THE EFFECTS OF PREPAREDNESS ON CAREER AND TECHNICAL EDUCATION
STUDENTS’ PROGRAM PERFORMANCE AND VOCATIONAL ATTAINMENT

by

Walter V. Warren

Liberty University

A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

Liberty University
November 2015
THE EFFECTS OF PREPAREDNESS ON CAREER AND TECHNICAL EDUCATION
STUDENT’S PROGRAM PERFORMANCE AND VOCATIONAL ATTAINMENT

by Walter V. Warren

A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

Liberty University, Lynchburg, VA
November 2015

APPROVED BY:

SCOTT B. WATSON, Ph.D., Committee Chair

JOSEPH F. FONTANELLA JR., Ed.D., Committee Member

CHRISTOPHER A. DANIEL, Ed.D., Committee Member

SCOTT B. WATSON, Ph.D., Associate Dean, Graduate Programs
THE EFFECTS OF PREPAREDNESS ON CAREER AND TECHNICAL EDUCATION
STUDENT’S PROGRAM PERFORMANCE AND VOCATIONAL ATTAINMENT

Abstract

The purpose of this quantitative correlational study was to consider the effects that academic and vocational preparedness have on postsecondary students’ performance in a Career and Technical Education (CTE) or apprenticeship program, and the relationship between their in-program performance and vocational attainment after program completion. The study was conducted using archival data from a postsecondary CTE institution with a proven track record for administering apprentice programs. The findings from this study are an indication that academic and vocational preparedness are relevant factors when considering students’ ability to complete a postsecondary CTE program, level of performance in a CTE program, and vocational attainment or outcome after completing a CTE program.

Keywords: academic preparedness, vocational preparedness, career and technical education (CTE), remediation, apprenticeship
Dedication

This dissertation is dedicated to my wife, Christy, and son, Jake. Christy, whose faith, love and encouragement constantly remind me of who I need to be. When this journey seemed overwhelming and impossible, she prayed for me, encouraged me, and inspired me to persevere. Christ has truly blessed me with a best friend and helpmate who truly completes me. Jake, a son who makes me proud every day to be his father, and whose determination to complete undergraduate and graduate degrees during this same time was a source of great inspiration to me. Christy and Jake, this would have never happened without your love and support.

Acknowledgements

To Dr. Scott B. Watson for your patience, guidance and support in serving as my committee chair.

To Dr. Joseph F. Fontanella Jr. and Dr. Christopher A. Daniel for your support and encouragement in serving on my committee.
# Table of Contents

ABSTRACT .............................................................................................................. 3  
Dedication ............................................................................................................. 4  
Acknowledgements .............................................................................................. 4  
List of Tables ....................................................................................................... 9  
List of Figures .................................................................................................... 10  
List of Abbreviations .......................................................................................... 11  

CHAPTER ONE: INTRODUCTION ................................................................. 12  
  Background ........................................................................................................ 13  
  Theoretical Framework ..................................................................................... 15  
  Problem Statement ........................................................................................... 16  
  Purpose Statement ........................................................................................... 16  
  Significance of the Study .................................................................................. 17  
  Research Questions .......................................................................................... 17  
  Null Hypotheses ............................................................................................... 18  
  Identification of Variables ............................................................................... 19  
  Definitions ......................................................................................................... 21  

CHAPTER TWO: LITERATURE REVIEW ....................................................... 24  
  Introduction ...................................................................................................... 24  
  Theoretical Framework .................................................................................... 25  
  Review of Literature ......................................................................................... 27  
    Postsecondary Remediation ........................................................................ 29
Remediation by the Numbers ........................................ 30
Disparities in Postsecondary Preparedness ....................... 31
Academic Preparedness .................................................. 33
Strategies to Address Lack of Preparedness ....................... 38
CTE and Apprenticeship .................................................. 40
CTE Preparedness .......................................................... 43
Biblical Perspectives on Student Preparedness .................... 44
Summary ........................................................................ 46

CHAPTER THREE: METHODOLOGY ..................................... 48
Design ............................................................................ 48
Research Questions and Hypotheses .................................. 49
Participants .................................................................... 51
Setting ............................................................................ 53
Instrumentation .............................................................. 53
Math Placement Test ....................................................... 54
Academic Assessment Instrument ...................................... 54
Admissions Application ................................................... 55
Craft Evaluation Instrument ............................................. 56
Procedures ...................................................................... 56
Data Analysis .................................................................. 58
Research Question 1 ....................................................... 58
Research Question 2 ....................................................... 61
Influential Cases ...................................................... 82
Normality ............................................................... 82
Multiple Regression Results ........................................ 83
Null Hypothesis Three .............................................. 84
Descriptive Statistics ............................................... 84
Assumption Testing .................................................. 86
Outliers ................................................................. 87
Leverage Values ...................................................... 87
Influential Cases ...................................................... 87
Multinomial Logistic Regression Results ....................... 88
Model Equations ...................................................... 89
Independence from Irrelevant Alternatives ...................... 92

CHAPTER FIVE: DISCUSSION ......................................... 94
Findings ................................................................... 96
Conclusions ............................................................. 100
Implications ............................................................. 101
Limitations ............................................................... 103
Recommendations for Future Research ......................... 104
REFERENCES .............................................................. 106
APPENDIX A: IRB APPROVAL LETTER ......................... 116
APPENDIX B: CSL INSTITUTION PERMISSION LETTER ............. 117
List of Tables

