Master’s Thesis

entitled

Predictors of Success in a Baccalaureate Respiratory Care Educational Program

by

Christa Turley

Submitted to the Graduate Faculty as partial fulfillment of the requirements for the

Masters of Education in Research and Measurement

__________________________
Noela A. Haughton, PhD

__________________________
Craig Black, PhD, RRT-NPS, FAARC

__________________________
Barry W. Scheuermann, PhD

__________________________
Dr. Amanda C. Bryant-Friedrich, rer.NAT, Dean
College of Graduate Studies

The University of Toledo
May 2017
An Abstract of

Predictors of Success in a Baccalaureate Respiratory Care Educational Program

by

Christa Turley

Submitted to the Graduate Faculty as partial fulfillment of the requirements for the

Masters of Education in Research and Measurement

This study examined the relationship between pre-requisite classes required for admission and success in developing critical thinking skills that can contribute to passing the Written Registered Respiratory Therapist (WRRT) credentialing examination on the first attempt. **PURPOSE:** To determine if student performance in the pre-requisite classes required for admission into a Baccalaureate Respiratory Care Educational Program is related to their passing the WRRT credentialing examination on the first attempt. **METHODS:** The University of Toledo’s Registrar’s Office provided a list that included the number of A’s through F’s (including whether the grade was a plus or minus) awarded for each pre-requisite class (10 classes), for a particular academic year (2011-2013). In addition, WRRT examination scores for each participant were retrieved. A logistic regression analysis was conducted to assess the relationship between student performance in each of the pre-requisite classes (predictors) required for admission into a Baccalaureate Respiratory Care Educational Program and passing the WRRT credentialing examination on the first attempt (criterion). Because the outcome variable is dichotomous, this analysis can predict the probability that an observation falls into one of
two categories (pass or fail on the first attempt) on the basis of continuous variables (numeric value of the letter grade in each pre-requisite class). In addition, this analysis was used to predict the effect size a pre-requisite class had on passing the examination on the first attempt. Statistical significance was set at $p < 0.05$. **RESULTS:** Based on the Chi-Square, none of the pre-requisite classes were statistically significant in predicting first time pass rates on the examination, $\chi^2 (10, n=40) = 11.839, p>0.5$. No individual pre-requisite class was a stronger predictor of success on the WRRT credentialing examination compared to other classes. Furthermore, no individual student performance was a stronger predictor over and above another student’s performance when determining whether that individual would pass the exam on the first attempt. **CONCLUSION:** Even though the results of this study indicated no individual pre-requisite class as statistically significant in predicting first time pass rates on the WRRT credentialing examination Respiratory Care Educational Programs should continue to evaluate the relationship between grades and success on the examination. By continuing to analyze academic performance programs will be better prepared to select the most appropriate student for the admissions process in the hopes of becoming a respiratory therapist.
Acknowledgments

First I would like to thank my thesis committee, Noela Haughton, Barry Scheuermann, and Craig Black, for their ongoing support and advice during all aspects of my coursework. I’d also like to thank Zakaria Al Yousif for his outlook and suggestions towards completing my thesis.

Additionally, I would like to thank my family for encouraging me to continue on with my education. Without their love and willingness to adjust I would not have been able to complete this degree.

Finally, I would like to thank Clayton Chiarelott for his help in formatting this thesis.
# Table of Contents

Abstract .................................................................................................................................................. iv

Acknowledgements ............................................................................................................................... vi

Table of Contents ................................................................................................................................... vii

List of Tables .......................................................................................................................................... ix

Abbreviations ....................................................................................................................................... x

I. Introduction ........................................................................................................................................... 1
   A. Statement of Purpose ....................................................................................................................... 8
   B. Research Question .......................................................................................................................... 9

II. Literature Review ................................................................................................................................ 10
   A. Health Occupation Basic Entrance Exam .................................................................................. 10
   B. Traditional Measures of Admission ........................................................................................... 12
   C. Watson-Glaser Critical Thinking Appraisal .......................................................................... 15
   D. Math, Science, and English GPA .............................................................................................. 18
   E. Summary ....................................................................................................................................... 20

III. Methodology ...................................................................................................................................... 22
   A. Subjects ......................................................................................................................................... 22
   B. Instrumentation ............................................................................................................................. 23
      a. Math .......................................................................................................................................... 25
      b. Philosophy ................................................................................................................................. 25
      c. Health ...................................................................................................................................... 26
      d. Psychology ............................................................................................................................... 26
      e. Chemistry ................................................................................................................................. 26
      f. Kinesiology ............................................................................................................................... 27
   D. Study Design ............................................................................................................................... 28
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. Data Collection Procedures</td>
<td>30</td>
</tr>
<tr>
<td>F. Variables</td>
<td>32</td>
</tr>
<tr>
<td>G. Data Analysis Procedures</td>
<td>34</td>
</tr>
<tr>
<td>IV. Results</td>
<td>40</td>
</tr>
<tr>
<td>A. Demographics</td>
<td>41</td>
</tr>
<tr>
<td>B. Logistic Regression Analysis Results</td>
<td>44</td>
</tr>
<tr>
<td>a. Case Processing Summary</td>
<td>44</td>
</tr>
<tr>
<td>b. Dependent Variable Encoding</td>
<td>45</td>
</tr>
<tr>
<td>c. Omnibus Tests of Model Coefficients</td>
<td>45</td>
</tr>
<tr>
<td>d. Model Summary</td>
<td>46</td>
</tr>
<tr>
<td>e. Hosmer and Lemeshow Test</td>
<td>47</td>
</tr>
<tr>
<td>f. Variables in Equation</td>
<td>47</td>
</tr>
<tr>
<td>C. Summary</td>
<td>50</td>
</tr>
<tr>
<td>V. Conclusion</td>
<td>51</td>
</tr>
<tr>
<td>A. Pre-requisite Courses</td>
<td>51</td>
</tr>
<tr>
<td>B. Limitations</td>
<td>52</td>
</tr>
<tr>
<td>C. Discussion</td>
<td>55</td>
</tr>
<tr>
<td>D. Program Clinical Implication</td>
<td>57</td>
</tr>
<tr>
<td>E. Recommendations</td>
<td>60</td>
</tr>
<tr>
<td>D. Conclusion</td>
<td>61</td>
</tr>
<tr>
<td>References</td>
<td>63</td>
</tr>
<tr>
<td>Appendix</td>
<td>68</td>
</tr>
</tbody>
</table>
List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 3.1</td>
<td>The University of Toledo’s 10 Pre-Requisite Course Descriptions</td>
<td>26</td>
</tr>
<tr>
<td>Table 4.1</td>
<td>Descriptive Statistics</td>
<td>43</td>
</tr>
<tr>
<td>Table 4.2</td>
<td>Case Processing Summary</td>
<td>44</td>
</tr>
<tr>
<td>Table 4.3</td>
<td>Dependent Variable Encoding</td>
<td>45</td>
</tr>
<tr>
<td>Table 4.4</td>
<td>Omnibus Tests of Model Coefficients</td>
<td>45</td>
</tr>
<tr>
<td>Table 4.5</td>
<td>Model Summary</td>
<td>46</td>
</tr>
<tr>
<td>Table 4.6</td>
<td>Hosmer and Lemeshow Test</td>
<td>47</td>
</tr>
<tr>
<td>Table 4.7</td>
<td>Variables in Equation</td>
<td>48</td>
</tr>
</tbody>
</table>
Abbreviations

APA..........................American Philosophical Association
CHEM..........................Chemistry
CoARC..........................Commission on Accreditation for Respiratory Care
CRT..........................Certified Respiratory Therapist
CumGPA..........................Cumulative entering GPA
FERPA..........................Family Educational Rights and Privacy Act
GPA..........................Grade Point Average
HEAL..........................Health
HOBET..........................Health Occupation Basic Entrance Exam
IRB..........................Institutional Review Board
KINE..........................Kinesiology
LL..........................Log Likelihood
NBRC..........................National Board for Respiratory Care
NSciGPA..........................Non-science GPA
PHIL..........................Philosophy
PSY..........................Psychology
RT GPA..........................Respiratory Therapy GPA
RRT..........................Registered Respiratory Therapist
SciGPA..........................Science GPA
THGPA..........................High school GPA
VIF..........................Variance Inflation Factors
WGCTA-S..........................Watson-Glaser Critical Thinking Appraisal Score
WRRT..........................Written Registered Respiratory Therapist
Critical thinking is important in major professions because it is not a single way of thinking, but a complex, multidimensional cognitive process dependent on reflective thought and tolerance for ambiguity essential for decision making (Jones & Brown, 1991). The importance of fostering critical thinking skills within an educational framework is discussed and endorsed in medical literature; however, there is no universally accepted definition of critical thinking. For example, Scriven and Paul (2013) defined critical thinking as the mental process and subtle perception, analysis, synthesis, and evaluation of information collected or derived from observation, experience, reflection, reasoning, or the communication leading to conviction of action. Huit (1998) described critical thinking as the disciplined mental activity of evaluating arguments or propositions and making judgments that can guide the development of beliefs and actions steps. In a Delphi research report of the American Philosophical Association, Facione (1990) defined critical thinking as purposeful, self-regulatory judgment that uses cognitive tools such as interpretation, analysis, evaluation, inference, and explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations on which judgment is based. Scheffer and Rubenfeld (1996) further expanded on Facione’s definition of critical thinking for nurses as an essential component of professional accountability and quality nursing care. Critical thinkers in nursing exhibit these habits of mind: confidence, contextual perspective, creativity, flexibility, inquisitiveness, intellectual integrity, intuition, open-mindedness, perseverance, and reflection. Critical thinkers in nursing
practice the cognitive skills of analyzing, applying standards, discriminating, information seeking, logical reasoning, predicting, and transforming knowledge.

(p. 357)

Furthermore, critical thinking applies to nurses, as they have diverse multifaceted knowledge to handle various situations encountered during their shifts while faced with constant stress in an environment of changing conditions. They must make important decisions using critical thinking to collect and interpret information that are necessary for making a decision (Papathanassiou et al. 2014). Therefore, because a healthcare setting is a fast-paced, ever-changing environment that requires professionals to make quick decisions in order for a patient to survive, a healthcare worker has to have well-defined, adaptable critical thinking skills.

In the field of respiratory care Mishoe (2003) suggests that critical thinking involves the ability to prioritize, anticipate, troubleshoot, communicate, negotiate, make individual, shared, and consultative decisions, negotiate responsibilities, and medical orders for patient care, and reflect on the patients, the decisions, and the profession. These characteristics are not only important when working in a clinical setting, but are objectively tested as part of the written registered respiratory therapist (WRRT) credentialing examination.

As stated on the website for the National Board for Respiratory Care (NBRC) (2017),

the written examination associated with the RRT was developed to objectively measure essential knowledge, skills, and abilities required of advanced respiratory therapists, and to set uniform standards for measuring such knowledge. The
examination consists of 140-multiple-choice questions distributed among three major content areas: patient data evaluation and recommendations, troubleshooting and quality control of equipment and infection control, and initiation and modification of interventions. Thus, many of the characteristics Mishoe used to describe the process of critical thinking in respiratory care are included in the WRRT credentialing examination.

Upon graduating from a Respiratory Care Educational Program, graduates must pass both the credentialing examination and a clinical simulation exam in order to in order to obtain the registered respiratory therapist (RRT) credential. An outline of the critical thinking skills covered on the WRRT exam is provided to programs and students by the NBRC (2017). These elements include performing procedures to gather clinical information, evaluating data and procedure results in the patient record, recommending additional diagnostic procedures to gather supplementary information, assembling and troubleshooting equipment, and initiating and modifying interventions to the respiratory care plan. These elements of critical thinking tested on the WRRT credentialing examination are considered necessary skills for practicing therapist (Mishoe, 2003). Thus, it is imperative that programs prepare graduates to engage in critical thinking skills so they can pass the examination however, the national pass rate is low.

