the research discussed by Olsen (2017), this study examined early program success by comparing pre-nursing GPA to the cumulative grades in nursing courses at the end of the first semester. While examining program completion as a measure of success is important, this approach identifies the students who persist, but does not examine factors that result in a gradual loss of students through attrition across the curriculum. More research is needed to gain better understanding of the relationship of admission criteria and early success and progression in nursing education. Additionally, knowledge of attrition factors as they occur at common points of attrition, such as the completion of each semester, would be beneficial in developing strategies for retention.

### Research Question 3

Research Question 3 addressed whether current scholastic knowledge was predictive of success in the first semester. This question was answered by evaluating pre-entrance ATI TEAS scores, both composite and component results, in comparison to end-semester GPA. The results indicated that the overall ATI TEAS score was significant in terms of the GPA at the end of the first semester. This is a new addition to the literature as no published reports could be found that compared the first semester GPA to pre-admission scores using the ATI TEAS.

However, the literature does have studies published that examined the relationship of ATI TEAS scores to other measures of knowledge attainment such as standardized tests administered across the curriculum, specific nursing course grades, or end-program outcomes such as cumulative GPA, completion, or NCLEX-RN success. Researchers of one large study of associate degree students ( $n = 3149$ ) reported a significant correlation of composite ATI TEAS scores and the results on another ATI exam, the RN Fundamentals ( $R^2 = .405, p < .001$ ; Liu et al., 2018). The composite ATI TEAS scores were also significantly related to the RN Fundamentals exam in a study of 3253 baccalaureate nursing students ( $R^2 = .444, p < .001$ ; Bremner et al., 2014). Other studies completed over the last decade also supported the predictive value of pre-admission testing and include evaluation of the ATI TEAS, HESI A<sup>2</sup>, the ACT, and NET (Esper, 2009; Luna, 2014; Trofino, 2013; Van Hofwegen et al., 2019; Wambuguh et al., 2016; Wolkowitz & Kelley, 2010). Most relevant to this study were two reports that examined the predictive ability of the composite ATI TEAS scores. In a study of 120 students, Esper (2009) found a significant correlation of the preadmission overall TEAS score to the nursing fundamentals course grade ( $r = .258, p = .001$ ) and the grade earned in health assessment ( $r = .320, p = .005$ ). However, the cumulative GPA of these courses was not compared to the

preadmission test scores. Similarly, a study by Luna (2014) cited a positive correlation between preadmission composite TEAS scores and one unspecified first semester nursing course ( $n = 78$ ,  $r = .455$ ,  $p < .001$ ).

In this dissertation study, content-specific, or component scores, were also evaluated in relation to the end semester cumulative nursing GPA. Findings indicated that both Math and Language sub scores were significant predictors of first semester GPA. Of the previous studies that used the ATI TEAS, most reported that one or more sub score components were significant predictors of success. Significant predictors in prior reports included Math (Esper, 2009; Luna, 2014), Language (Esper, 2009), English (Luna, 2014), and Science (Esper, 2009; Liu et al., 2018; Luna, 2014; Rogers, 2009). Thus, the results of this study are consistent with prior findings reported in the literature.

#### **Research Question 4**

The fourth research question addressed the ability of the Nursing Cognitive Aptitude Model to predict first semester cumulative nursing GPA. In this final step, the most significant variables from each of the first three research questions that influenced the end of first semester cumulative GPA were used to represent the components of the NCAM: critical thinking, past academic performance, and current scholastic knowledge (Twidwell et al., 2018). This revised model contained four independent variables: (a) the HSRT-AD Numeracy score to represent critical thinking, (b) pre-program GPA for past academic performance, (c) ATI TEAS Language score, and (d) ATI TEAS Math scores to represent current academic knowledge. Language and Math scores contributed most to the prediction of GPA but only Language scores were statistically significant.

This is the first test of the NCAM for its utility for guiding admission decisions with associate degree students, and as with most models, it requires additional testing and refinement to best identify students who would be successful as nursing students. Although this study did not show a relationship between overall critical thinking skill and first semester GPA, this phenomenon requires further examination. The assessment of critical thinking at multiple points across the curriculum would provide insight into the way in which this important skill is acquired.

### **Implications for Educational Practice**

The success of students in nursing programs is an essential component of alleviating the predicted shortfall in the numbers of practicing nurses (United States Department of Labor, Bureau of Labor Statistics, 2019). Meeting the criteria for admission is the first step that begins the educational journey of a nurse and is one factor in the complex problem of student attrition that is determined by each program. However, the factors that predict success are interdependent and the current literature revealed contradictory evidence for many of the criteria typically used for admission (Olsen, 2017). Therefore, it is essential that nursing programs examine the processes that determine their applicant pool and evaluate the relevancy and value of each criterion based on student outcomes and current educational and practice requirements.