Table 1. Descriptive Statistics for RQ1 Categorical Variables (Ethnicity*Gender* Program Completion) Cross Tabulation .............................................. 67

Table 2. Descriptive Statistics for Continuous Predictor Variables in RQ1........ 68

Table 3. Collinearity Statistics for Predictor Variables.............................. 71

Table 4. Continuous Predictor Variables (Interactions) ............................... 72

Table 5. Predictor Variables in the Model ............................................... 74

Table 6. Classification Rate.................................................................... 75

Table 7. Descriptive Statistics for Predictor and Criterion Variables in RQ2 .... 76

Table 8. Contribution of Predictor Variables for Criterion Variable

In-Program GPA .................................................................................. 84

Table 9. Descriptive Statistics for RQ3 Categorical Variables (Ethnicity*Gender*

Vocational Attainment) Cross-Tabulation............................................. 85

Table 10. Descriptive Statistics for Continuous Predictor Variables in RQ3....... 85

Table 11. Results of the Multinomial Logistic Regression Showing Effects of

Predictor Variables on Vocational Attainment ..................................... 89

Table 12. Case Processing Summary for Model ....................................... 91

Table 13. Classification for Model ......................................................... 92
List of Figures

Figure 1. Scatter plot (In-program GPA – Standardized Residuals)………………. 79
Figure 2. Scatter plot (Remedial Need in Math and In-program GPA)…………… 80
Figure 3. Scatter plot (Academic Assessment and In-program GPA)…………… 80
Figure 4. Scatter plot (Age When Started Apprenticeship and

In-program GPA).................................................................................. 81
Figure 5. Histogram (In-Program GPA)..................................................... 82
Figure 6. Normal P-P Plot (Expected versus Observed Cumulative Probability).... 83
List of Abbreviations

Career and Technical Education (CTE)

American College Testing (ACT)

On-The-Job Training (OJT)

Grade Point Average (GPA)
CHAPTER ONE: INTRODUCTION

A significant number of students entering community colleges, universities, and one- and two-year career and technical education (CTE) programs are inadequately prepared to deal with the comprehensive subject matter and demanding coursework requirements associated with postsecondary education (Levin & Calcagno, 2008). Challenges with students being academically prepared extend beyond traditional postsecondary education programs to CTE and apprenticeship programs. Levin and Calcagno (2008) posit that many incoming freshmen are underprepared in the foundational skills of mathematics, reading, and writing. Gonzalez (2010) also suggests that under preparation and poor academic skills, specifically in reading and math, are considerable obstacles for students attempting to enter and successfully complete postsecondary CTE programs.

In addition to the importance of being prepared academically, vocational preparedness is another factor to examine when considering students’ ability to persist and succeed in postsecondary CTE programs and apprenticeships. Although limited in depth and breadth, some research has suggested that previous vocational experience and training are not positively correlated with the employment status, job positions attained or annual income of students completing apprentice programs (Rezin & McCaslin, 2001). However, research is scant and dated regarding the relationship between students’ academic and vocational preparedness and their performance in a postsecondary CTE or apprentice program. With greater focus being placed on college preparedness and the transition of postsecondary students to the workforce with the requisite skills to be successful (Lerman, 2012; Gonzales, 2010), additional research is
needed regarding the effect that being academically and vocationally prepared has on students’ ability to perform in and successfully complete postsecondary CTE programs.

**Background**

According to Howell (2011), much of the blame for students’ lack of preparedness in English and mathematics belongs to the public schools, the primary supplier of college-bound students. Nationally, only 24% of 2010 high school graduates were deemed college ready in English, math, and science, as indicated by their performance in the American College Testing (ACT) program. Additionally, the U.S. Department of Education reported in 2008 that 44% and 27% of students less than 25 years old attending two-year public institutions and four-year public colleges or universities, respectively, were enrolled in at least one remedial course (Spak, 2011). Combining these percentages with the fact that approximately 75% of high school graduates elect to attend two- and four-year colleges and universities (Howell, Kurlaender & Grodsky, 2010) and a significant portion of students requiring developmental courses in postsecondary programs are non-traditional adult learners (Vandal, 2010), institutions are increasingly challenged to ensure the efficacy of developmental programs to increase academic preparedness (Bahr, 2007); encourage the persistence of students with respect to completion of certificate and degree programs (Gonzales, 2010); and support the successful transition of graduates into the workforce with the necessary skills, knowledge, and abilities (Lerman, 2012).

Although the pervasiveness of ill-prepared students entering postsecondary education requires most colleges and universities in the United States to provide students with some type of remedial or developmental support (Attewell, Lavin, Domina, & Levey, 2006), the value of remediation remains a major controversy in postsecondary education, and a topic of increasing
interest for researchers (Bahr, 2007). According to Bahr (2008), “despite longstanding controversy and much rhetoric, we have comparatively little dependable information about whether remediation is accomplishing the purpose for which it is intended” (p.421). Recent studies on the efficacy of remediation mostly concur that “postsecondary remediation is beneficial to the long-term attainment of skill-deficient students, when compared to students who do not participate in remediation or who participate but do not complete the remedial process successfully” (Bahr, 2010a, p.178-179). However, remediation imposes substantial costs on underprepared students entering postsecondary education and the United States as a whole. An analysis of postsecondary students enrolled during the 2007-2008 school year revealed that direct remediation costs over the course of their time in college will reach an estimated $3.6 billion (Alliance for Excellent Education, 2011).