The pass rate for the WRRT is relatively low considering its importance. Data from the NBRC indicate that over a three-year academic span (2011–2013) approximately 67% of graduates (nationally) successfully passed their WRRT credentialing examination on the first attempt (NBRC, 2015a). This is a concern because the Commission on Accreditation for Respiratory Care (CoARC) requires Respiratory
Care Educational Programs meet a minimum outcome threshold regarding RRT credentialing. This threshold requires that 80% of the total number of graduates obtain the RRT credential during a three-year average (CoARC website, 2017). If pass rates on the examination continue to remain low, this could affect a program’s ability to maintain the RRT credential threshold which in turn could influence accreditation for a program. Furthermore, as a result of failing the examination, graduates are unable to achieve RRT credential in a timely manner and frequently are unable to obtain work as respiratory therapists immediately following graduation. Although there is no evidence in the literature suggesting that poor pass rates automatically contribute to hospital staffing issues, this is a problem presently as the demand for respiratory therapist is increasing (Ari et al., 2008). For that reason, it is essential that Respiratory Care Educational Programs produce graduates who are able to engage in critical thinking abilities in the hope that national pass rates on the WRRT credentialing examination improve.

Employers seek out therapists who have the ability to evaluate, analyze, make and reflect on decisions, and then are able to communicate those decisions to others (Mishoe, 2003). According to an online survey, It Takes More Than a Major: Employer Priorities for College Learning and Student Success, nearly all 318 employers surveyed (93%) said that “a demonstrated capacity to think critically, communicate clearly and solve complex problems is more important than (a candidate’s) undergraduate major” (p. 1). In addition, the survey results suggest that employers believe universities should place more emphasis on critical thinking and analytical reasoning (82% more emphasis), complex problem-solving and analysis (81% more emphasis), and oral communication (80% more emphasis) (p. 8). Thus, universities need to review curriculums in order to determine an
optimal educational format, which will allow and promote student learning and engagement in critical thinking skills. This curriculum review should include both Associate Degree and Baccalaureate Respiratory Care Educational Programs.

A significant challenge for the 61 (Commission on Accreditation for Respiratory Care (CoARC), 2017) Baccalaureate Respiratory Care Educational Programs in the United States is to produce graduates who can engage in critical thinking abilities. David Shelledy illustrated this in the CoARC presentation, Critical Diagnostic Thinking in Respiratory Care, at the 2012 American Association of Respiratory Care International Congress (CoARC, 2012). Shelledy suggests that educational programs need to produce graduates who are able to assess, diagnosis, and treat patient illnesses. Furthermore, critical thinking skills will enable respiratory therapist to select, apply, evaluate, and troubleshoot equipment within the clinical setting. Therefore, it is in the interest of Baccalaureate Respiratory Care Educational Programs to select candidates who are able to engage in the process of critical thinking so that they are able to treat patients in a healthcare setting and pass the WRRT credentialing examination.

Although curriculum structure in a Baccalaureate Respiratory Care Educational Program is typically uniform from program to program, limited research has been conducted to explore if one possible explanation for the low national pass rate on the WRRT credentialing examination is because of insufficient standardized admissions criteria. For example, Sperle (2013) examined the lack of a standard set of admissions criteria that could affect the students’ ability to succeed in the program both academically and clinically. While Ari et al. (2008) examined the relationship of selected admissions criteria to student performance on the NBRC examinations. Because limited research has
been conducted on the fitness of admission criteria, programs are dependent on the Commission on Accreditation for Respiratory Care (CoARC) Standards 2010 Guidelines to guide them with admissions criteria.

CoARC governs most aspects of respiratory care education; however, they only provide general guidelines for the admissions process. As stated in the CoARC Standards 2010 Guidelines, “admission of students must be made in accordance with clearly defined and published practices of the institution and program and should include the academic catalog and other published materials, admission pre-requisites and rationale, and admission policies and procedures, including minimal technical standards” (p. 28). These guidelines allow each program to define and provide rationale for its own admissions process and set its own pre-requisite requirements. As a result, programs may differ in the number of pre-requisite classes required for admission as well as what grade in those pre-requisite classes is sufficient for admission, and at what grade level (freshman, sophomore, junior or senior) a student can be accepted into a program.

There are five Baccalaureate Respiratory Care Educational Programs in The State of Ohio. Upon reviewing the pre-requisites for each program’s admissions criteria, all required math, science, and English classes; however, dissimilarities between academic institutions exist. For example, at The Ohio State University’s Respiratory Care Program, two physic classes are required for admission while the other four baccalaureate programs require none. In addition, the course level and the number of pre-requisite classes required for admission (science, English, math) differ for all five programs. Because of this variability in pre-requisite classes required for admission, it can be difficult for programs to determine which, if any, pre-requisite classes contribute to
students’ ability to develop critical thinking skills. Thus, is there a relationship between pre-requisite classes required for admission and success in developing critical thinking skills that can contribute to passing the WRRT credentialing examination on the first attempt?

Even though research has been done to evaluate various predictors of success on the credentialing exam, limited research has been found that assessed whether any of the pre-requisite classes, when evaluated separately, could help predict student development of critical thinking skills that are essential for their passing of the WRRT credentialing examination on the first attempt. For example, Wettstein, Wilkins, Gardner, and Restrepo (2011) examined the relationship between the Watson-Glaser Critical Thinking Appraisal score (WGCTA-S) and student performance on the clinical simulation component of the national credentialing examination. The results showed no significant relationship between critical thinking score and the information-gathering portion of the examination ($p = 0.61$) or critical thinking score and the decision making score of the examination ($p = 0.56$). A more recent study by Sperle (2013) examined the role the pre-requisite GPA, English GPA, math GPA, and science GPA for admission into the program in determining student success in the professional phase of a baccalaureate respiratory therapy program as measured by respiratory therapy (RT) GPA, clinical GPA and national credentialing examination scores. The results indicated that the greatest predictor for success was science GPA ($r = 0.60, p = 0.000$). In addition, a moderate correlation was found between RT GPA and CRT examination scores ($r = 0.680, p = .000$), RT GPA and WRRT examination scores ($r = .588, p = .000$) and clinical GPA and WRRT examination scores ($r = .589, p = .000$). Because there is limited research on
individual pre-requisite classes required for admissions into a Baccalaureate Respiratory Care Educational Program, which could help predict student development of critical thinking skills, additional research is needed to further explore the value of traditional measures used for admissions criteria.

Typically, programs rely on traditional measures, overall pre-program GPA, math GPA, and science GPA, when evaluating students for admission into a program (Sperle, 2013). While these traditional measures provide some guidance to Respiratory Care Educational Programs on selecting a student who has the highest probability of passing the national credentialing examination (Ari et al. 2008), faculty are still uncertain about whether individual pre-requisite classes best predict passing the WRRT examination on the first attempt. Through this evaluation process, it could expose that a particular pre-requisite class may improve students’ ability to develop critical thinking skills over and above other pre-requisite classes required for admission. Furthermore, it may uncover that the particular pre-requisite class that promotes critical thinking skills is neither a math nor science class, which are the traditional measures used for admissions criteria. Thus, it is imperative to evaluate pre-requisite classes individually instead of a grouping them together. The information gained through this evaluation may assist in selecting future candidates for admission into a Baccalaureate Respiratory Care Educational Program who have the best chance to pass the WRRT credentialing examination on the first attempt.

**Statement of Purpose**

The purpose of this study is to determine if student performance in the pre-requisite classes required for admission into a Baccalaureate Respiratory Care Educational
Program is related to their passing the WRRT credentialing examination on the first attempt. The latter will be used as a proxy indicator of the successful development of critical thinking skills by a student. The pre-requisite classes examined in this study will include Math (Math 1320), Philosophy (PHIL 3370), Psychology (PSY 1010), Health (HEAL 1800), and Science (KINE 2460, KINE 2560, KINE 2470, KINE 2570, KINE 2590, CHEM 1120).

**Research Question**

The following major research question is addressed: Is there a relationship between student performance in each of the pre-requisite classes required for admission into a Baccalaureate Respiratory Care Educational Program and passing the WRRT credentialing examination on the first attempt?

This research question is further divided into the following five minor research questions:

1. Is there a relationship between student performance in Math 1320 and passing the WRRT credentialing examination on the first attempt?
2. Is there a relationship between student performance in Philosophy (PHIL 3370) and passing the WRRT credentialing examination on the first attempt?
3. Is there a relationship between student performance in Health (HEAL 1800) and passing the WRRT credentialing examination on the first attempt?
4. Is there a relationship between student performance in science (KINE 2460, KINE 2560, KINE 2470, KINE 2570, KINE 2590, CHEM 1120) and passing the WRRT credentialing examination on the first attempt?
5. Is there a relationship between student performance in Psychology (PSY 1010) and passing the WRRT credentialing examination on the first attempt?

Chapter 2
LITERATURE REVIEW

Because CoARC provides only general guidelines for the admissions process, Respiratory Care Educational Programs are continuously searching for which factors are more likely to correlate with success on the national credentialing examination (Sperle, 2013). Predictors of academic success and admissions criteria have traditionally consisted of cognitive measures such as pre-admission GPA and GPA in selected courses such as math and science. However, research has also looked at other predictors of success on the national credentialing examination, such as percent scores on reading comprehension and essential math skills from the Health Occupation Basic Entrance Exam (HOBET), GPA at high school graduation, exit GPA from the program, and the Watson-Glaser Critical Thinking Appraisal score (WGCTA-S). In the present paper, student performance in each pre-requisite class will be examined to determine if it is related to their passing of the WRRT credentialing examination on the first attempt. The following five literature reviews illustrate what has been studied regarding predictors of success on the national credentialing examination and the reasons why a new direction in this topic needs to be examined.

Health Occupation Basic Entrance Exam

In the research article by Gardenhire and Restrepo (2003), the study’s purpose was to explore whether correlations existed between multiple variables, student scores on the Health Occupation Basic Entrance Exam (HOBET) and program completion in an
associate degree respiratory care program. Thus, the research question addressed whether there was a correlation between multiple variables (students’ high school GPA and students’ scores on the Health Occupation Basic Entrance Exam (HOBET) and success on the national credentialing examination. The HOBET evaluates critical reading abilities, basic mathematic skills, comprehension in reading college level material, and identifies student-learning approaches (Gardenhire & Restrepo, 2003). The respiratory care program used in this study requires that students take the HOBET as part of pre-admissions criteria. Gardenhire and Restrepo (2003) noted that the results will assist, “respiratory care programs in deciding whether to implement, terminate or continue using the HOBET as an entrance tool” (p. 23).

The sample consisted of 42 students, from the academic years 1996 to 1999, who took the HOBET and had been accepted into the program. After students graduated from the program, they sat for the national credentialing examination and scores from that test were used in the study. The study’s independent variables are high school GPA (THGPA) and the HOBET score while the national credentialing examination score is the criterion variable. The results showed no significant correlation between THGPA and the national credentialing examination score ($r = .12, p > 0.1$). In addition, there was a moderate ($r = .30$), although not statistically significant association between the HOBET reading score, HOBET composite, and the national credentialing examination score (Gardenhire & Restrepo, 2003).

Several limitations are associated with this study. For example, the results of the study can only be generalized to this group of students and not to other respiratory care educational programs because of this program’s specific requirement of taking the
HOBET as part of the admissions criteria. If other programs require students to take the HOBET as part of the admissions criteria then limited generalizations can be made. Gardenhire and Restrepo (2003) never mentioned how many attempts it took the student to pass the credentialing examination. This is an important element when determining success in a program. As part of the CoARC accreditation process, Respiratory Care Educational Programs have to document the number of attempts it takes a student to pass the examination. The relationship between the number of attempts on the credentialing examination and THGPA and HOBET could provide better insight into whether these variables are predictors of success. The authors concluded that the program should continue to use THGPA and the HOBET for admissions criteria. However, with no significant correlation between THGPA and national credentialing examination score and a moderate ($r = .30$), although not statistically significant association between the HOBET reading score, HOBET composite, and the national credentialing examination score, why would this program continue to use these variables as criteria for admission? Based on these results, it stresses the importance of evaluating other predictors of success in order for programs to select the best students for admission who can pass the WRRT credentialing examination on the first attempt.