Academic aptitude is most often measured by cumulative GPA of prerequisite courses and is a common component of preadmission criteria (Olsen, 2017). The findings from this study are congruent with previous research (Gilmore, 2008; Luna, 2014; Muecke, 2008; Payne, 2011; Shelton, 2012), as there was a small, but significant correlation between cumulative prerequisite grades and nursing GPA. However, comparison of findings between studies is problematic. Each nursing program's curriculum can vary in prerequisite requirements and college grading scales,

so study results may reflect institutional differences. In a recent systematic review, Al-Alawi et al. (2020) suggested that although evidence shows that pre-nursing GPA is a significant predictor of future academic success, it is not clear whether GPA is a reliable measure. Institutional differences in student populations, course quality and rigor, and institutional or program philosophy, should be considered when interpreting GPA.

To avoid comparison of GPAs across programs, researchers have examined individual pre-nursing course grades as related to success in nursing to determine content-specific influences (Olsen, 2017). Most researchers reported significant relationships between grades in several science courses in relation to progress in a nursing program. A study by Beery (2014) conducted with 200 students found a significant relationship between anatomy and physiology and pathophysiology grades taken prior to nursing with medical surgical course grades in nursing ( $r = .253, p < .001$ ;  $r = .321, p < .001$ , respectively). Similarly, Gilmore (2008) and Higgins (2005) reported a significant relationship between anatomy and physiology course grades and end-of-program nursing GPA ( $R^2 = .196, p < .001$ ;  $R^2 = .152, p < .05$ , respectively). Higgins (2005) also reported a significant relationship between microbiology with program completion ( $R^2 = .191, p < .05$ ) and with NCLEX-RN pass rates ( $R^2 = .171, p < .05$ ). Payne (2011) conducted a study of 117 students and reported a significant relationship between anatomy and physiology grades with a fundamentals nursing course grade ( $r = .636, p < .001$ ). Dolinar (2010) conducted a study of 1,350 students and reported that lower grades in science courses were correlated to non-completion in an associate degree program. Using odds ratio, Dolinar (2010) discovered that students who earned an F in biology had 3.85 times greater likelihood of noncompletion when compared to students who earned an A. In contrast, Jeffreys' (2007) findings did not find a

significant relationship between anatomy and physiology grades to attrition or retention. In sum, strong evidence exists for the use of science grades to predict nursing program success.

Evidence has also been reported for the relationship of prerequisite math course grades to attrition. Dolinar (2010) reported that lower grades in math were associated with noncompletion. Using logistic regression analysis for the grades earned in math as the coefficient to calculate the odds ratios, Doliner reported that a student who earned a failing grade in math had a 2.6 times greater chance of noncompletion than that of a student who earned an A. Esper (2009) also reported that pre-admission math grades were significant in relation to grades in the first semester nursing fundamentals course ( $r = .224, p = .05$ ). A more recent study isolated the influence of introductory math course grades and found them to be significant in predicting success as measured by program completion. In a retrospective review of 473 associate degree student transcripts, Maley and Rafferty (2019) reported that performance in pre-calculus and calculus courses taken prior to nursing courses was predictive of nursing program completion, while statistics and algebra courses were not.

In this dissertation study, individual math course grades were not assessed. However, Numeracy scores of the HSRT-AD (RQ1) and the Math component of the ATI TEAS (RQ3) were examined and found to be significant in predicting end of first semester GPA. However, when combined for analysis in the last research question, neither sub scores were statistically significant. This suggests that the role of math competency skills is not well understood, and additional research is needed to identify the math content necessary to prepare students with the computational skills required for both academic progression and safe practice.

The Nursing Cognitive Aptitude Model, or NCAM (Twidwell et al., 2018), was used to frame the approach in this study. The model introduced the concept of critical thinking skill, an

essential competency of safe nursing practice, as a potential factor of success in nursing education. This study's findings did not support the use of the HSRT-AD composite score as a predictor of success in the first semester of an associate degree nursing program, but the premise of the model represents a relevant bridge between education and practice and requires further examination. Critical thinking is recognized as a core competency in nursing education and practice (Accreditation Commission for Education in Nursing, 2017; AACN, 2008;). But despite its importance, the process of teaching critical thinking remains a challenge. Nursing educators must foster critical thinking in nursing students and develop effective strategies to enhance and measure this competency (Von Colln-Appling & Giuliano, 2017). Furthermore, additional research is needed to determine the predictive value of pre-existing critical thinking as a means of forecasting student success in nursing education.