Sixty-three percent of postsecondary students in the United States are enrolled in community colleges. More than 50% of community college students and approximately 30% of all postsecondary students in the United States are in enrolled in CTE programs (Cohen & Brawer, 2008). As a result, there are a substantial number of CTE students requiring remediation in at least one subject when entering postsecondary education. Compton, Laanan, and Starobin (2010) suggest that in spite of the significant number of students entering CTE programs requiring remediation, legislators, lawmakers, and the general public often fail to provide adequate attention, support, and resources in order to address these deficiencies. They further suggest this lack of attention to CTE students notwithstanding, underprepared students entering two- and four-year postsecondary institutions remains a widely discussed topic in education, primarily because developmental or remedial education offers opportunities to correct academic
differences in gender, race, and class that may have been perpetuated in primary and secondary educational settings. On the other hand, critics of remediation offer the argument that in addition to taxpayers’ incurring of additional costs for re-educating individuals in skills they should have received in primary and secondary education, remediation tends to weaken academic standards, diminish the value of postsecondary degrees, and discourage faculty who are tasked with teaching developmental courses (Bahr, 2008).

**Theoretical Framework**

Piaget’s schema theory (cognitive constructivism) and Merton’s (1968) Matthew Effect are two theoretical frameworks that supported this study and contributed to the understanding of the effect that students’ academic and vocational preparedness has on their performance, ability to complete a program, and their vocational attainment beyond program completion. Pritchard (2009) suggests that schemas are personal; incomplete and constantly evolving; based on our general world knowledge and experiences; and a means for understanding new information by providing explanations of what is happening, what it means, and what is likely to result. Doolittle and Camp (1999) suggest that cognitive constructivism, with respect to CTE learners specifically, recognizes the role of previous knowledge in understanding and reasoning; benefit of domain-general and -specific problem solving strategies; importance and influence of individual learner differences; and eventual goal of becoming an independent life-long learner.

The Matthew Effect is a phenomenon that refers to the biblical passage, “For to everyone who has, more will be given, and he will have abundance; but from him who does not have, even what he has will be taken away” (New King James Version, Matthew 25:29). The Matthew Effect, as it pertains to underprepared students, is simply the idea that, although designed to
minimize inequalities between privileged and underprivileged students, ultimately, individuals who have the greatest need for remedial or developmental education and training are less likely to be successful (Bahr, 2010b).

**Problem Statement**

Because of the significant number of high school graduates and non-traditional students (adult learners) entering postsecondary CTE programs and apprenticeships; the more than 40% of incoming students being unprepared academically (Spak, 2011) for the rigors of postsecondary coursework and training; and the limited and dated research on CTE students’ level of academic and vocational preparedness (Bahr, 2007; Rezin and McCaslin, 2001), additional research is needed to better inform students, parents, educators, policy makers, and legislators regarding the effect that academic and vocational preparedness have on students’ ability to successfully complete CTE programs or apprenticeships, and attain desired vocational outcomes beyond program completion.

**Purpose Statement**

The purpose of this quantitative ex-post facto multivariate correlational study was to consider the effects that remedial need in mathematics, academic preparedness, and pre-program work experience and vocational education have on postsecondary students’ ability to complete a CTE or apprenticeship program. The study also examined the effects that postsecondary students’ remedial need in mathematics and academic preparedness have on their academic attainment (in-program academic performance) in a CTE or apprenticeship program. Lastly, this study considered the effects that academic attainment (in-program academic performance) and
on-the-job training (OJT) performance of postsecondary CTE students have on their post-program vocational attainment.

**Significance of the Study**

This study has the potential to inform students, parents, educators, policy makers and legislators regarding the importance of students’ academic and vocational preparedness when entering postsecondary CTE programs and apprenticeships. In addition, understanding the relationship between underprepared students and their performance and persistence in these programs can positively influence partnerships between secondary educators, postsecondary educators, and business and industry leaders. Providing reliable, sound information on students’ level of academic and vocational preparedness can influence educators and decision makers on local, state, and federal levels to enact policy, allocate resources, and revise secondary and postsecondary educational programs in order to positively impact student performance and outcomes in postsecondary CTE programs and apprenticeships.

**Research Questions**

The following research questions guided this quantitative study:

RQ1: How well do students’ remedial need in mathematics (as measured by a pre-program math placement test), academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses), pre-program work experience (measured in years of related and non-related experience), and vocational education (vocational courses completed with a minimum grade of “B” during secondary or postsecondary education) predict their ability to complete a postsecondary CTE program?
RQ2: How well do students’ remedial need in mathematics (as measured by a pre-program math placement test) and academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses) predict their academic attainment (in-program GPA) in a postsecondary CTE program?

RQ3: How well do students’ academic attainment (in-program GPA) and on-the-job training (OJT) performance (numerically averaged grade measuring five areas: technical knowledge and comprehension; quantity; quality, leadership and initiative; and conduct) in a postsecondary CTE program predict their post-program vocational attainment (vocational positions entered after completing a CTE program)?