**Traditional Measures of Admission**

A study by Ari, Goodfellow, and Gardenhire (2008) evaluated which admissions criteria are valid predictors of student performance on the NBRC exams. These authors highlighted that, “the precise relationship of selected admission criteria to student performance on the NBRC examination was lacking” (p. 2). Thus, the objective of the study was to develop a model that predicts student performance on the written registered
respiratory therapy examination (WRRT) by analyzing three admissions criteria: science GPA (SciGPA), non-science GPA (NSciGPA), and cumulative entering GPA (CumGPA). From the study’s purpose, three research questions were formulated by Ari et al. (2008). First, what is the relationship between admissions criteria, including SciGPA, NSciGPA, and CumGPA, and student success on the Certified Respiratory Therapist (CRT) and WRRT examinations? Secondly, to what extent does admissions criteria predict student performance on the CRT and the WRRT examination? Thirdly, to what extent do students’ exit GPA and students’ scores on the CRT predict student success on the WRRT examination?

The sample consisted of 375 students admitted to a four-year Respiratory Care Educational Program between the academic years 1995 to 2005 at a southeastern university. The independent variables include SciGPA, NSciGPA, CumGPA, and Exit GPA. SciGPA was calculated based on the science pre-requisite classes: biology, physics, mathematics, and chemistry. While the NSciGPA was computed from all other pre-requisite classes required for admission that were not included in calculation of SciGPA (Ari et al. 2008). CumGPA was calculated prior to the student entering the Respiratory Care Educational Program and refers to the overall entering GPA. Exit GPA signifies the student GPA upon graduating from the university. The criterion variables include CRT and WRRT examination scores on the first attempt. The examination scores were obtained from the NBRC.

For the first research question, the relationship between admissions criteria, including SciGPA, NSciGPA, and CumGPA, and student success on the CRT and WRRT examinations, Ari et al. (2008) reported a positive relationship between student
scores on the CRT and WRRT ($p < 0.05$) and admissions criteria (SciGPA, NSciGPA, and CumGPA). With SciGPA having the strongest correlation with WRRT scores, $r = .420$, $p = .000$. In regards to the second research question, to what extent does admissions criteria predict student performance on the CRT and the WRRT examination, two separate multiple regression analyses were performed to understand the extent to which admissions criteria predict student performance on the CRT and WRRT examination on the first attempt (Ari et al. 2008). The regression analysis for CRT scores resulted in an overall $R = 0.673$, $R^2 = 0.452$, adjusted $R^2 = 0.422$ ($p < 0.01$), and indicated that SciGPA ($p = 0.001$) and CumGPA ($p = 0.039$) were the best predictors of student success on the CRT exam. Ari et al (2008) noted that 45% of the variance in CRT examination scores were accounted for by SciGPA and CumGPA. However, the multiple regression analysis for WRRT scores indicated no single admissions criterion as predictive on examination performance ($p > 0.05$). Finally, for the third research question, to what extent does students’ exit GPA and students’ score on the CRT predict student success on the WRRT, 40% of the variance in student success on the WRRT was accounted for by exit GPA and scores on the CRT exam ($R = 0.653$, $R^2 = 0.404$, adjusted $R^2 = 0.362$, and $p < 0.01$). None of the individual admissions criteria predicted student performance on the WRRT examination (Ari et al., 2008).

Limitations to this study by Ari et al. (2008) include the possibility that some of the subjects may have transferred into the four-year university setting. Therefore, some of the pre-requisite classes required for admission may have been taken at other academic institutions (2-year community colleges or online). This may have influenced the calculation of the students’ SciGPA, NSciGPA, and CumGPA, which could have affected
the relationship between variables. In addition, it is interesting that the researchers included mathematic grades into the calculation of SciGPA. With the addition of mathematic grades into SciGPA, this may have affected the relationship between variables. While an interesting fact was presented in this study, 40% of the variance for student success on the WRRT was accounted for by the exit GPA and scores on the CRT exam, this information does not assist programs when selecting the right student for admission. Exit GPA and scores on CRT examinations are determined at the conclusion of program enrollment; therefore their criterion is of no use in pinpointing the precise relationship of select admissions criteria to student performance on the WRRT credentialing examination. Thus, it is essential that other predictors of success be evaluated to determine which pre-admission factors are more likely to correlate with success on the WRRT credentialing examination.

**Watson-Glaser Critical Thinking Appraisal**

Another study to evaluate a particular predictor of success on the national credentialing examination was conducted by Wettstein, Wilkins, Gardner, and Restrepo (2011). They noted that critical thinking has been used as a single predictor of success of board examination performance in healthcare professions and has been proposed as a measure of teaching effectiveness (p. 284). Thus, Wettstein et al. (2011) designed their study to identify which factors predict critical thinking in respiratory care students of a baccalaureate respiratory care program, and to determine if critical-thinking scores predict student performance on the clinical-simulation component of the national respiratory care board examination. Wettstein et al. (2011) formulated two research questions. First, do students with stronger science-course background have more
advanced critical-thinking skills? Secondly, does the Watson-Glaser Critical Thinking Appraisal score (WGCTA-S) correlate with student performance on the clinical simulation component of the NBRC examination?

Wettstein et al. (2011) provided an extensive explanation regarding the components of the WGCTA. The WGCTA includes 40 multiple-choice items and five scenarios in which the test taker is asked to judge the potential conclusions to the presented data. The scenarios provide scores (ranging from 0 to 40) for five subtests. These five subtests include: inference, recognition of assumptions, deductions, interpretation, and evaluation of arguments. Inference requires the student to discriminate among degrees of truth or falsity when evaluating data. Recognition of assumptions involves recognizing unstated assumptions or presuppositions in given statements or assertions. The deduction portion of the subtest has the student determining whether certain conclusions necessarily follow from information in given statements or premises. Interpretation requires weighing evidence and deciding if generalizations or conclusions based on the given data are warranted. Finally, evaluation of arguments requires distinguishing between arguments that are strong and relevant and those that are weak or irrelevant to a particular question at issue. This particular baccalaureate program administered the WGCTA during spring semester of the students’ senior year prior to the taking the national credentialing examination. The WGCTA was administered in a classroom setting and no time limit was set. Nevertheless, Wettstein et al. (2011) reported that most subjects completed the WGCTA in less than 40 minutes.

The sample included 46 subjects from three cohort classes: 2004, 2005, and 2006 who completed a bachelor’s of science degree in respiratory care at a southwestern
university. Subjects were de-identified by removing their names from academic transcripts and examination results from the NBRC database. Thus, subjects were assigned a new identification number (1–46). Science-course background was determined from each transcript by identifying course designations for biology, chemistry, biochemistry, anatomy, physiology, physics, and microbiology that were in addition to the program pre-requisite science courses. The pre-requisite science courses included anatomy and physiology I and II with labs, general chemistry with lab, general physics with lab, and microbiology with lab (Wettstein et al. 2011). In addition, the subjects took the national credentialing examination within six months of the WGCTA. Passing score for the clinical simulation component of the examination was based on the “minimal passing level” established by the NBRC (Wettstein et al. 2011).

Wettstein et al. (2011) reported no significant relationship between the WGCTA score and the information-gathering portion of the examination ($p = 0.61$) or critical thinking score and the decision making score of the examination ($p = 0.56$). However, Chi-square analysis showed a significant relationship between strong science course background and critical-thinking score; chi-square value of 4.22 ($p = 0.04$). Thus, it was concluded that students with above-average critical-thinking were 4.3 times more likely to have a strong science background (Wettstein et al. 2011).

Limitations to this study include the use of the WGCTA. Upon reviewing curriculum structure for the five Baccalaureate Respiratory Care Educational Programs in the State of Ohio, none indicated the use of this measurement tool to evaluate critical thinking abilities for their students. Although the WCGTA may be considered the standard test for critical-thinking ability, it may not be the best way to measure critical
thinking in healthcare professions (Wettstein et al. 2011). Thus, evaluating other predictors of success on the WRRT credentialing examination needs to occur.

**Math, Science, and English GPA**

A more recent study by Sperle (2013) explored the relationship between program admissions criteria and success in the professional phase of a baccalaureate respiratory therapy program. In her 2013 publication, Sperle pointed out,

No standard admissions criteria have been adopted by CoARC. This lack of a standard set of admissions criteria can result in the admission of students unable to succeed in the program both academically and clinically. Providing admissions committees (CoARC) with sound guidelines may ensure that only those students most likely to succeed in the program and pass licensure examinations would be admitted. (p. 29).

Therefore, the purpose of this study was to explore the relationship between GPA in select admissions criteria and success in the professional phase of a baccalaureate respiratory therapy program as measured by respiratory therapy program (RT) GPA, clinical GPA, and national credentialing examination scores (Sperle, 2013). Sperle (2013) purposed two research questions. First, is there a significant correlation between program admissions criteria and success in the professional phase of a baccalaureate respiratory therapy program? Secondly, which program admissions criteria are the best predictors of success in the professional phase of a baccalaureate respiratory therapy program?

Data was collected from 52 graduates of a four-year baccalaureate program over the academic years 2003–2009. All information was gathered from student academic
transcripts (final grades) and the NBRC website (national credentialing examination scores). Pre-requisite GPA, English GPA, and math GPA was calculated for each student based on the academic transcript. Science GPA was determined by averaging final grades in two semesters of an introductory sequence of chemistry, two semesters of human anatomy and physiology, and one semester of physics. If a student took a course more than once, the final grades in both attempts were averaged together (Sperle, 2013). Cumulative RT GPA (GPA in all respiratory therapy courses including clinical courses) and clinical GPA (GPA in all respiratory therapy clinical courses) was determined for each student based on existing records maintained by the program (Sperle, 2013). The independent variables include pre-requisite GPA, math GPA, and science GPA. While the dependent variables are cumulative RT GPA, clinical GPA, CRT and WRRT examination scores on the first attempt.

Sperle (2013) reported that based on the Pearson’s $r$ correlation, the greatest predictor of success on the WRRT was science GPA, $r = .60$, $p = .000$. In addition, a moderate correlation between RT GPA and CRT examination score, $r = .680$, $p = .000$ and RT GPA and WRRT examination score, $r = .588$, $p = .000$ was noted (Sperle, 2013). Finally, in regards to other independent variables, pre-requisite GPA, math GPA, and English GPA, pre-requisite GPA had the strongest correlation with WRRT examination scores, $r = .545$, $p = 0.000$. English GPA and math GPA showed weak correlations with WRTT examination scores, ($r = .205$, $p = .143$; $r = .332$, $p = .045$).

While the results of this study highlighted that English and math GPA are not valid predictors of success on the WRRT credentialing examination, the study did indicate that science GPA is a valuable predictor of success on the exam. Since most
science pre-requisite classes (anatomy, physics, and chemistry) are indicative of a student’s problem-solving ability (Shelledy and LeGrand, 1999) and the profession of respiratory care requires therapists to engage in critical thinking Sperle thought it might be interesting to further expand on the idea of science GPA. She wrote,

> It may be advantageous to consider not only overall science GPA but also the GPA of individual science courses. This information may be beneficial in assessing the ability of an applicant to succeed in the professional phase of a baccalaureate respiratory therapy program from both an academic and clinical perspective. (p. 33)

**Summary**

Collectively, previous studies have provided some insight for admissions criteria into Respiratory Care Educational Programs however, limitations were noted in the methodology. For example, in the study conducted by Wettstein et al. (2011), the predictor evaluated, WGCTA-S, is currently not used in any of the five Baccalaureate Respiratory Care Educational Programs in the State of Ohio. While Ari et al. (2008) included mathematic grades into the calculation of SciGPA thus possibly affecting the relationship between SciGPA and scores on the WRRT credentialing examination.