The NCAM (Twidwell et al., 2018) aligns with the emerging trend of broadening the admissions process to include nonacademic factors. Recently, a change to a more holistic admissions review has been suggested to diversify the health care workforce (Rosenberg, 2019). Providing graduates who mirror the communities in which they work can improve health outcomes and bridge the gap created by health disparities (Glazer et al., 2016). Nursing programs have traditionally used academic metrics as the primary measures for admission and have lagged behind other health care professions in adopting holistic admissions review (Glazer et al., 2016). Holistic admission review involves considering other characteristics such as personal experiences and attributes and not just academic performance based on test scores or grades (DeWitty, 2018). The NCAM contains a nonacademic measure, critical thinking skill, which could provide additional evidence to support other attributes evaluated during the holistic admissions review.



## Limitations

There were several limitations to this study that must be considered when evaluating the findings. First, although the research design was developed to include multiple sites, the final sample was limited to students from one community college. According to Grove et al. (2013), nonprobability sampling, such as the convenience sample used in this study, increases the likelihood of attaining samples that are not representative of target populations. The sample for this study was recruited from a single setting and included students who self-selected to participate. A volunteer sample may have important personal, academic, or demographic differences than the target population which limits the conclusions that can be drawn (Grove et al., 2013). Therefore, the findings are reflective only of the sample studied and cannot be generalized.

Another limitation was the theoretical framework and selected variables used in the study. The NCAM combines critical thinking skill, current scholastic knowledge, and academic aptitude to predict student success as determined by cumulative GPA (Twidwell et al., 2018). In this study, these variables were defined by composite HSRT-AD score, composite ATI TEAS score, pre-nursing GPA, and cumulative GPA earned at completion of the first semester of nursing. In research question one, the critical thinking skill of students was evaluated for its predictive value in GPA as suggested by the NCAM model. However, there was no significance found between the overall HSRT-AD score and the cumulative nursing GPA and this variable was changed to the Numeracy score in the final analysis of research question four. Additionally, the variable initially selected for current scholastic knowledge was the overall ATI TEAS score, which had a weak predictive relationship with the dependent variable. This variable was also changed to represent the more statistically significant relationships identified in analysis of

question three. The final variables selected to represent current scholastic knowledge were the Language and Math sub scores of the ATI TEAS. Moreover, the limited nature of cumulative GPAs produced by a narrow variance in letter grades diminished the influence of the pre-nursing grades on first semester GPAs.

The choice of the ATI TEAS as the measure for current academic knowledge presented an additional limitation. There are several preadmission tests that could be used in guiding admission decisions. In a recent integrative review of standardized exams used for nursing admission, Twidwell and Records (2017) reported that while the ATI TEAS, ACT, and HESI A<sup>2</sup> were all predictive of success in program completion and on the NCLEX-RN exam, the HESI A<sup>2</sup> provided the best predictive value. However, in this dissertation study participating programs were limited to those that offered the ATI TEAS, as this was the test that most programs within the community college system used. Further, some pre-admission nursing tests are used because their publishers also provide learning resources to the nursing programs. Thus, some students take first semester tests that are generated from the same source materials as their pre-admission tests. All of these factors may confound the relationship between standardized test scores and first semester GPA.

### **Recommendations for Further Research**

Future research is needed to examine the ongoing problem of student attrition in nursing education and additional knowledge is required to gain better understanding of this complex issue. This study focused on admission criteria as predictors for success and used a new model, the NCAM (Twidwell et al., 2018), as a theoretical framework to develop and operationalize the research. The outcomes of this study have brought to light several recommendations for future

research. Further study is needed to evaluate the NCAM and to better understand each component of the model as predictors for success.

The NCAM requires additional study to gain knowledge about the model, as well as how each variable, when considered individually and in combination, could identify successful candidates for nursing program admission. While previous research has been completed on prior academic performance, more information about the significance of prerequisite cumulative GPA, course-specific grades, and the predictive influence of previous academic work on success is needed.

A second component of the NCAM, current academic knowledge, can be measured by several standardized entrance exams. In an integrative review of the value of available pre-admission tests, Twidwell and Records (2017) reported that the HESI A<sup>2</sup> was most predictive of program completion or NCLEX-RN success. Studies that employ the HESI A<sup>2</sup> and additional research in use of the ATI TEAS as measures of current academic knowledge for the NCAM are needed. In this study, success was defined as first semester nursing GPA. To further explore the predictive value of preadmission standardized exams, longitudinal studies that measure success at common points of attrition occurrence across the curriculum are needed. In addition, the NCAM should be studied in larger, ethnically diverse populations, in both baccalaureate and associate degree programs, and in students in both urban, suburban, and rural settings.