Null Hypotheses

H01: Students’ remedial need in mathematics (as measured by a pre-program math placement test), academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses), previous work experience (measured in years of related and non-related experience), and vocational education (vocational courses completed with a minimum grade of “B” during secondary or postsecondary education) do not predict their ability to complete a postsecondary CTE program.

H02: Remedial need in mathematics (as measured by a pre-program math placement test) and academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses) do not predict the academic attainment (in-program GPA) of students in a postsecondary CTE program.

H03: Students’ academic attainment (in-program GPA) and on-the-job training (OJT) performance (numerically averaged grade measuring five areas: technical knowledge and
comprehension; quantity; quality, leadership and initiative; and conduct) in a postsecondary CTE program do not predict their post-program vocational attainment (vocational positions entered after completing a CTE program).

**Identification of Variables**

**Predictor Variables**

1. Remedial need in mathematics – “remedial need refers to the degree of deficiency in a given subject” (Bahr, 2008, p.444). This continuous predictor variable measured students’ remedial need in mathematics using a math placement test that was administered prior to students entering their CTE program or apprenticeship.

2. Academic preparedness – academic readiness or preparedness can be defined as possessing the “knowledge, skills, and metacognitive strategies needed to be successful at postsecondary institutions” (Barnes & Slate, 2010, p.1). For the purposes of this study, academic preparedness was a continuous predictor variable that measured students’ pre-program performance in qualifying courses including Algebra I, Geometry, Algebra II, Trigonometry, advanced math (Pre-Calculus, Calculus, and Statistics), chemistry, physics, computer science, and principles of technology.

3. Vocational preparedness – vocational preparedness includes pre-program related and non-related work experience and vocational education.

   a. Pre-program work experience – While a study by Rezin and McCaslin (2001) only considered students’ prior related experience and its relationship to post-program vocational attainment, this study included prior non-related work experience. Holzer (1997) presented survey findings that suggested employers consider general
employment skills and individual qualities such as integrity, accountability, and the ability to self-manage as equal to, or more desirable than, work-related basic skills. Holzer’s findings suggest non-related work experience may have an effect on student performance and outcomes in CTE programs or apprenticeships. Pre-program related work experience and non-related work experience served as continuous predictor variables measuring students’ pre-program work experience in years. For purposes of this study, related experience included work involving skills that are similar to ones used in industrial occupations/settings; including, but not limited to, welding, machining, pipefitting, etc. Non-related experience includes, but was not limited to, working in areas such as retail, fast food, etc.

b. Vocational education/training – Snyder and Dillow (2010) define vocational education as structured educational courses or programs which help prepare students for paid and unpaid work or employment. For purposes of this study, vocational education was a continuous predictor variable measuring the number of secondary and/or postsecondary vocational or CTE courses completed by students with a final grade of “B” or better.

4. Academic attainment – academic attainment can refer to an individual’s ability to earn a certificate, associate’s degree, bachelor’s degree, etc. within the context of an academic program (Bahr, 2008). For the purposes of this study, academic attainment was a continuous predictor variable measuring students’ in-program academic performance based on their GPA.

5. On-the-job training (OJT) performance – Jacobs and Osman-Gani (1999) posit that structured OJT must contain essential elements, one of the most obvious being “the use of a
systematic process to design and deliver the training” (p.17). OJT performance in this study was a continuous predictor variable measuring students’ in-program performance in five areas using a numerical grade: technical knowledge and comprehension; quantity; quality, leadership and initiative; and conduct. The institution where this study was conducted uses a structured approach to delivering OJT.

**Criterion Variables**

1. Ability to complete a CTE program – this dichotomous criterion variable measured program completers and non-completers.

2. Academic attainment – in addition to serving as a continuous predictor variable, academic attainment served as a continuous criterion variable measuring students’ in-program academic performance using their GPA when considering RQ2.

3. Vocational attainment – this categorical criterion variable measured students’ post-program attainment with respect to job position/title in the following categories: hourly tradesperson, salaried non-management, and salaried management.

**Definitions**

*Academic attainment.* Academic attainment can refer to an individual’s ability to earn a certificate, associate’s degree, bachelor’s degree, etc. within the context of an academic program (Bahr, 2008). Academic attainment in this study is defined as the in-program academic performance of students as measured by their GPA.

*Depth of remedial need.* “Depth of remedial need refers to the degree of deficiency in a given subject” (Bahr, 2008, p.444). Depth of remedial need in mathematics, for the purposes of
this study, is the math placement scores of students who entered CSL institution from 2005-2007.

*Developmental education.* Developmental education will be used interchangeably with remediation for the purposes of this study.

*Postsecondary career and technical education (CTE).* Postsecondary CTE pertains to career-related, prescribed undergraduate programs (certificate, associate’s degree, and bachelor’s degree levels) intended to teach relevant knowledge and skills commensurate to the requirements of specific occupations or careers. CTE usually involves less theory-related instruction, more practical application of knowledge and skills, and greater focus on core subject matter (Levesque et al., 2008).