Furthermore, all five studies reviewed used different predictors of success and none showed a strong correlation between a particular predictor and passing the examination on the first attempt. Finally, as Sperle (2013) noted in her conclusion the advantage of considering the grades of individual science courses in addition to overall science GPA.

Given the current literature, these studies as a whole are inconclusive in determining the best predictor of success for passing the WRRT credentialing
examination on the first attempt. Even though Sperle (2013) illustrated a moderate correlation between science GPA and success on the WRRT, it still raises questions on which science pre-requisite class is the best promoter of developing critical thinking skills. Because of this gap, it’s important to explore individual pre-requisite classes as possible predictors of success. The information gained through this exploration could further expand on the importance of science pre-requisite classes as predictors of success on the WRRT credentialing examination.

In order to gain a deeper understanding of academic predictors of success on the WRRT credentialing examination, it is necessary to conduct a study that evaluates individual pre-requisite classes and not the traditional measures (overall pre-program GPA, math GPA, and science GPA) for admissions criteria. By examining grades in individual classes, it could expose that a particular class may improve a student’s ability to develop critical thinking skills over and above other pre-requisite classes. In addition, it may reveal that traditional measures used for admissions criteria are not valid predictors of success on the WRRT examination. Therefore, the information gained through this evaluation would assist Baccalaureate Respiratory Care Educational Programs in selecting the right candidate for admission who has the best chance to pass the WRRT credentialing examination on the first attempt.
Chapter 3

METHODOLOGY

This chapter explains the methodological details of the study, including subjects, instrumentation, design, data collection procedures, and data analysis procedures. A correlational design was used for this study. Creswell (2011) defined a correlational design as a process in which the researcher explains relationships among variables. These methods were designed to answer the research question: is there a relationship between student performance in each of the pre-requisite classes required for admission into a Baccalaureate Respiratory Care Educational Program and passing the WRRT credentialing examination on the first attempt?

Subjects

For the current study design, the sample included 40 graduates across three cohorts (graduating class of 2011, 2012, and 2013) from one Baccalaureate Respiratory Care Educational Program at a Midwest State University. Of these 40 graduates, 10 were male and 30 were female. All graduates were granted admission into this particular Baccalaureate Respiratory Care Educational Program at the conclusion of their sophomore year (spring semester). In order to be granted admission into this program, applicants must have completed two requirements. First, the student is required to complete all pre-requisite classes which equates to 50 credit hours. Secondly, the student must have achieved at least a 2.8 overall GPA in those required pre-requisite classes. The purpose for selecting these three cohorts of graduates was to examine outcomes on the WRRT credentialing examination prior to the test being revised in 2014.
Instrumentation

Academic achievement as defined by CoARC (2017) requires Baccalaureate Respiratory Care Programs meet certain outcome thresholds. These outcome thresholds include: completing professional coursework once formally admitted into the program, successfully passing the WRRT credentialing examination, and acquisition of employment, utilizing skills within the scope of the respiratory care profession, within the three-year reporting period (CoARC, 2017). However, being able to predict students’ academic achievement depends on being able to assess it. Tertiary (i.e., undergraduate university students’ performance) is usually expressed in terms of grade point average (GPA), that is, the mean of marks from weighted courses contributing to assessment of the final degree. GPA is the key criterion for postgraduate selection and graduate employment is predictive of occupational status. As such, it is an index of performance directly relevant to training and employment opportunities (Richardson et al, 2012). Respiratory Care Educational Programs review students’ overall GPA as part of the admissions process. However, examining overall GPA should be viewed as only one component towards achieving academic success. Evaluation of individual pre-requisite course grades and descriptions needs to occur to determine whether or not the class helped prepare the student for academic achievement; i.e., passing the WRRT credentialing examination. Listed in Table 3.1 are the 10 pre-requisite course descriptions, as noted in The University of Toledo’s course description handbook, academic year 2011–2012, and whether the NBRC has course outlines for the required pre-requisite.
Table 3.1

*The University of Toledo’s 10 Pre-Requisite Course Descriptions*

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>NBRC Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math 1320</td>
<td>The study of elementary theory of equations and inequalities; functions and relations’ exponentials and logarithms; systems of equations and topics in analytic geometry.</td>
<td>Yes</td>
</tr>
<tr>
<td>Philosophy 3370</td>
<td>The application of ethics to the practice of medical professions. Topics include authority, paternalism, truth-telling, informed consent, health care reform, genetic manipulation, abortion, infanticide and euthanasia.</td>
<td>No</td>
</tr>
<tr>
<td>Health 1800</td>
<td>The study of the origin and structure of medical words, their prefixes, suffixes, special endings, and singular to pleural forms. These medical terms relate to the body and to clinical procedures.</td>
<td>No</td>
</tr>
<tr>
<td>Psychology 1010</td>
<td>A survey of the branches of psychology and the scientific approach to the study of behavior.</td>
<td>No</td>
</tr>
<tr>
<td>Chemistry 1210</td>
<td>A series of elementary courses oriented toward the life processes in plant and animals.</td>
<td>Yes</td>
</tr>
<tr>
<td>Kinesiology 2560</td>
<td>The study of the structure and function of the human body. This includes the study of cells, tissues, special senses, and the skeletal, muscle, and nervous system.</td>
<td>Yes</td>
</tr>
<tr>
<td>Kinesiology 2460</td>
<td>The laboratory component for Kinesiology 2560. The lab portion entails the histology, dissection identification, and physiology of the axial and appendicular skeletal system, the skeletal muscle system, the central and peripheral nervous system, tissues, the eye, and cell transport.</td>
<td>Yes</td>
</tr>
<tr>
<td>Kinesiology 2570</td>
<td>The analysis of the human endocrine, blood, cardiovascular, lymphatic, respiratory, digestive, urinary and electrolyte, and reproductive systems.</td>
<td>Yes</td>
</tr>
<tr>
<td>Kinesiology 2470</td>
<td>To perform lab exercises relating to the endocrine, cardiovascular, respiratory, digestive, lymphatic, urinary, and reproductive anatomy, histology, physiology, including computer assisted experiments.</td>
<td>Yes</td>
</tr>
<tr>
<td>Kinesiology 2590</td>
<td>Examining the structure and function of bacteria and viruses; antigen-antibody reactions, immunology, serology, growth and inhibition of microorganisms. In addition, the student will study the pathologic response to infection; pathogenesis and disease, principal infection diseases of man.</td>
<td>Yes</td>
</tr>
</tbody>
</table>
The NBRC Admissions Committee has designed generalized course outlines for the basic science and mathematics classes that should be included as part of the admissions process into a Respiratory Care Educational Program. These outlines provide guidelines towards achieving academic success as defined by the NBRC, passing the WRRT credentialing examination (NBRC, 2017). These course outlines recommend the content areas which should be covered in each of the basic sciences (anatomy, physiology, microbiology, chemistry, mathematics, and physics) (NBRC, 2017). However, the NBRC does not provide course outlines for other pre-requisites required for program admission such as Philosophy, Psychology and Health related curriculums.

Math

The NBRC recommends that programs include a remedial college level math course as part of the pre-requisite curriculum. The NBRC notes that the math course should include the following features: linear equations, word problems, inequalities, logarithms, and scientific and complex numbers (NBRC, 2017). Math 1320, required by this Respiratory Care Educational Program, includes the study of elementary theory of equations and inequalities; functions and relations’ exponentials and logarithms; systems of equations and topics in analytic geometry (The University of Toledo’s course description handbook, 2011–2012).

Philosophy

The University of Toledo’s course description of Philosophy 3370 is as follow, “the application of ethics to the practice of medical professions. Topics include authority, paternalism, truth-telling, informed consent, health care reform, genetic
manipulation, abortion, infanticide and euthanasia” (p. 1314). The NBRC has no course content guidelines regarding pre-requisite Philosophy courses.

Health

Health 1800 is the study of the origin and structure of medical words, their prefixes, suffixes, special endings, and singular to plural forms. These medical terms relate to the body and to clinical procedures (The University of Toledo course description handbook, 2011–2012). No course content guidelines are provided by the NBRC regarding this type of pre-requisite class.

Psychology

Only one psychology pre-requisite course is required for admission into this Baccalaureate Respiratory Care Educational Program. As noted in The University of Toledo’s course description handbook, psychology curriculum includes, “a survey of the branches of psychology and the scientific approach to the study of behavior” (p. 1444). No course content guidelines are provided by the NBRC regarding this type of pre-requisite class.

Chemistry

The NBRC recommends that pre-requisite chemistry curriculum include the following components, “principles of atomic theory: mole concept, elements, chemical calculations, ions, solutions, and acid-base theory (NBRC, 2017). While the course description for Chemistry 1210 (Chemistry for the Life Sciences I) includes the following, “a series of elementary courses oriented toward the life processes in plant and animals (The University of Toledo’s course description handbook, 2011–2012).
Kinesiology

The Kinesiology curriculum at The University of Toledo includes both lecture and laboratory coursework for its Anatomy and Physiology classes. In the interest of student academic growth, lecture and laboratory classes should be taken in the same semester. Furthermore, as part of the pre-requisite admissions process, students are required to take sequential kinesiology courses. The NBRC Admissions Committee supports this curriculum structure as noted by following statement, “human Anatomy & Physiology should include combined classes that emphasize respiratory physiology and pathophysiology” (NBRC, 2017).

The following course descriptions are listed in The University of Toledo’s course description handbook for the academic year 2011–2012. Kinesiology 2560 is the study of the structure and function of the human body. This includes the study of cells, tissues, special senses, and the skeletal, muscle, and nervous system. Kinesiology 2460 is the laboratory component for Kinesiology 2560. The lab portion entails the histology, dissection identification, and physiology of the axial and appendicular skeletal system, the skeletal muscle system, the central and peripheral nervous system, tissues, the eye, and cell transport.

After completing the first series of Kinesiology classes (KINE 2460 and 2560) students must then complete the second portion of the Kinesiology series (KINE 2570 and 2470) as part of the admissions process. Kinesiology 2570 includes the analysis of the human endocrine, blood, cardiovascular, lymphatic, respiratory, digestive, urinary and electrolyte, and reproductive systems. The laboratory portion (Kinesiology 2470) enables the student to perform lab exercises relating to the endocrine, cardiovascular,
respiratory, digestive, lymphatic, urinary, and reproductive anatomy, histology, physiology, including computer assisted experiments (The University of Toledo’s course description handbook, 2011–2012).

Kinesiology 2590 (Microbiology and Infectious Diseases) includes examining the structure and function of bacteria and viruses; antigen-antibody reactions, immunology, serology, growth and inhibition of microorganisms. In addition, the student will study the pathologic response to infection; pathogenesis and disease, principal infection diseases of man (The University of Toledo’s course description handbook, 2011–2012).
The NBRC Admissions Committee does provide course content guidelines regarding microbiology curriculum. These guidelines include, “principles of microbial life: cell structure, anatomy, metabolism, genetics, diseases transmission, principles of sterilization and disinfection, function of antibiotics with respect to microbial life, bacteriology, and immunology (NBRC, 2017).