A gap in knowledge exists pertaining to pre-existing critical thinking skill and success as a nursing student. Nurse educators are responsible for preparing students with the thinking skills required for safe practice and for developing the cognitive skills that lead to competent patient care (Paul, 2014). In the literature, critical thinking has been examined as a competency that is gained during nursing education and not as a pre-existing skill set on which nursing knowledge

can be built (Brudvig et al., 2013; Perez et al., 2015; Romeo, 2010). Specific strategies for critical thinking development have been examined and measured to identify the best approach to teaching critical thinking (Carvalho et al., 2017).

However, the aptitude and cognitive skills required for complex decision-making have not been viewed previously as attributes that could impact eventual success, or lack thereof, or contribute to the problem of attrition. Critical thinking skill is not a common assessment used for screening applicants (Twidwell & Records, 2017), despite the existence several commercially available instruments. Research is needed to examine the importance of pre-existing critical thinking and to benchmark the achievement of critical thinking competency as an outcome of nursing education across the curriculum. Measurement of critical thinking in students might need to occur at multiple points to gain a better understanding about the development of critical thinking and to measure the influence of specific teaching strategies designed to improve this cognitive aptitude (Sommers, 2018).

### **Conclusions**

The findings of this study are consistent with the outcomes of most prior research. The variables that create nursing student attrition are complex, multifactorial, and interrelated. The findings of this research were congruent with results from previous work that reported significant relationships between pre-admission testing and pre-nursing GPA to the end-program outcome of graduation. This study added to the current literature by reporting a significant link between the ATI TEAS composite score and first semester GPA, an early measure of performance. However, success has not been measured in early academic performance in nursing programs when the occurrence of attrition can be prevented or mitigated. The NCAM (Twidwell et al., 2018) provides a new framework for further study. This model combines measures of current

scholastic knowledge, prior academic performance, and critical thinking skill to measure the cognitive aptitude required for success in nursing education. While the level of critical thinking skill did not predict nursing GPA in this study, the essential nature of critical thinking to safe nursing practice warrants future investigation to better understand its impact on success.

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**APPENDIX A**  
**STUDENT RECRUITMENT LETTER AND CONSENT**



CONSENT FORM FOR HUMAN PARTICIPANTS IN RESEARCH  
UNIVERSITY OF NORTHERN COLORADO

Project Title: Cognitive Aptitude as a Predictor of Success in Associate Degree Nursing Programs

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e-mail: Kathryn.records@unco.edu

Welcome to nursing! As a new nursing student, you are exposed to many new things, including learning how to read and study complex nursing content and taking care of patients. This is an exciting time for you as you begin to acquire the skills and knowledge to assume the role of the professional nurse.

I am a full-time nursing faculty member at a Virginia Community College System (VCCS) nursing program and a doctoral student working towards a degree in Nursing Education. I am asking for your participation in my dissertation research project. It focuses on the critical thinking skills in new nursing students as compared to success in the 1<sup>st</sup> semester nursing courses.

Your only action to join the study is to read this informed consent and ask any questions that you might have about the study. If you want to participate, then you click on the link below to take a multiple-choice assessment called the Health Sciences Reasoning Test (HSRT-AD). This test takes about 45-50 minutes to complete. You do not need to have any specific medical knowledge or health care experience to take the assessment. The test can be taken at your convenience using any electronic device.

I will compare your HSRT-AD test score to the test score that you received on your nursing entrance exam test, your pre-nursing GPA, and your end of 1<sup>st</sup> semester nursing grades (NSG 100, NSG 106, NSG 130, NSG 200). Therefore, I am also seeking permission to have confidential access to these results. Grading data will be provided to me by your college only *after* the semester ends and *after* the college Registrar posts them. You do not need to do any additional tasks for the study.



There are no foreseeable risks of participation in this study. Participation is voluntary and you may decide to withdraw from the study at any time. If you withdraw, your decision will be respected and will not impact your program standing or course grades. Your information will be available only to me and your identity will remain confidential. All results will be reported as group data.

You may find that the assessment results are helpful as they provide detailed information about the strengths and weaknesses in your thinking processes. Your results will be immediately available upon completion of the assessment and you can print, save, or share your scores as desired. In appreciation for your participation, students who complete the assessment can enter a drawing to receive a \$25 Amazon gift card. There will be two gift cards awarded at your college.