*Remediation.* Martorell and McFarlin (2011) suggest that remediation, in its most widely accepted form, involves coursework that reflects a foundational curriculum that comprises basic skills in reading, writing, and mathematics. As a result, remedial courses involve less-complex material, do not apply credits towards a degree, and are often taught by an institution’s adjunct faculty. Martorell and McFarlin further posit that remediation can be provided in formal and informal settings and formats, and, according to many developmental specialists at two- and four-year institutions, are surprisingly similar in their content and approach. Examples of informal remediation approaches that are intended to augment formal course-based remediation include free tutoring, learning assistance centers, and additional instruction. Remediation, in this study, is defined as support or resources provided by postsecondary institutions that better prepares students for college-level academics.
**Vocational education.** Vocational education is used interchangeably with career and technical education (CTE) in this study. Vocational education is defined as structured programs that offer a series of educational courses which are directly related to the training and development of individuals in compensated or unpaid current or emerging careers that require qualifications other than postsecondary undergraduate or advanced degrees (Carl D. Perkins Act, 1990).

**Apprenticeship.** Apprenticeship or apprentice programs represent a structured approach that enables individuals to acquire a “recognized and valued credential attesting to their mastery of skill required in a relevant occupation” (Lerman, 2012, p.4). Lerman also suggests that apprentice programs utilize a work-based training and development model in the context of a production environment, along with related academic instruction that includes mathematics, verbal and written communications, and content that is specific to the vocation or trade. Apprenticeship or apprentice program in this study refers to a combination of related academic instruction, trade theory, and structured OJT.
CHAPTER TWO: LITERATURE REVIEW

Introduction

A significant number of students entering colleges and universities are inadequately prepared to deal with the comprehensive subject matter and demanding coursework requirements associated with postsecondary education. As a result, many incoming freshmen are underprepared in the foundational skills of mathematics, reading, and writing (Levin & Calcagno, 2008). According to Howell (2011), much of the blame for students’ lack of preparedness in English and mathematics belongs to the public schools, the primary supplier of college-bound students. Nationally, only 24% of 2010 high school graduates were deemed college ready in English, math, and science, as indicated by their performance in the American College Testing (ACT) program. Additionally, the U.S. Department of Education reported in 2008 that 44% of students under 25 attending two-year public institutions, and 27% of students under 25 attending four-year public colleges or universities, were enrolled in at least one remedial course (Spak, 2011). Combining the aforementioned percentages with the fact that approximately 75% of high school graduates elect to attend two- and four-year colleges and universities (Howell et al., 2010), postsecondary institutions are increasingly challenged to ensure the efficacy of remediation programs.

Research in the area of postsecondary remediation has historically lacked rigor and sound methodology to be considered trustworthy in determining its efficacy (Bettinger and Long, 2009). Specifically, the research concerning student persistence and performance beyond developmental coursework is limited. Bettinger and Long believe that “despite the extensive use of remedial courses to address academic deficiencies, little is known about their effects on
subsequent student performance in college” (p.738). Recent research is encouraging and provides policy makers, administrators, teachers, and students with new evidence regarding the long-term value of remedial courses. However, very little research exists regarding the effects that depth and breadth of students’ remedial need have on their successful completion of developmental courses, first-level college courses, certificate programs, and two- and four-year degree programs (Bettinger and Long, 2009). Additionally, research is scant concerning vocational students, specifically students enrolled in apprentice programs, with respect to depth and breadth of their developmental needs and their ability to successfully complete an apprenticeship. The goal of this study is to examine the relationship between students’ academic and vocational preparedness and their performance in a postsecondary career and technical education (CTE) program or apprenticeship and post-program vocational attainment.

**Theoretical Framework**

One theory that can be associated with learning, and more specifically developmental learning, is Piaget’s schema theory (cognitive constructivism). According to Pritchard (2009), schema can be described as “a theoretical multidimensional store for almost innumerable items of knowledge, or as a framework with numerous nodes and even more numerous connections between nodes” (p.21). Merriam, Cafferella, and Baumgartner (2007) posit that schemas may be fixed in other schemas or may stand alone, and are building blocks filled with descriptive materials. They are not, however, merely passive warehouses of experience; “they are also active processes whose primary function is to facilitate the use of knowledge” (p.401). Pritchard (2009) suggests that schemas are personal; incomplete and constantly evolving; based on our general world knowledge and experiences; and a means for understanding new information by
providing explanations of what is happening, what it means, and what is likely to result. Schema supports constructivists’ learning in that prior knowledge plays a vital role in creating new understanding. Remediation is intended to re-familiarize individuals with concepts, theories, and information that were previously learned. Lowery-Carter (2012) posits that “developmental classes are designed to reacquaint students with information they should have already acquired. After successful completion of developmental classes, students should be prepared to pursue college-level work” (p.5).

An individual’s existing schema represents a current state of knowledge and understanding of a particular subject, experience, or action. New understanding expands the current schema and increases its complexity through the processes of accommodation and assimilation (Pritchard, 2009). Because schemas are personal, based on previous knowledge and experiences and constantly changing (Pritchard, 2009), they may help explain why some individuals are underprepared academically and vocationally for the workforce, traditional postsecondary education programs, and postsecondary CTE and apprenticeships. In addition, schemas may also affect an individual’s ability to overcome greater deficiencies in one or more subject areas or vocational skills, thereby impacting their ability to successfully continue in or complete a postsecondary CTE course or program.