**Study Design**

Based on the traditional classification of non-experimental designs, the most appropriate design to answer the research question is a correlational design. In correlational designs, according to Creswell (2011), “investigators … describe and measure the degree of association (or relationship) between 2 or more variables or sets of scores” and do not “control or manipulate the variables as done in an experiment; instead they relate, using the correlation statistic” (p. 338). In the current study, the researcher evaluated the relationship between student performance in each of the 10 pre-requisite classes required for admission into a Baccalaureate Respiratory Care Educational Program and passing the WRRT credentialing examination on the first attempt.
In addition, this study can be classified as a retrospective because the researcher looked backward in time. According to Johnson (2001), “researchers typically start with the dependent variable and move backward in time to locate information on independent variables that help explain current differences on the dependent variable” (p. 10). In this study, the researcher reviewed past student performance in each of the 10 pre-requisite classes required for admission into a Baccalaureate Respiratory Care Educational Program and WRRT credentialing examination scores. In other words, the researcher will look “back in time using existing data to explain or explore an existing occurrence” (Belli, 2009, p. 66). The researcher used existing data to evaluate which of the 10 pre-requisite classes was the best predictor of passing the WRRT credentialing examination on the first attempt.

The study design also includes ex post facto components. Kerlinger and Rint (1986) explained that in the context of social science research, an ex post facto investigation seeks to reveal possible relationships by observing an existing condition or state of affairs and searching back in time for plausible contributing factors. While, Ary Jacobs, and Sorensen (2014) described retroactive ex post facto research as seeking possible antecedent causes (independent variables) for a preexisting dependent variable. This study will attempt to explain if passing the WRRT credentialing examination on the first attempt is the result of student performance (grades) in the pre-requisite classes required for admission into a Baccalaureate Respiratory Care Educational Program. Thus, the researcher is attempting to determine the influence of a variable (student performance, i.e., grade) on another variable (passing the WRRT credentialing
examination on the first attempt). By analyzing data already collect, the investigator has no control over the events prior to the analysis.

**Data Collection Procedures**

According to the Institutional Review Board (IRB) Determination Flow Chart, approval was required for this study because the researcher “can link the data directly, or through a coding system to identifiable information about… individuals.” Furthermore, as noted in the IRB Guidance for Student Research and Class Projects, “IRB approval is required if human subjects are involved, either directly or through use of identifiable data about them, and the project involves a systematic investigation of individuals with an intent to develop generalizable new or expanded knowledge about living individuals.” In regards to consent, since the data collection method required the researcher to access and retrieve existing data, and no direct human contact was involved, informed consent was implied. Nevertheless, the researcher followed the regulations set forth by IRB regarding informed consent. As noted in the Ethical Standards for the Reporting and Publishing of Scientific Information, “before determining that planned research (such as research involving only anonymous questionnaires, naturalistic observations, or certain kinds of archival research) does not require the informed consent of research participants, psychologists consider applicable regulations and institutional review board requirements, and they consult with colleagues as appropriate” (p. 392).

Once IRB approval was obtained (exempt status), the researcher gathered factual information: participants’ grades in each of the 10 pre-requisite classes and WRRT credentialing examination scores. Due to the nature in which the information was gathered, retrospective retrieval of existing data, informed consent is not necessary.
However, since the study required acquisition of graduates’ transcripts, the researcher was prohibited to review grades for each participant because of the Family Educational Rights and Privacy Act (FERPA). According to the United States Department of Education (2015), FERPA is a federal law that protects the privacy of student educational records. The general rule is that educational records cannot be disclosed without written consent. Because the researcher was unable to locate each participant, thus preventing the acquisition of informed consent, the researcher was denied access to pre-requisite class grades. If the researcher had reviewed subjects’ grades without their consent, violation of the participants’ rights (FERPA) would have transpired.

Due to the constraints placed on the researcher, a formal request was submitted to The University of Toledo’s Registrar’s Office for a list of grades (number of A’s through F’s) for each of the 10 pre-requisite courses during the academic years 2011–2013. The university granted the researcher’s request and a list was provided which included the number of A’s through F’s (including whether the grade was a plus or minus) awarded for each pre-requisite class (10 classes), for a particular academic year (2011, 2012, or 2013). The information provided by The University of Toledo’s Registrar’s office included no personal identifiers thus, the researcher had no knowledge of individual grades for each participant.

In addition to student performance (grades) data, the study required acquisition of WRRT credentialing examination scores. In order to gather such data, an adjunct faculty member was granted access to the NBRC website database. Once the faculty member had identified a qualified participant (graduated from the program and took the WRRT credentialing examination with the academic years 2011–2013), examination scores were
printed out and de-identified using a coding system. The use of the coding system removed all personal identifiers (name, Social Security number, year the WRRT examination was taken, and home address) and a new identification number was assigned to each participant and placed on the WRRT examination results sheet. Thus, the ethical principle of protection from harm was adhered to by removing any personal identifiers.

**Variables**

The independent variables include student performance in each of the pre-requisite classes required for admission into a Baccalaureate Respiratory Care Educational Program. Student performance was measured as the final letter grade in each pre-requisite class. As such, each independent variable is categorical. Final grades were initially entered into the data spreadsheet as a letter grade (A, A-, B+, B, B-, C+, C, C-, D+, D, D-, F) but then re-coded into a numeric value (A = 4.0, A- = 3.67, B+ = 3.33, B = 3.0, B- = 2.67, C+ = 2.33, C = 2.00, C- = 1.67, D+ = 1.33, D = 1.00, D- = 0.67, F = 0.00).

The value of these grades is standard to the meaning of the letter grade. Without an accurate description of the grading system used for a particular pre-requisite class, there is no way of knowing the true measure of a student’s level of knowledge for that class. Therefore, these values are just numbers, not true representation of student intelligence.

As previously mentioned, grades were obtained for the following 10 pre-requisite classes: Math 1320, Kinesiology (KINE) 2460, Kinesiology (KINE) 2560, Health (HEAL) 1800, Philosophy (PSY) 1010, Kinesiology (KINE) 2470, Kinesiology (KINE) 2570, Chemistry (CHEM) 1120, Kinesiology (KINE) 2590, and Philosophy (PHIL) 3370.

The dependent variable is passing the national credentialing examination on the first attempt. The dependent variable was initially coded as an examination score.
Examination scores range from 0 to 140, with a score of 72 indicating passing. Once the scores were entered into the database, conversion of the score to pass/fail was completed (0 = no, the student did not pass the national credentialing examination on the first attempt or 1 = yes, the student passed the national credentialing examination on the first attempt). Thus, the dependent variable is categorical.

In order to record all variables (student performance in each of the pre-requisite classes and WRRT credentialing examination scores) an excel spreadsheet was created. Headings for each column include: pre-requisite course name (recording of letter grades for each participant in the 10 pre-requisite classes required for admission into the Baccalaureate Respiratory Care Educational Program) and WRRT examination score (first attempt only) (See Appendix). All measures were collected at the beginning of the study.

Data Analysis Procedures

To answer the research question, a logistic regression analysis was used. According to Hosmer et al. (2013) a logistic regression is used to find the best fitting and most parsimonious, clinically interpretable model to describe the relationship between an outcome (dependent or response) variable and a set of independent (predictor or explanatory) variables. The main feature that distinguishes this type of assessment from other forms of regression analysis is the use of a dichotomous dependent variable. Because the outcome variable is dichotomous, logistic regression can be used to predict the probability that an observation falls into one of two categories on the basis of a continuous, categorical, or a combination of independent variables. Furthermore, logistic
regression can determine the effect size the independent variables have on the dependent variable.

When using a logistic regression several assumptions should be met. First, the criterion variable must be measured on a dichotomous scale. For the current study, the criterion variable (yes, passed the WRRT credentialing examination on the first attempt and no, did not pass the WRRT credentialing examination on the first attempt) is dichotomous. Next, the analysis necessitates that there be more than one predictor and these variables can be either continuous, categorical or a combination. For this study, predictors are on a continuous scale (letter grades were re-coded into a numeric value for each of the 10 pre-requisite classes). Furthermore, a logistic regression requires that each predictor (student performance) be independent of another and not linear combinations of one another. Upon reviewing collinearity results none of the variance inflation factors (VIFs) had a value greater than three. Therefore, none of the predictors (letter grades in each of the 10 pre-requisite classes) were highly correlated with one another. Finally, Garson (2016) states the following about logistic regression assumptions, “independent variables should be measured without error, no extraneous variables should be added, and no significant variables should be omitted).

This type of regression analysis employs the use of logistic coefficients. Logistic coefficients are semi-partial coefficients. This means that they reflect the variation in the given predictor variable while controlling for other independent variables. Therefore, logistic coefficients reflect the unique contribution of a given predictor when explaining the total variance in the criterion (Garson, 2016). The researcher entered student performance (grades for all 10 pre-requisite classes) into the analysis however each pre-
requisite class was evaluated separately to determine its unique contribution to the criterion (passing the WRRT credentialing examination on the first attempt). Pre-requisite classes were not grouped together to evaluate their combined contribution towards passing the exam on the first attempt.

In order to assess model fit, the assumption is made that the variables included in the model should be there (nothing added or deleted) and that these variables have been entered in the correct form (Hosmer et al, 2013). Once these assumptions have been made the Omnibus Tests of Model Coefficients is used to assess whether the new model (which includes the predictors, i.e., grades) is an improvement over the baseline model (does not include the predictors, i.e., grades). Does the model which contains predictors (i.e., grades) inform more about the dependent variable (first time pass rates on the exam) than the model without predictors?

There are two hypotheses in relation to the overall fit of the model (Garson, 2016). The null proposes that there is no statistical significance between predictors and the criterion. With the null hypothesis, all coefficients in the regression equation take the value zero (Burns & Burns, 2009). While the alternative hypothesis states that the predictors did have a significant effect (Burns & Burns, 2009). The model with predictors differs significantly from the null of zero, i.e. gives significantly better than chance or random prediction level of the null hypothesis (Burns & Burns, 2009). In most cases, we want to reject the null, which signifies that there is a statistically significant relationship between some or all predictors and the criterion. For this study the null would be stated as none of the grades (student performance), when evaluated individually and as a group, in the 10 pre-requisite classes were statistically predictive for first time
pass rates on the WRRT credentialing exam. While the alternative would be stated as
individual grades (student performance) in the 10 pre-requisite classes did statistically
predict first time pass rates on the WRRT credentialing examination. To determine
which hypothesis is supported comparison of the observed values of the response variable
to those predicted by each of the two models (the first with, and the second without the
variable in question) needs to occur (Hosmer et al, 2013). When the model has a Chi-
square significance level greater than 0.5, it denotes that the relationship between the
predictors and criterion was not due to chance. That student performance is not
statistically predictive of first time pass rates on the WRRT credentialing examination.
However, if the Chi-square has a significance level less than .05, it suggest that the new
model is explaining more of the variance in the outcome due to the addition of the
independent variables; acceptance of the alternative hypothesis.

There are three different versions of the Omnibus Tests of Model Coefficients:
step, block, and model. The model row compares the new model (which includes the
predictors) to the baseline (does not contain predictors). For the current study, all
predictors were entered in one block thus only one step was needed. Again, if the
significance value is less than 0.05 in the model row, this denotes that the model
improved when predictors were added.

Hosmer, Lemeshow, and Sturdivant (2013) proposed grouping based on the
values of the estimated probabilities. This grouping is referred to as the Hosmer and
Lemeshow Test Goodness of Fit. The process requires dividing and grouping the sample
based on predicted probabilities. By grouping the sample (usually in 10 groups of near
equal size), it is to ensure that the predicted and observed frequencies closely match one
another, and the more closely they match, the better the fit. As a result of this grouping, a contingency table is produced in the analysis output. Within the contingency table, a chi-square statistic is computed comparing the observed frequencies with those expected under the linear model (Hosmer et al., 2013). A non-significant chi-square (p > 0.05) suggests that the model is a good fit to the data, the set predictors did accurately predict actual probabilities. The major limitation to the reliability of this test is when a small sample size is used. Hosmer et al. (2013) acknowledges this limitation by stating, “When a small sample is employed, the researcher may miss an important deviation when grouping the sample.” Because a small sample (n = 40) was used in the current study, placing too much importance on the results of this test could provide misleading information leading to a possible conclusion that would be invalid.