Please take your time to read and thoroughly review this document and decide whether you would like to participate in this research study. If you decide to participate, the completion of the online assessment indicates your consent to join the study and to allow my confidential access to your pre-admission GPA and TEAS test scores and your end of first semester grades.

Please keep or print this form for your records. If you have any concerns as a research participant, please contact Nicole Morse, Office of Research & Sponsored Programs, Carter Hall, University of Northern Colorado Greeley, CO 80639; 970-351-1910.

I thank you in advance for taking part in my study and helping us learn more about how to help students succeed. I welcome your questions about the study at any time.

To join the study and take the critical thinking assessment, click [HERE](#).

Thank you,

A handwritten signature in cursive script that reads "Nancy Leahy".

Nancy Leahy, RN, MSN, CHSE

[leah2668@bears.unco.edu](mailto:leah2668@bears.unco.edu)

Professor of Nursing, John Tyler Community College  
Doctoral Candidate, University of Northern Colorado

**APPENDIX B**  
**PROGRAM RECRUITMENT LETTER**



Dear \_\_\_\_\_,

I am currently a full-time faculty member of John Tyler Community College and working towards a PhD in Nursing Education at the University of Northern Colorado. I have been awarded a grant by the Virginia Community College System to conduct a multi-site research project which will study critical thinking skills of incoming students in 2020 and 2021 cohorts. I would like to invite your incoming nursing students to participate and this letter provides information about what that participation involves.

As a nursing faculty member for 14 years, I have noticed that some students who enter the program with high GPAs and strong pre-nursing test scores still struggle with the transition to our nursing courses. I wonder if nursing's emphasis on critical thinking means that students with enhanced critical thinking skills are more prepared for our rigorous curricula than those with lower levels of critical thinking abilities. I am investigating the relationship of critical thinking during the first semester of the nursing programs in our community college system and hope to determine if the level of critical thinking skill is associated with success in our nontraditional student population.

I need your help to conduct this study. I am asking if you will:

1. Post a student recruitment letter that I will provide to your college's learning management system for one of your first semester nursing courses. As an alternative, I can visit your college during orientation or in the early portion of the semester to explain the study and ask for volunteers. Informational posters will also be available as desired.
2. Assist in facilitating the collection of pre-admission and end of semester data, including pre-admission grades and TEAS test scores (from admission process records), and first semester nursing course grades. This information will be compared to performance on a standardized critical thinking test. I can visit onsite or work with the person you recommend to collect these data, which can be retrieved from course records generated by the college learning management or admission and records systems.

Students who consent to participate will:

1. Consent to the release of pre-admission data (GPA and standardized test score) and end of semester grades (NSG 100, NSG 106, NSG 130, NSG 200).
2. Take an online critical thinking test, the Health Sciences Reasoning Test for Associate Degree Students (HSRT-AD). The HSRT-AD is a 33-item, multiple choice test that measures overall reasoning and individual thinking skills to support sound critical

thinking. The test takes approximately 50 minutes to complete and will be available online for students who will begin the program. The test can be taken from any electronic device.

3. On completion of the HSRT-AD, students will have access to their scores which may be useful. Identified areas of strengths and weaknesses may provide important insight into their reasoning and help them to target areas for improvement.

A group summary of the overall scores on the HSRT-AD will be made available to you, as this may provide important information regarding the critical thinking skills of the cohort and may be useful for programmatic planning. However, the specific programs and specific students who participate will remain confidential, known only to myself.

Thank you so much for considering this request. It is essential that we investigate all risk factors associated with a lack of success in nursing to better inform our policies related to admission and progression. This project may give evidence to support changes to our processes to include a measure of critical thinking as a metric for success.

I will reach out to you in the next few days to answer questions and determine interest in giving your students the opportunity to participate.

Sincerely,



Nancy Brooks Leahy, RN, MSN, CHSE  
Professor of Nursing, John Tyler Community College  
nleahy@jtcc.edu (xxx) xxx-xxxx (cell)  
Doctoral Candidate, University of Northern Colorado  
leah2668@bears.unco.edu

**APPENDIX C**  
**INSTITUTIONAL REVIEW BOARD APPROVAL**



*Institutional Review Board*

DATE: April 14, 2020

TO: Nancy Leahy

FROM: University of Northern Colorado (UNCO) IRB

PROJECT TITLE: [1566504-2] Cognitive Aptitude as a Predictor of Success in Associate Degree Nursing Programs

SUBMISSION TYPE: Revision

ACTION: APPROVAL/VERIFICATION OF EXEMPT STATUS

DECISION DATE: April 14, 2020

EXPIRATION DATE: April 14, 2024

Thank you for your submission of Revision materials for this project. The University of Northern Colorado (UNCO) IRB approves this project and verifies its status as EXEMPT according to federal IRB regulations.