In addition to schema theory, the Matthew Effect, a phrase attributed to Merton (1968), has been expanded by researchers in education to suggest that “those who have the greatest need for remediation are the least likely to remediate successfully, while those who require the least remediation are the most likely to remediate successfully” (Bahr, 2007, p.695-696). The Matthew Effect is associated with the biblical passage “For to everyone who has, more will be
given, and he will have abundance; but from him who does not have, even what he has will be taken away” (Matthew 25:29, New King James Version). This theory suggests that students who possess solid academic skills or ability in a particular subject matter area will be able to further expand and develop that knowledge base (Pritchard, 2009), while students who lack such an advantage may struggle with developing and expanding their knowledge in a particular area. According to Bahr (2010b), “one of the remaining unanswered questions about the efficacy of postsecondary remediation involves the extent to which remediating successfully in a given subject area resolves the inherent academic disadvantage faced by the poorest skilled students” (p.179). In other words, the depth and breadth of students’ developmental needs may impact their ability to successfully remediate in one or more subject-matter areas and persist to complete a postsecondary course or program.

Stanovich (2008) suggests that individuals who self-enable additional learning with the use of a “previously existing knowledge base that is rich and elaborated” (p.37) or schema, are in essence validating the Matthew Effect. As a result, students having that rich, mature, and expanded knowledge base that Stanovich refers to are more likely to succeed academically than those with a shallow, immature, and undeveloped information base. Herein lies the challenge with remediation and its intent to help level the playing field for all students; specifically, with students who may be moderately to severely deficient in basic math and English skills when entering postsecondary education.

**Review of the Literature**

According to Levesque, et al. (2008), CTE at the postsecondary level is related to the preparation of individuals for employment in particular vocations or occupations. Hirschy,
Bremer, and Castellano (2011) further suggests that “career education programs at the secondary and postsecondary levels prepare students with technical knowledge and skills for specific occupations” (p.297). The technical knowledge and skills referred to by Hirschy et al. as necessary for successful transition into particular occupations are impacted by the academic and vocational preparedness of students entering CTE postsecondary programs.

While developmental education in postsecondary education has existed since the 1840s, “remedial courses have become far more prevalent in the last 30 years as the need for a better educated workforce has become paramount, and access to college has become more widely available in the United States” (Handel & Williams, 2011, p.29). Stated differently, there is a greater need for students to be better prepared academically in order to transition successfully to the workforce or postsecondary education. Handel and Williams (2011) also suggest that with more than 40% of students requiring one or more developmental courses when entering college, remediation remains an important and much debated topic among students, taxpayers, educators, legislators, and administrators. In addition, because “remedial education programs that successfully prepare college students to become academically successful in their college-level course work are critical to the educational goal attainment of underprepared students” (Biegel, 2009, p.1), the single greatest question revolving around these constituencies pertains to the efficacy of remediation (Bahr, 2010a).

In addition to the academic preparedness of students entering the workforce and postsecondary education, their vocational preparedness is also a factor when considering the successful completion of a postsecondary CTE program and subsequent vocational attainment. Lerman (2012) posits that substantially increased attention on the academic attainment of
students, to better prepare them for traditional postsecondary education opportunities, has diminished the significance and quality of secondary CTE programs. As a result, students “gain little complementary workplace training” (p.21) that can better prepare them for the work-related training of an apprenticeship.

**Postsecondary Remediation**

Postsecondary remediation can be defined as support provided by colleges and universities that helps prepare students with inadequate skills in particular subjects for college-level academics. Remediation, in its most widely accepted form, involves coursework that reflects a foundational curriculum that comprises basic skills in reading, writing, and mathematics (Martorell & McFarlin, 2011). As a result, remedial courses involve less-complex material, do not apply credits towards a degree, and are often taught by an institution’s adjunct faculty. Remediation programs can be provided in formal and informal settings and formats, and according to many developmental specialists at two- and four-year institutions, are surprisingly similar in their content and approach. Examples of informal remediation approaches that are intended to augment formal course-based remediation include free tutoring, learning assistance centers, and additional instruction. Depth and breadth of remedial need help education researchers and practitioners further define remediation and students’ specific remedial needs. The depth of remedial need represents the amount of deficiency students have in a particular subject, while breadth of remedial need denotes the number of subject-matter areas in which students require developmental or remedial help (Bahr, 2007; Bahr 2008).

Questions about the efficacy of remediation draw the attention of both advocates and opponents. Supporters believe that greater focus and resources are needed for remediation to
ensure that dependable pathways are established for students who have been historically underserved by the public education system (Handel & Williams, 2011, p.29). Attewell et al. (2006) suggest that those who support developmental education efforts view any disagreement over remediation as an attack on access to college for the aforementioned underserved student populations. According to Bahr (2008), “remediation is, by definition, a ‘remedy’ intended to restore opportunity to those who otherwise may be relegated to meager wages, poor working conditions, and other consequences of socioeconomic marginalization” (p.422). Bahr suggests that opponents of remedial education argue that it is an inefficient pedagogical strategy and equally inappropriate as a social policy. Bettinger and Long (2009) believe that “critics question whether the courses remove the incentive for students to adequately prepare while in high school” (p.738). Both advocates and opponents agree, however, that too many students entering college require remediation and not enough of them reap the intended benefits (Handel & Williams, 2011, p.29).