The Model Summary Table provides the -2 log likelihood (LL) and pseudo-R values for the full model. The -2LL measures how poorly the model predicts the decisions (Hosmer, et al, 2013). Thus, this statistic tests whether a set of independent variables improve the prediction of the criterion variable better than by chance (Hosmer et al, 2013). If the -2LL value in the model summary is less than the -2LL value in the omnibus test of model coefficients this indicates the new model (with the predictors) is significantly better than the null model. The Cox & Snell R-Square value approximates how much variation in the outcome is explained by the model. As Garson (2016) explained, “the Cox & Snell is an attempt to imitate the interpretation of multiple R-square based on the log likelihood of the final model vs. log likelihood for the baseline model, but its maximum can be (and usually is) less than 1.0, making it difficult to interpret.” While the Nagelkerke R-Square accounts for the variation in the outcome.
Garson (2016) explained Nagelkerke’s R-Square as a modification of the Cox and Snell coefficient. Therefore, Nagelkerke’s R² divides the Cox and Snell R² by its maximum in order to achieve a measure that ranges from zero to one. The general rule of thumb when assessing the value of Nagelkerke’s R² is to consider zero as weak, .3 to .6 as moderate, and .6 or higher as strong (Garson, 2016). Because both the Cox & Snell’s R-Square and Nagelkerke R-Square are pseudo-R –squares caution should be used when evaluating these values.

Finally, a logistic analysis focuses on the Wald statistic and the term odds ratio. The Wald statistic provides an index of the significance for each predictor in the equation (Burns & Burns, 2009). So, upon reviewing results in the Variables in the Equation Table, if the Wald statistic is less than 0.5 one would reject the null hypothesis, therefore, the independent variable (pre-requisite class) did make a significant prediction towards first time pass rates on the exam (criterion). However, if the Wald statistic is greater than 0.5, fail to reject the null hypothesis, the independent variable failed to make a significant prediction towards first time pass rates on the exam.

Garson (2016) explains odds ratio as, “the odds of an outcome occurring (increases or decreases) when there is a unit change in the associated explanatory variable” (p. 457). The rational for using a logistic regression was to predict passing the national credentialing examination on the first attempt based on student grades in each pre-requisite class. In another words, which pre-requisite class was more or less likely to predict passing the examination on the first attempt. By reviewing such output, the researcher could rank which pre-requisite class was a better predictor over and above
another class. Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 21.0 statistical software (IBM; Chicago, IL).
Chapter 4

RESULTS

Data from the NBRC indicates that over a three-year academic span (2011–2013) approximately 67% of graduates (nationally) successfully passed their WRRT credentialing examination on the first attempt (NBRC, 2015a). This is a concern because CoARC requires Respiratory Care Educational Programs meet a minimum outcome threshold regarding RRT credentialing. This threshold requires that 80% of the total number of graduates obtain the RRT credential during a three-year average (CoARC website, 2017). If pass rates on the examination continue to remain low, this could affect a program’s ability to maintain the RRT credential threshold which in turn could influence accreditation for a program. Because of this CoARC requirement Respiratory Care Educational Programs are continuously searching for which factors are more likely to correlate with success on the national credentialing examination (Sperle, 2013). Thus, the purpose of this study was to determine if student performance in the pre-requisite classes required for admission into a Baccalaureate Respiratory Care Educational Program is related to their passing the WRRT credentialing examination on the first attempt.

This chapter comprises the analysis, presentation, and interpretation of findings. To complete this study, data was analyzed to identify, describe, and explore the relationship between student performance in each of the pre-requisite classes required for admission into a Baccalaureate Respiratory Care Educational Program and passing the
WRRT credentialing examination on the first attempt. As indicated in the preceding chapter, data was analyzed using a logistic regression method.

**Demographics**

The demographics presented here are descriptive statistics and provide a background regarding the status and number of subjects included in the study. The sample included 40 graduates across three cohorts (graduating class of 2011, 2012, and 2013) from one Baccalaureate Respiratory Care Educational Program at a Midwest State University. Of these graduates, 10 were male and 30 were female. All participants meet the inclusion criteria of graduating from the Respiratory Care Educational Program and completing the WRRT credentialing examination within the academic years 2011–2013. The researcher was unaware of ethnic origin, age, or any other demographic information because of how the data was retrieved and coded.

The predictors included student performance (i.e., grades) in each of the 10 pre-requisite classes required for admission into the Baccalaureate Respiratory Care Educational Program. These classes include: Math 1320, Kinesiology (KINE) 2460, Kinesiology (KINE) 2560, Health (HEAL) 1800, Philosophy (PSY) 1010, Kinesiology (KINE) 2470, Kinesiology (KINE) 2570, Chemistry (CHEM) 1120, Kinesiology (KINE) 2590, and Philosophy (PHIL) 3370. Grades were obtained after a formal request was submitted to the University of Toledo’s Registrar’s office. The University granted the researcher a list containing the number of A’s through F’s (including whether the grade was a plus or minus) for each of the 10 pre-requisite classes during the academic years 2011–2013. The information provided by the University of Toledo’s Registrar’s office included no personal identifiers thus the researcher had no knowledge of individual
grades for each participant. Final grades were initially entered into the data spreadsheet as a letter grade but then re-coded into a numeric value (A = 4.0, A- = 3.67, B+ = 3.33, B = 3.0, B- = 2.67, C+ = 2.33, C = 2.00, C- = 1.67, D+ = 1.33, D = 1.00, D- = 0.67, F = 0.00) for data analysis.

Table 4.1 provides a summary of the minimum, maximum, and means for each of the 10 pre-requisite classes. The average grade for Math 1320 was a 3.0250 (B) with a standard deviation of 0.91084, a low score of 0.67 (F), and a maximum of 4.00 (A). Philosophy 3370 had an average grade of 3.4425 (between a B+ and an A-) with a standard deviation of 0.56692, a minimum of 2.00 (C), and a maximum of 4.00 (A). Psychology 1010 had a mean of 3.1920 (between a B and B+) with a standard deviation of 1.03466, a minimum of 0.00 (F), and a maximum of 4.00 (A). Health 1800 had an average of 3.4663 (between a B+ and an A-) with a standard deviation of 0.69167, a minimum of 1.33 (D+), and a maximum of 4.00 (A). Kinesiology (KINE) 2460 (laboratory class) had an average grade of 3.5415 (close to an A-) with a standard deviation of 0.44473, a minimum of 2.67 (B-), and a maximum of 4.00 (A). The average grade for Kinesiology (KINE) 2560 is a 3.0758 (B) with a standard deviation of 0.62007, a minimum of 2.00 (C), and a maximum of 4.00 (A). Kinesiology (KINE) 2470 (laboratory class) had an average grade of 3.6178 (between an A- and A) with a standard deviation of 0.48634, a minimum of 2.33 (C+), and a maximum of 4.00 (A). Kinesiology (KINE) 2570 had a mean grade of 3.0500 (B) with a standard deviation of 0.86618, a minimum of 1.00 (D), and a maximum of 4.00 (A). Kinesiology (KINE) 2590 had an average of 2.6998 (B-) with a standard deviation of 0.73556, a minimum of 1.00 (D), and a maximum of 4.00 (A). Finally, Chemistry (CHEM) 1120 had an average grade of 3.1255
(between a B and B+) with a standard deviation of .78405, a minimum of 1.00 (D), and a maximum of 4.00 (A).

A WRRT examination score of 72 indicates passing (NBRC, 2017). The variable was initially entered into the data analysis spreadsheet as an examination score but then re-coded to 0 = the graduate did not pass the WRRT credentialing examination on the first attempt and 1 = the graduate did pass the WRRT credentialing examination on the first attempt. Table 4.1 provides descriptive statistics regarding WRRT credentialing examination scores for the 40 participants. The average score was a 77.6 with a standard deviation of 6.5194, a minimum of 62, and a maximum of 89.

Table 4.1

Descriptive Statistics of GPAs in the 10 Prerequisite Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math_1320</td>
<td>40</td>
<td>0.67</td>
<td>4.00</td>
<td>3.0250</td>
<td>0.91084</td>
</tr>
<tr>
<td>PHIL_3370</td>
<td>40</td>
<td>2.00</td>
<td>4.00</td>
<td>3.4425</td>
<td>0.56692</td>
</tr>
<tr>
<td>PSY_1010</td>
<td>40</td>
<td>0.00</td>
<td>4.00</td>
<td>3.1920</td>
<td>1.03466</td>
</tr>
<tr>
<td>HEAL_1800</td>
<td>40</td>
<td>1.33</td>
<td>4.00</td>
<td>3.4663</td>
<td>0.69167</td>
</tr>
<tr>
<td>KINE_2460</td>
<td>40</td>
<td>2.67</td>
<td>4.00</td>
<td>3.5415</td>
<td>0.44473</td>
</tr>
<tr>
<td>KINE_2560</td>
<td>40</td>
<td>2.00</td>
<td>4.00</td>
<td>3.0758</td>
<td>0.62007</td>
</tr>
<tr>
<td>KINE_2470</td>
<td>40</td>
<td>2.33</td>
<td>4.00</td>
<td>3.5178</td>
<td>0.48634</td>
</tr>
<tr>
<td>KINE_2570</td>
<td>40</td>
<td>1.00</td>
<td>4.00</td>
<td>3.0500</td>
<td>0.86618</td>
</tr>
<tr>
<td>KINE_2590</td>
<td>40</td>
<td>1.00</td>
<td>4.00</td>
<td>2.6998</td>
<td>0.73556</td>
</tr>
<tr>
<td>CHEM_1120</td>
<td>40</td>
<td>1.00</td>
<td>4.00</td>
<td>3.1255</td>
<td>0.78405</td>
</tr>
<tr>
<td>WRRT_Score</td>
<td>40</td>
<td>62.0</td>
<td>89.0</td>
<td>77.600</td>
<td>6.5194</td>
</tr>
<tr>
<td>Valid N (listwise)</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Logistic Regression Analysis Results**

A logistic regression analysis was conducted to assess the relationship between student performance in each of the pre-requisite classes (predictors) required for admission into a Baccalaureate Respiratory Care Educational Program and passing the WRRT credentialing examination on the first attempt (criterion). Because the outcome variable is dichotomous, this type of analysis can predict the probability that an observation falls into one of two categories (pass or fail on the first attempt) on the basis of continuous variables (grades). In addition, this analysis will be able to predict the effect size a predictor has on the dependent variable. Thus, for this study, how much influence an individual pre-requisite class had on first time pass rates.

**Case Processing Summary**

Table 4.2, Case Processing Summary, specifies the number of selected and missing cases included in the study. Total number of participants included in the study, \( n = 40 \), and no missing cases were observed.

Table 4.2

<table>
<thead>
<tr>
<th>Case Processing Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unweighted cases</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>Selected cases</td>
</tr>
<tr>
<td>Included in analysis</td>
</tr>
<tr>
<td>Missing cases</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Unselected cases</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
**Dependent Variable Encoding**

Table 4.3, Dependent Variable Encoding, indicates how the dependent variable was coded. Zero (0) denotes that the participant did not pass the WRRT credentialing examination on the first attempt. While one (1) designates that the participant did pass the WRRT credentialing examination on the first attempt.

Table 4.3

*Dependent Variable Encoding*

<table>
<thead>
<tr>
<th>Original value</th>
<th>Internal value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fail</td>
<td>0</td>
</tr>
<tr>
<td>Pass</td>
<td>1</td>
</tr>
</tbody>
</table>

**Omnibus Test of Model Coefficients**

Table 4.4, Omnibus Test of Model Coefficients (Block 1), identifies how the predictors were entered into the logistic regression analysis and evaluates the Chi-Square goodness of fit. All predictors (grades for each pre-requisite class) were entered into one block, no stepwise or hierarchical approach was used. Based on Table 4.4, the test statistic is not statistically significant, Chi-Square $\chi^2 (10, n=40) = 11.839, p > 0.5$. Therefore, we fail to reject the null hypothesis. Adding grades (predictors) to the model did not significantly predict first time pass rates on the WRRT credentialing examination.