We will retain a copy of this correspondence within our records for a duration of 4 years.

If you have any questions, please contact Nicole Morse at 970-351-1910 or [nicole.morse@unco.edu](mailto:nicole.morse@unco.edu). Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within University of Northern Colorado (UNCO) IRB's records.

**APPENDIX D**

**HEALTH SCIENCES REASONING TEST-ASSOCIATE DEGREE  
SAMPLE STUDENT REPORT**

**Result for: Sample Report**  
**Completed: 5/3/2017 10:46:27 AM**  
**Instrument: Health Sciences Reasoning Test (HSRT) 15.1.15 AD**



OVERALL:	79	
Analysis:	82	
Inference:	75	
Evaluation:	82	
Induction:	81	
Deduction:	76	
Numeracy:	75	

**OVERALL: 79 Moderate**

Moderate overall skill in critical thinking indicating potential for skills related challenges when engaged in the reflective problem-solving and reflective decision making associated with learning or employee development

The Reasoning Skills Overall score describes overall strength in using reasoning to form reflective judgments about what to believe or what to do. High Overall scores are attained by test takers who excel in the sustained, focused and integrated application of core thinking skills measured on this test, including analysis, interpretation, inference, evaluation, explanation, induction and deduction. The Overall score predicts the capacity for success in educational or workplace settings which demand reasoned decision making and thoughtful problem solving.

**Percentile: 43**

A note of interpretation: A score that falls in the 60th percentile indicates that out of one hundred test takers, roughly 40 would earn a higher score and 60 a lower score. A percentile score is not an indication of the percent correct, but of relative ranking. Percentile approximations are suggested for advisory purposes only.

**Analysis: 82 Strong**

Analytical reasoning skills enable people to identify assumptions, reasons and claims, and to examine how they interact in the formation of arguments. We use analysis to gather information from charts, graphs, diagrams, spoken language and documents. People with strong analytical skills attend to patterns and to details. They identify the elements of a situation and determine how those parts interact. Strong interpretation skills can support high quality analysis by providing insights into the significance of what a person is saying or what something means.

**Inference: 75 Moderate**

Inference skills enable us to draw conclusions from reasons and evidence. We use inference when we offer thoughtful suggestions and hypotheses. Inference skills indicate the necessary or the very probable consequences of a given set of facts and conditions. Conclusions, hypotheses, recommendations or decisions that are based on faulty analyses, misinformation, bad data or biased evaluations can turn out to be mistaken, even if they have been reached using excellent inference skills.

**Evaluation: 82 Strong**

Evaluative reasoning skills enable us to assess the credibility of sources of information and the claims they make. And, we use these skills to determine the strength or weakness of arguments. Applying evaluation skills we can judge the quality of analyses, interpretations, explanations, inferences, opinions, beliefs, ideas, proposals, and decisions. Strong explanation skills can support high quality evaluation by providing the evidence, reasons, methods, criteria, or assumptions behind the claims made and the conclusions reached.

**Induction: 81 Moderate**

Decision making in contexts of uncertainty relies on inductive reasoning. We use inductive reasoning skills when we draw inferences about what we think is probably true based on analogies, case studies, prior experience, statistical analyses, simulations, hypotheticals, and patterns recognized in familiar objects, events, experiences and behaviors. As long as there is the possibility, however remote, that a highly probable conclusion might be mistaken even though the evidence at hand is unchanged, the reasoning is inductive. Although it does not yield certainty, inductive reasoning can provide a confident basis for solid belief in our conclusions and a reasonable basis for action.

**Deduction: 76 Moderate**

Decision making in precisely defined contexts where rules, operating conditions, core beliefs, values, policies, principles, procedures and terminology completely determine the outcome depends on strong deductive reasoning skills. Deductive reasoning moves with exacting precision from the assumed truth of a set of beliefs to a conclusion which cannot be false if those beliefs are true. Deductive validity is rigorously logical and clear-cut. Deductive validity leaves no room for uncertainty, unless one alters the meanings of words or the grammar of the language.