**Remediation by the Numbers**

According to the National Center for Education Statistics (2011), the percentage of public two- and four-year postsecondary institutions offering some type of remediation remained relatively consistent between 1995 and 2000. Two-year institutions offering remedial courses in 1995 and 2000 were 98% and 100%, respectively, while four-year institutions offering remediation between 1995 and 2000 remained consistent at 80%. The number of institutions offering some type of remediation remains consistent due to the number of students requiring developmental courses when entering postsecondary education. “For all institutions, approximately 28% of first-time freshmen enrolled in a minimum of one developmental
education course; the corresponding figure for community colleges was 42%” (Pretlow & Wathington, 2011).

Remedial education and training is costly. The Alliance for Excellent Education (2011) estimates the nation loses $3.7 billion a year because students are not learning basic needed skills, including $1.4 billion to provide remedial education for students who have recently completed high school. According to Pretlow and Wathington (2011), to reduce costs associated with remedial education, state education boards and higher education systems are increasing the use of technology and distance learning approaches; requiring that developmental education be shifted to community colleges, where lower costs can be achieved; and restricting the number of times a student can take remedial courses. Public community colleges have significantly increased the number of remedial courses being offered using the latest distance education technology. Specifically, two-year postsecondary institutions now deliver four times as many online developmental education courses as they did in 1996. As a result, costs associated with providing remediation to students at the institution and aggregate levels have been considerably increased (Pretlow & Wathington, 2011).

**Disparities in Postsecondary Preparedness**

According to Calcagno, Crosta, Bailey, and Jenkins (2007), “although enrollment in remedial courses decreases the odds of graduating for all students, older students who enroll in remediation are less negatively affected than are younger ones who take remedial classes” (p.775). One possible explanation posited by Calcagno et.al. regarding remediation affecting older students less, particularly with respect to their academic attainment, is that older students are simply “out of practice” versus being grossly deficient in a subject-matter area, particularly
the area of mathematics. As a result, these students may only require remedial strategies similar
to short-term workshops, tutorials, and online resources in lieu of semester-long classes.
Calcagno et al. (2007) also suggest that community colleges provide more intense support
mechanisms to assist students requiring remedial courses, particularly younger students, in order
to improve their chances of completing with a certificate or two-year degree.

As previously mentioned, developmental education is intended to provide greater
opportunity for individuals who may otherwise be limited to fewer opportunities due to their
deficiencies in basic skills including math and English. With this thought in mind, “one would
hope that students of historically disadvantaged and advantaged groups would benefit equally
from remediation, advancing up to college-level proficiency in core subjects at comparable rates.
Yet, this is not the case” (Bahr, 2010a, p.210). In his study of racial disparities in postsecondary
remedial math, Bahr found significant racial gaps with respect to successful outcomes in
developmental math, particularly with Blacks and Hispanics. Bahr (2008) discovered that racial
disparities in math remediation success are primarily due to differences in math ability when
entering college, student performance in an initial math class, and racial concentrations at
colleges and universities. Specifically noteworthy in Bahr’s (2010a) work is that racial
disparities in math performance are identifiable as early as kindergarten. These gaps are
amplified further throughout students’ elementary and secondary years, culminating in
disproportionate numbers of Blacks and Hispanics requiring postsecondary remediation in the
lower developmental math sequences beginning with arithmetic, as compared to Whites and
Asians being able to enroll in intermediate algebra and geometry. The result of these disparities
is that White and Asian students requiring postsecondary remediation acquire math skills within
six years at rates exceeding 25% and 33%, respectively. Conversely, Hispanics and Blacks requiring remediation achieve college-level math skills at 20% and 11%, respectively (Bahr, 2010a).

In their study of remediation needs in the California State University system, Howell et al., (2010) found that Sacramento State non-white students were approximately 9% higher in their need for English remediation and 12% higher in their need for math remediation than their white peers. Howell, et al. also discovered that African-American students require developmental math at a rate 18.5% greater than their white peers, and at a 15.6% greater rate with respect to developmental English. Thus, all minority racial and ethnic students who participated in this study were more likely to require remediation than their white counterparts.

**Academic Preparedness**

Although remedial education has gained support from the federal government and various foundations, there remains a void with respect to consistent, carefully regulated research which independently evaluates the efficacy of developmental education methodologies. The preponderance of developmental education research lacks generalizability because studies are based on sample populations from few institutions; fail to control for student preparedness; and are incomplete with respect to other factors that affect success (Handel & Williams, 2011). Handel and Williams also posit that although substantial public and private financial resources that have been devoted to remediation research, developmental efforts and programs have yet to be proven a sound investment, particularly as they relate to students with the greatest remedial needs. According to Bahr (2010b), recent studies employing sound methodological approaches and comprehensive state and national data have produced findings that take remediation research
to a more reliable level. These studies concur with respect to postsecondary remediation being “beneficial to the long-term attainment of skill-deficient students, when compared to students who do not participate in remediation or who participate but do not complete the remedial process successfully” (p.179).