Table 4.4

*Omnibus Tests of Model Coefficients*

<table>
<thead>
<tr>
<th></th>
<th>Chi-square</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step</td>
<td>11.839</td>
<td>10</td>
<td>.296</td>
</tr>
<tr>
<td>Block</td>
<td>11.839</td>
<td>10</td>
<td>.296</td>
</tr>
<tr>
<td>Model</td>
<td>11.839</td>
<td>10</td>
<td>.296</td>
</tr>
</tbody>
</table>
Model Summary

Table 4.5, Model Summary, provides some approximations for -2LL, Cox & Snell R-Square, and Nagelkerke R-Square. Because the -2LL value (21.978) is greater in the model summary than the -2LL value (11.839) in the omnibus test of model coefficients, we fail to reject the null hypothesis. Upon adding predictors to the model it did not statistically predict passing the WRRT credentialing examination on the first attempt. The Cox & Snell R-Square denotes that 25.6% of the variation in first time pass rates on the WRRT credentialing examination (dependent variable) is explained by the logistic model. Nagelkerke R Square indicates that 44.9% of the variance in passing the WRRT credentialing examination on the first attempt can be accounted for by the predictor variables (student performance in each of the 10 pre-requisite classes). With Nagelkerke R Square having a value of .449, there is a moderate relationship between the predictors and the prediction.

Table 4.5

<table>
<thead>
<tr>
<th>-2 Log likelihood</th>
<th>Cox &amp; Snell R Square</th>
<th>Nagelkerke R Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.978a</td>
<td>0.256</td>
<td>0.449</td>
</tr>
</tbody>
</table>

a. Estimation terminated at iteration number 8 because parameter estimates changed by less than .001.
**Hosmer and Lemeshow Test**

Table 4.6, Hosmer and Lemeshow Test goodness of fit results denote the test statistic is not statistically significant, $\chi^2 (8) = 2.648, p > .05$. Because the Hosmer and Lemeshow statistic has a significance level of .954, which is not significant, our model is a good fit, that the set of predictors (grades) will accurately predict actual probabilities (first time pass rates on the exam). However, as previous noted, the major limitation to this test is the possibility of missing important deviations when grouping a small sample. Therefore, caution should be exercised when placing too much emphasis on this particular information.

Table 4.6

<table>
<thead>
<tr>
<th>Step</th>
<th>Chi-square</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.648</td>
<td>8</td>
<td>0.954</td>
</tr>
</tbody>
</table>

**Variables in the Equation**

Variables in the Equation Table (Table 4.7) include two important components, the Wald statistic and the odds ratio. Based on the results, the Wald criterion showed no single predictor (pre-requisite class) as statistically significant in predicting passing the WRRT credentialing examination on the first attempt. None of the individual pre-requisite classes had a significance level less than .05. Because no individual class (predictor) was statistically significant, there was no reason to evaluate the odds ratio. No individual class was a better predictor over and above another class.
Table 4.7

Variables in the Equation

<table>
<thead>
<tr>
<th>Course Variable</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>Sig.</th>
<th>Exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math_1320</td>
<td>1.537</td>
<td>1.189</td>
<td>1.671</td>
<td>1</td>
<td>0.196</td>
<td>4.649</td>
</tr>
<tr>
<td>PHIL_3370</td>
<td>-0.304</td>
<td>1.822</td>
<td>0.028</td>
<td>1</td>
<td>0.867</td>
<td>0.738</td>
</tr>
<tr>
<td>PSY_1010</td>
<td>-0.887</td>
<td>1.208</td>
<td>0.539</td>
<td>1</td>
<td>0.463</td>
<td>0.412</td>
</tr>
<tr>
<td>HEAL_1800</td>
<td>0.684</td>
<td>0.979</td>
<td>0.488</td>
<td>1</td>
<td>0.485</td>
<td>1.981</td>
</tr>
<tr>
<td>KINE_2460</td>
<td>0.851</td>
<td>2.512</td>
<td>0.115</td>
<td>1</td>
<td>0.735</td>
<td>2.342</td>
</tr>
<tr>
<td>KINE_2560</td>
<td>3.587</td>
<td>2.941</td>
<td>1.488</td>
<td>1</td>
<td>0.223</td>
<td>36.115</td>
</tr>
<tr>
<td>KINE_2470</td>
<td>-2.923</td>
<td>2.457</td>
<td>1.415</td>
<td>1</td>
<td>0.234</td>
<td>0.054</td>
</tr>
<tr>
<td>KINE_2570</td>
<td>0.474</td>
<td>0.973</td>
<td>0.238</td>
<td>1</td>
<td>0.626</td>
<td>1.606</td>
</tr>
<tr>
<td>KINE_2590</td>
<td>0.648</td>
<td>1.469</td>
<td>0.194</td>
<td>1</td>
<td>0.659</td>
<td>1.911</td>
</tr>
<tr>
<td>CHEM_1120</td>
<td>-1.083</td>
<td>1.193</td>
<td>0.823</td>
<td>1</td>
<td>0.364</td>
<td>0.339</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.910</td>
<td>9.309</td>
<td>0.098</td>
<td>1</td>
<td>0.755</td>
<td>0.054</td>
</tr>
</tbody>
</table>

Math 1320. The study examined whether there was a relationship between student performance in Math 1320 and passing the WRRT credentialing examination on the first attempt. The result indicate that Math 1320 did not significantly predict passing the WRRT credentialing examination on the first attempt, $b = 1.537$, Wald $\chi^2(1) = 1.671$, $p > .05$.

Philosophy 3370. Is there a relationship between student performance in Philosophy (PHIL 3370) and passing the WRRT credentialing examination on the first attempt? The pre-requisite class Philosophy 3370 did not significantly predict passing the WRRT credentialing examination on the first attempt, $b = -0.304$, Wald $\chi^2(1) = 0.028$, $p > .05$.

Psychology 1010. Is there a relationship between student performance in Psychology (PSY 1010) and passing the WRRT credentialing examination on the first
The results showed that Psychology 1010 did not significantly predict passing the WRRT credentialing examination on the first attempt, $b = -.887$, Wald $\chi^2 (1) = .539$, $p > .05$.

**Health 1800.** Health 1800 did not significantly predict passing the WRRT credentialing examination on the first attempt, $b = .684$, Wald $\chi^2 (1) = .488$, $p > .05$. Thus, there is no relationship between student performance in Health 1800 and passing the WRRT credentialing examination on the first attempt.

**Kinesiology courses (KINE 2460, 2560, 2470, 2570, and 2590).** Several Kinesiology courses (KINE 2460, 2560, 2470, 2570, and 2590) where entered into the logistic regression model to evaluate the relationship between student performance in each individual class and passing the WRRT credentialing examination on the first attempt. No kinesiology course showed a significant relationship between student performance and passing the exam on the first attempt. KINE 2460 did not significantly predict passing the WRRT credentialing examination on the first attempt, $b = .851$, Wald $\chi^2 (1) = .115$, $p > .05$. KINE 2560 did not significantly predict passing the WRRT credentialing examination on the first attempt, $b = 3.587$, Wald $\chi^2 (1) = 1.488$, $p > .05$. KINE 2470 did not significantly predict passing the WRRT credentialing examination on the first attempt, $b = -2.923$, Wald $\chi^2 (1) = 1.415$, $p > .05$. KINE 2570 did not significantly predict passing the WRRT credentialing examination on the first attempt, $b = .474$, Wald $\chi^2 (1) = .238$, $p > .05$. KINE 2590 did not significantly predict passing the WRRT credentialing examination on the first attempt, $b = .648$, Wald $\chi^2 (1) = .194$, $p > .05$. 
Chemistry 1120. Chemistry 1120 was another science pre-requisite class evaluated to determine the relationship between student performance and first time pass rates. Just like the other science pre-requisites this class did not significantly predict passing the WRRT credentialing examination on the first attempt, $b = -1.083$, Wald $\chi^2 (1) = .823$, $p > .05$.

Summary

Results from this study indicate that no individual pre-requisite class was a strong predictor of success on the WRRT credentialing examination compared to other classes. Therefore, the classes required for admission by this Baccalaureate Respiratory Care Educational Program had no statistical influence on whether the student passed the examination on the first attempt. Furthermore, no individual student performance was a stronger predictor over and above another students’ performance when determining whether that individual would pass the exam on the first attempt.
This chapter includes a discussion of the results and their broader significance in Respiratory Care Educational Programs. In particular, the results of individual pre-requisite classes and their relationship in passing the WRRT credentialing examination on the first attempt are highlighted in relation to previous research. Additionally, limitations, program curriculum implications, recommendations, and conclusions are discussed.

**Pre-requisite Courses**

The purpose of this exploratory study was to determine if student performance in the pre-requisite classes required for admission into a Baccalaureate Respiratory Care Educational Program was related to their passing the WRRT credentialing examination on the first attempt. The latter was then used as a proxy indicator of successful development of critical thinking skills by a student. The pre-requisite classes examined include Math (Math 1320), Philosophy (PHIL 3370), Psychology (PSY 1010), Health (HEAL 1800), and Science (KINE 2460, KINE 2560, KINE 2470, KINE 2570, KINE 2590, CHEM 1120).

A logistic regression analysis was conducted to assess the relationship between student performance in each of the pre-requisite classes (predictors) required for admission into a Baccalaureate Respiratory Care Educational Program and passing the WRRT credentialing examination (criterion) on the first attempt. Based on a Chi-Square $\chi^2 (10, n=40) = 11.839, p > 0.5$, we fail to reject the null hypothesis. Adding grades
(predictors) to the model did not significantly predict first time pass rates on the WRRT credentialing examination. Furthermore, the Wald criterion showed no single predictor (individual pre-requisite class) as statistically significant in predicting first time pass rates on the examination.

**Limitations**

Creswell (2011) defines a limitation as “potential weaknesses or problems with the study identified by the researcher” (p. 199). The major limitations of this study concerned the sample and acquisition of data. When the researcher selected only one Baccalaureate Respiratory Care Educational Program the results of the study became limited. Results can only be generalized to this group of students and this program. However, it can be argued that similar results would be expected for graduates from other programs with the same pre-requisite class admissions criteria. The findings of this study may also have limited use due to the assessment of students from the academic years 2011–2013 only. As a result, the study used a small sample size (n=40). However, acquisition to examination results limited the ability to included additional participants (other academic years).

Due to the nature in which the grades were obtained the researcher was limited in the ability to correlate a particular student’s performance and passing the WRRT credentialing examination on the first attempt. The researcher was restricted to unidentified data therefore matching of individual grades to participants was not a possibility. This made it difficult to evaluate whether individual student performance had a contributing influence on WRRT credentialing examination first time pass rates.
Another limitation was the acquisition of online WRRT examination scores controlled by the NBRC. Availability of scores prior to 2011 is non-existent. In addition, this program did not have documentation within their files regarding student exam scores. Due to the inability to access scores prior to 2011, it limits the validity and extrapolation of the findings. If scores had been more readily available, this would have increased the sample size, thus possibly leading to a relationship between an individual pre-requisite class and passing the exam on the first attempt.

As previously mentioned several assumptions should be met prior to running a logistic regression analysis. Garson (2016) states the following regarding assumptions, “independent variables should be measured without error, no extraneous variables should be added, and no significant variables should be omitted.” For this study, student grades provided by the University were presented without bias (University of Toledo’s Registrar’s office), no addition information (courses not under investigation) was added into the analysis, and upon entering the data variables were not excluded by the researcher. However, mistakes could have been made during the information gathering process (errors in documentation by the Registrar’s office) or inputting (adding or deleting) of data into the spreadsheet. Thus, these possible errors could have led to limitations in this study.