**Numeracy: 75 Moderate**

Numeracy skills are used when applying knowledge of numbers, arithmetic, measures, and mathematical techniques to situations that require the interpretation or evaluation of information. Numeracy refers to the ability to solve quantitative reasoning problems, or make judgments derived from quantitative reasoning in a variety of contexts. More than being able to compute a solution to a mathematical equation, numeracy includes the understanding of how quantitative information is gathered, manipulated, and represented visually, such as in graphs, charts, tables and diagrams.

**Session Duration:** 45 min, 12sec

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**APPENDIX E**

**HEALTH SCIENCES REASONING TEST-ASSOCIATE DEGREE  
SAMPLE PROGRAM REPORTS**

Skill/Attribute Name	N	Mean	Median	Standard Deviation	SE Mean
OVERALL	531	82.6	83	6.5	0.3
Analysis	531	83.8	86	8.9	0.4
Interpretation	531	76.6	78	9.7	0.4
Inference	531	82.9	84	7.8	0.3
Evaluation	531	71.5	72	7.5	0.3
Explanation	531	84.7	86	7.8	0.3
Induction	531	85.8	88	6.6	0.3
Deduction	531	80.2	81	9.5	0.4
Numeracy	531	76.3	75	9.4	0.4

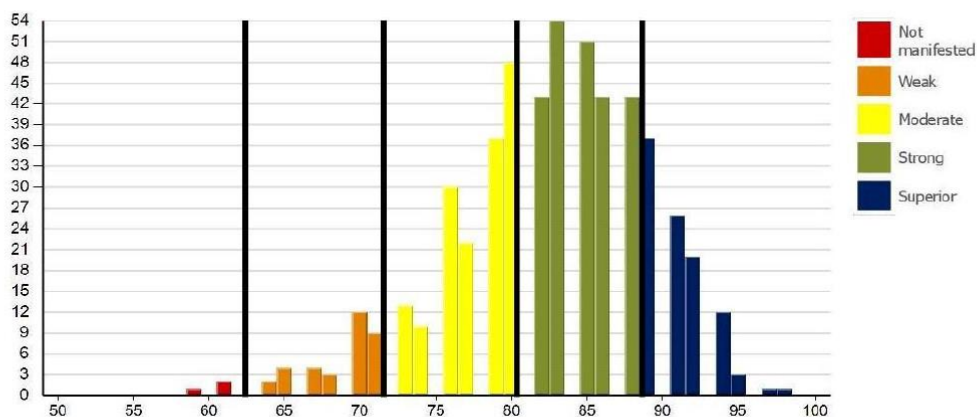
Skill/Attribute Name	Minimum	Maximum	Quartile 1	Quartile 3
OVERALL	59	98	79	88
Analysis	55	100	77	91
Interpretation	50	100	72	83
Inference	53	100	78	88
Evaluation	50	94	67	78
Explanation	55	100	82	91
Induction	59	100	82	91
Deduction	50	100	75	88
Numeracy	50	100	71	83

Based on the distribution of the overall score percentiles for the test takers in this group, as compared to an aggregate sample of HSRT Graduate Physician Assistant, the average percentile score of this group of test takers is 52.

Descriptive Information: OVERALL

N	Mean	Median	Standard Deviation	SE Mean	Minimum	Maximum	Quartile 1	Quartile 3
531	82.6	83.0	6.5	0.3	59	98	79.0	88.0

OVERALL



**APPENDIX F**

**ASSESSMENT TECHNOLOGIES INSTITUTE TEST OF  
ESSENTIAL ACADEMIC SKILLS SAMPLE  
STUDENT REPORT**

## Individual Performance Profile ATI TEAS Retake 12



Individual Name:	<b>SAMPLE STUDENT</b>	Test Date:	<b>8/26/2016</b>
Institution:	<b>ATI</b>	Attempt:	<b>2 of 2</b>
Program Type:	<b>BSN</b>	Days Since Last Attempt:	<b>2102</b>

### Scores

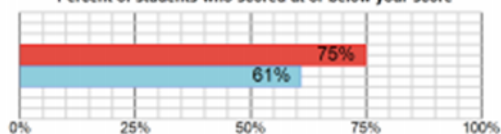
#### Total Score:

**74.0%**

Academic Preparedness Level: **Proficient**

National Mean: 65.6% All BSN Programs Mean: 70.4%

Percent of students who scored at or below your score



#### Reading Score:

**51.1%**

#### Math Score:

**93.8%**

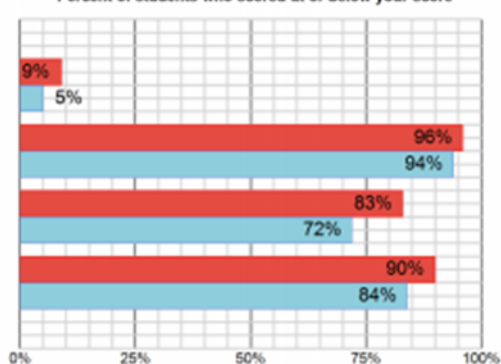
#### Science Score:

**72.3%**

#### English and Language Usage Score:

**83.3%**

Percent of students who scored at or below your score



National

All BSN Programs

Content areas do not add up to the total score

### Topics To Review

#### Reading (47 items)

##### Key Ideas and Details (22 items, 68.2% answered correctly)

- Summarize a complex text.
- Identify information from a graphic representation of information.
- Follow a given set of directions.
- Recognize events in a sequence.
- Recognize events in a sequence.

Please see page 3 for an explanation of the Scores

Page 1 of 3

Report Created on: 8/26/2016 09:16 AM EDT

ATI\_TEAS\_Individual

**APPENDIX G**  
**GRANT AWARD LETTER**

December 5, 2019

Nancy Leahy  
John Tyler - Chester  
13101 Jefferson Davis Highway  
Chester, Virginia 23831

[nleahy@itcc.edu](mailto:nleahy@itcc.edu)

Re: Spring 2020 Grant Application S2020-620P-PF: **The Relationship of Critical Thinking Disposition and Student Attrition in the First Semester of Nursing: A Multi-Site Study**

Dear Professor Leahy:

On behalf of the VCCS Professional Development Committee, thank you for your proposal for spring 2020. The grants committee, comprised of faculty and grants coordinators from throughout the VCCS, conducts a peer review of each proposal and makes recommendations based upon the stated objectives of the VCCS Professional Development program and the quality of the proposal.

Your proposal, *The Relationship of Critical Thinking Disposition and Student Attrition in the First Semester of Nursing: A Multi-Site Study* was partially funded as submitted. The review committee provided the following specific information for you:

The committee is able to support the testing materials and associated fees for this worthwhile study, but is prohibited from using funds from this source for student recruitment.

We believe your project will benefit personnel from more than one Virginia Community College and ultimately contribute to student learning. We request you share the results of your work with your colleagues at statewide peer group meetings, national conferences, articles published in *Inquiry: The Journal of the Virginia Community Colleges*, and other venues. We also ask you to promote your findings systematically through your college.

Please complete the enclosed acceptance sheet by:

- Obtaining the necessary signatures,
- Scanning the acceptance sheet into a PDF format, and
- Emailing the PDF document to Nancy Harris by **December 15, 2019**. Your online final grant report will be due by **August 15, 2020**. If you apply for another professional development/mini-grant award in the future, you may be asked to attach a summary of your final grant report to your proposal.

The next proposal deadline is February 1, 2020 for the summer 2020 period. For more information go to <http://www.vccs.edu/careers/office-of-professional-development/opd-grants-program/>. Should you have any questions, feel free to contact me or your college's representative to the VCCS Professional Development Committee. If you need to communicate with us regarding this proposal be sure to include the entire application number (i.e., S2020-620P-PF).

Thank you for your proposal. It is your enthusiasm for teaching and learning that makes a difference to our students and communities.

Sincerely,



Laura J. Clark  
Assistant Vice Chancellor, Student Success and Professional Development  
Executive Director, Virginia's Student Success Center  
Virginia's Community Colleges

300 Arboretum Place, Suite 200  
Richmond, VA 23236  
(o): 804.819.1697

cc: Ted Raspiller, President, JTCC  
Yvonne Holzbach, College Business Office, JTCC  
Sharon Morrissey, Senior Vice Chancellor for Academic & Workforce Programs

**APPENDIX H**

**COLLABORATIVE INSTITUTIONAL TRAINING INITIATIVE  
PROGRAM RESEARCH CERTIFICATE**



Completion Date 27-Jun-2018  
Expiration Date 26-Jun-2022  
Record ID 27654815

This is to certify that:

**Nancy Leahy**

Has completed the following CITI Program course:

**Students Conducting No More Than Minimal Risk Research** (Curriculum Group)  
**Students Conducting No More Than Minimal Risk Research** (Course Learner Group)  
**1 - Stage 1** (Stage)

Under requirements set by:

**University of Northern Colorado**



Verify at [www.citiprogram.org/verify/?w8f172a7f-f03a-4ace-a111-3dfbeca02a34-27654815](http://www.citiprogram.org/verify/?w8f172a7f-f03a-4ace-a111-3dfbeca02a34-27654815)