Another possible limitation to the current study is the amount of time between pre-requisite course work completion and examination completion. For this particular program, respiratory curriculum coursework is completed in five semesters. This equates to approximately two-and-half years in the Respiratory Care Educational Program only. All 10 pre-requisite classes have to be completed prior to program enrollment.
Therefore, the minimum amount of time between completion of pre-requisite classes and completion of the WRRT credentialing examination is over two and a half years. Thus, could there ever be a relationship between pre-requisite grades and first time pass rates with such a gap in time between completion dates?

Lastly, by evaluating final letter grades only during the admission process, faculty may be overlooking a student who could pass the examination on the first attempt, thus leading to a possible limitation in the study. The grade a student achieves at the conclusion of a course does not provide accurate representation of performance and knowledge. There may have been contributing factors that influenced the final outcome (grade). Examples of such factors include the instructor (male, female, full professor, lecturer, teaching assistant), the time the class was offered, the number of examinations, and the amount of outside classroom work required by the student. Therefore, without an accurate description of the grading system used in a particular pre-requisite class, there’s no easy way of knowing a student’s level of knowledge. Ideally evaluation of actual points achieved would provide a better understanding of a student’s academic performance. However, this option was not readily available to the researcher. Therefore, Respiratory Care Educational Programs should consider evaluating student’s strengths and weakness instead of admitting solely based on final grades.

Despite these limitations, this exploratory study’s results highlight a potentially troubling issue, possible misidentification of pre-requisites. By adding grades (predictors) to the model, it did not significantly predict first time pass rates on the WRRT credentialing examination. No individual pre-requisite class is a stronger predictor over and above another class when determining whether a student would pass
the exam on the first attempt. Furthermore, student performance in the classes required for admission was not statistically significant on first time pass rates. Finally, no individual performance by a student (i.e., grade) is a stronger predictor over and above another student’s performance when determining whether that individual would pass the WRRT credentialing exam on the first attempt. The fact that these results indicate such puts into question why Respiratory Care Educational Programs continue to emphasize the importance of grades when accepting students into a given program.

Discussion

As noted by previous studies, programs place strong importance on academic success (overall GPA, science GPA, and math GPA) when determining acceptance into a program (Ari et al. (2008) and Sperle (2013)). With the results of this exploratory study showing no individual pre-requisite as a statistically significant for first time pass rates on the examination, Respiratory Care Educational Programs may need to assess the weight placed on academic success (grades) when determining criteria for the admissions process. Furthermore, since grades are heavily weighted by programs are poor decisions being made by faculty? Are Respiratory Care Educational Programs accepting the wrong type of student when evaluating grades only and excluding the right candidate for admission? In order to evaluate the validity of individual student performance to first time pass rates on the examination, further investigation needs to occur not only for this program but for programs nationwide. By employing more programs (increasing number of participants) validation or contradiction to current findings will occur. However, to fully understand the significance of this exploratory study’s results, comparison of previous literature needs to be explored.
Even though there is limited literature regarding predictors of academic success (passing the WRRT credentialing examination) and admissions criteria for Respiratory Care Educational Programs several studies have analyzed this relationship by using various predictors. Traditionally, most studies have consisted of cognitive measures such as pre-admission GPA and GPA in selected courses such as math and science (Ari et al., 2008). However, these studies have been inconclusive when determining a relationship between these measures and success on the examination which agree with current findings. Ari et al. (2008) reported that when using a multiple regression analysis, no single admissions criteria (SciGPA, NSciGPA, and CumGPA) was predictive of WRRT examination performance ($p > .05$). In addition, Sperle (2013) noted a weak correlation between Math GPA and WRRT examination scores ($r = .332$, $p = .45$). The results of the current study support these previous findings, that when a particular predictor is correlated with passing the WRRT credentialing examination no significance can be observed.

Nevertheless, two studies did report conflicting results to current findings. Ari et al. (2008) reported a positive relationship (Pearson correlation) between student scores on the WRRT exam and admissions criteria (SciGPA, NSciGPA, and CumGPA) with SciGPA having the strongest correlation with WRRT scores ($r = .420$, $p = .000$). In addition, Sperle (2013) noted that science GPA was the greatest predictor of success on the WRRT exam ($r = .60$, $p = .00$). Even though these two studies showed a positive relationship between science GPA and success on the examination, in order to achieve such results it required multiple pre-requisite science classes be grouped together (science GPA). One would speculate that if cumulative science GPA showed a significant
relationship in regards to success on the exam, a single pre-requisite science class should do the same. However, none of the six science pre-requisite classes analyzed in the current study were statistically significant in regards to predicting first time success on the exam. Thus, one should question what is noteworthy about those science pre-requisite classes (studies by Ari et al. and Sperle) compared to the science courses required by this Respiratory Care Educational Program. Is it only possible to show significance by grouping science classes together (GPA)? Or were the science classes from the previous studies fundamentally different from the science classes required by this particular program? Because of these possibilities it’s important to review curriculum requirements to understand why none of the science pre-requisite classes evaluated in the current study were predictive in first time pass rates on the WRRT credentialing examination.

Program Clinical Implication

The objective of a Respiratory Care Educational Program is to prepare competent respiratory therapists for practice across multiple health care venues (AARC, 2017). In order for this to occur, programs must produce graduates who can achieve academic success. In terms of academic success for respiratory care programs Ari et al. (2008) defined this as when an individual (graduate) is able to pass the WRRT credentialing examination on the first attempt thus qualifying for practice. Therefore, by passing the examination the graduate is deemed competent by the national credentialing organization (NBRC) to practice in a healthcare setting. However, in order to achieve academic success faculty must select a student for admission who has the best chance to achieve this. Because the governing organization, CoARC, has no standard guidelines for the
admissions process, programs can differ in the number of pre-requisite classes required for admission as well as what grade in those classes is sufficient for admission. Due to the lack of standardization, programs are continuously reviewing which criteria should be used for admission. By understanding which predictors (classes) are valid indicators of success on the WRRT credentialing examination faculty will be better suited to select the appropriate student for admission.

Respiratory Care Educational Programs typically rely on traditional measures, overall GPA, math GPA, and science GPA, when evaluating students for admission into a program (Sperle, 2013). While these measures provide some guidance, faculty must question the validity of such predictors with first time pass rates (nationally) at 67%. Based on the present study and previous examination of other pre-admission academic predictors of success, it does raise questions on why programs continue to use the traditional measure of grades when accepting students into a given program. For example, Ari et al. (2008) indicated no single admissions criteria (SciGPA and CumGPA) as predictive on examination performance (p >.05). While Sperle (2013) showed a weak correlations between English GPA, math GPA and WRRT examination scores (r = .205, p = .143; r = .332, p = 0.45).

Current practice for this Respiratory Care Educational Program is to review student pre-requisite performance (grades) to predict development of critical thinking skills with the hopes that this is indicative of future success on the exam. However, the results of this study and previous exploration on academic predictors of success (grades) put this assumption into question. With none of the 10 pre-requisite classes statistically significant in predicting whether the student would pass the WRRT credentialing
examination on the first attempt, why should this program continue to place so much emphasis on pre-admission academic performance. There must be other contributing factors that influence first time pass rates.

Since this exploratory study showed that student performance (grades in pre-requisite classes) was not statistically predictive in first time pass rates on the examination, what characteristics should faculty assess for program admission? What attributes indicate student development of critical thinking skills? What can program faculty learn from these results? In order to understand what characteristics a student should encompass regarding the achievement of critical thinking skills, programs need to understand the concept of critical thinking in the field of respiratory care.

Mishoe (2003) suggests that critical thinking in the field of respiratory care involves the ability to prioritize, anticipate, troubleshoot, communicate, negotiate, make individual, shared, and consultative decisions, negotiate responsibilities, and medical orders for patient care, and reflect on the patients, the decisions, and the profession. Many of these characteristics are testing on the WRRT credentialing examination. As outlined by the NBRC, the WRRT credentialing examination is to objectively measure essential knowledge, skills, and abilities required of advanced respiratory therapists (NBRC, 2017). The acquisition of these characteristics necessitates that the student be able to evaluate, recommend, troubleshoot, initiate, and modified interventions (NBRC, 2017). With this exploratory study indicating no individual pre-requisite class as predictive in passing the WRRT credentialing examination on the first attempt, it leaves a void in the notion that pre-requisite classes’ aid in the development of critical thinking skills. Thus, the skills necessary to successfully pass the examination must be learned
and mentored during program attendance. Once enrolled in a program, faculty serve as mentors and guide a student towards the development and understanding of critical thinking. Thus, student performance (grades in pre-requisite classes) only provides information regarding the student’s dedication or obedience towards academic success not their ability in mentoring and developing critical thoughts.

**Recommendations**

Based on the findings and limitations, this study is more exploratory in nature which will allow for future recommendations to improve the quality and content for a potential investigation. Since the researcher was restricted to un-identified data and matching of individual grades to participants was not possible, the first recommendation is to develop a written consent. The details of the proposed study and consent can be explained to the student in the hopes that a signature will transpire. Once consent is obtained it will allow the researcher to retrieve and review grades post-graduation thus not violating FERPA. By being able to access and review participants’ grades the researcher will have a better understand of the relationship between individual grades in the pre-requisite classes required for admission and first time pass rates on the WRRT credentialing examination.

As of 2014, the NBRC revised the WRRT credentialing examination. The new examination has the same number of questions (140) and content however the cut-score is now 94 compared to the previous score of 72. It would be of interest to examine the relationship between individual pre-requisite grades and student performance on the new WRRT credentialing examination. However, such a study would be several years away because of the availability of participants (small graduating classes). In order to evaluate
statistically significant results, a larger sample should be analyzed. Furthermore, a comparison between this exploratory study and future results could provide evidence for support or contradiction to current findings.

Finally, even though two studies noted a positive relationship between science GPA and success on the WRRT examination (Ari, et al (2008), Sperle (2013)) it still puts into question what combination of pre-requisite classes should make-up science GPA. By understanding the composition of classes (science GPA) included in those studies, programs will be better equipped to review, thus possibly leading to revisions to current pre-requisite curriculums in the hopes that first time pass rates improve. Thus, further exploration between the relationship of individual pre-requisite classes, overall GPA (science) and first time pass rates on the WRRT credentialing examination needs to occur. This evaluation should not only occur with this program but programs nationwide.

**Conclusion**

Because CoARC provides only general guidelines for the admissions process, Respiratory Care Educational Programs are continuously searching for which factors are more like to correlate with success on the WRRT credentialing examination. With this exploratory study evaluating individual pre-requisite classes instead of the traditional measures of academic success (pre-program GPA, math and science GPA) the hope was that a particular class may predict a students’ ability to pass the WRRT credentialing examination on the first attempt over and above other classes required for admission. However, the analysis output indicated no individual pre-requisite course as statistically significant in predicting first time pass rates on the WRRT credentialing examination. Thus, this puts into question why programs continue to place such emphasis on academic
success (grades) for the admissions process. Even though the results of this study indicated such, this program and programs nationwide should continue to evaluate the relationship between academic predictors of success and first time pass rates on the WRRT credentialing examination. By analyzing various variables (academic performance in the pre-requisite classes), Respiratory Care Educational Programs will better prepared to select the most appropriate student for the admissions process in the hopes of becoming a respiratory therapist.
References


### Appendix

Spreadsheet for Recording Variables

<table>
<thead>
<tr>
<th>ID on # of participant</th>
<th>Math 1320</th>
<th>KINE 2460</th>
<th>KINE 2560</th>
<th>HEAL 1800</th>
<th>PSY 1010</th>
<th>KINE 2470</th>
<th>KINE 2570</th>
<th>CHEM 1120</th>
<th>KINE 2590</th>
<th>PHIL 3370</th>
<th>WRRT Exam Score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

68