Attewell et al. (2006) conducted a study of postsecondary remediation in order to assess what effect taking remedial courses had on students’ graduation rates and their time to complete a degree, including the significance of students taking multiple remedial courses; whether some remedial courses are more significant with respect to student attainment than others; and the relationship between students’ successful completion of remediation and degree attainment. Their research revealed that findings from previous studies regarding the negative effect that remediation has on student success and attainment are somewhat short-sighted. Attewell et al. concluded that students enrolling in at least one remedial course when entering a community college does not, itself alone, diminish a student’s chances of completing a degree. However, causal factors that do negatively impact students’ chances of completing a degree include low family socioeconomic status, being African-American, and entering two-year institutions having been inadequately prepared during high school. This was not the case concerning students entering four-year colleges and universities. Here, Attewell et al. concluded there was a moderately significant likelihood that remedial students were less likely to complete a degree when controlling for factors such as race, family status, and high school preparation.

While previous research from Deil-Amen and Rosenbaum (2002) found that students taking multiple remedial courses are significantly hindered with respect to completing an associate degree, Attewell et al. (2006) concluded that, when controlling for academic
preparation in high school, students’ chances of completing a two-year degree were not
diminished or adversely impacted by taking several developmental courses. They further
determined that “unlike the case for two-year colleges, students in four-year colleges who take
many remedial courses are at a disadvantage in earning a degree, over and above any
disadvantage stemming from their high school skills and background” (p.908). Attewell et al.
(2006) also surmised that taking multiple remedial courses at four-year colleges reduces
students’ chances of graduating by 12-15%. Students taking several developmental courses also
completed degrees at a 33% rate within a defined eight-year period. Although not identified as a
statistically significant difference, students taking three or more remedial courses did extend
their time to complete a degree by two to four months, as compared with students not taking
remedial courses.

In keeping consistent with the notion that the preponderance of remediation research
historically falls short of providing a comprehensive picture of developmental education’s value
to students in postsecondary education, Bettinger and Long (2009) believe that simple
comparisons of remedial students to non-remedial students are fundamentally deficient because
they fail to take into account student differences in areas such as family status, race, student
ability, and transfer across institutions. To mitigate this deficiency, Bettinger and Long
conducted a study of 28,000 full-time, traditional freshmen at public colleges and universities
over the course of six years, in order to determine the effect that remediation has on college
students’ ability to perform and persist in their postsecondary education. The methodology used
to control for selection issues, other than simply taking remedial courses, provided a much more
sound approach than just comparing remediated versus non-remediated students.
From their study results, Bettinger and Long (2009) estimated “that students in remediation have better educational outcomes in comparison to students with similar backgrounds and preparation who were not required to take the courses” (p.760). Another particularly salient point suggested by Bettinger and Long was that math and English remediation diminish the probability that students will not persist after five years and increase the chances of these students finishing their degrees in a four- to six-year timeframe. Bettinger and Long also found that students, who initially intended to major in math-related fields and were required to take developmental math, were positively impacted with respect to their persistence in completing a degree. These results are encouraging, considering that science, technology, engineering, and math continue to be a major focus in education. Conversely, Bettinger and Long (2009) found that students who anticipated majoring in English-related fields were negatively impacted when they were required to complete developmental English.

While many studies have been conducted and published concerning the efficacy of postsecondary remediation, most have been insufficient due to flawed research design, methodological deficiencies, and limited sample populations (Bahr, 2010b). In addition, even considering the far-reaching value of the aforementioned studies of Attewell et al. (2006) and Bettinger and Long (2009), questions still persist with respect to “the relationship between the depth and breadth of under preparation and the effectiveness of postsecondary remediation” (Bahr, 2010a, p.179). Depth of remedial need is the amount of deficiency in a particular subject-matter area, whereas breadth of remedial need involves the number of basic skill areas in which an individual needs developmental assistance (Bahr, 2007).
In identifying the remaining gaps in the research, Bahr (2010a) set out to conduct a study intended to answer the following questions: (1) To what extent does depth of under preparation at college entry moderate the successful remediation on academic attainment? (2) To what extent does breadth of under preparation at college entry moderate the successful remediation on academic attainment? Different from other studies, Bahr sought to examine the relationships between depth and breadth of remedial need and academic attainment, including the relationship between students’ math and English developmental needs. From his study, Bahr (2010a) suggested that 69% of students who exhibited no deficiencies in mathematics also demonstrated no deficiencies in English. In contrast, only 12% of students who displayed extremely poor math skills had no deficiencies in English. Bahr also noted that only 3% of students enrolling in higher-level math remediation needed developmental reading support, while 16% of students requiring lower-level math remediation also needed remedial reading support. Stated differently, “the more severe a student’s math skill deficiency at college entry, the more likely the student will be to have an English deficiency and the more likely it is that the deficiency will be severe” (p.187). Concerning depth of remedial need, Bahr (2010a) found that students who successfully complete one remedial course (English or math) and students who successfully remediate in both English and math, are equal or slightly better with respect to acquiring their degree or transferring credits to a four-year institution, than students who achieve proficiency in college-level math and English without remediation. Findings from this study are particularly noteworthy in current remediation research in that “testing the efficacy of remediation, it distinguishes both between varying degrees of deficiency and between varying combinations of deficiencies” (Bahr, 2010a, p.199).
While all three studies mentioned are sound in their approach and methodology, Bahr’s (2010a) research increases the comprehensive knowledge and understanding of remediation in postsecondary secondary education to greater lengths than previous studies.

Although recent studies are encouraging with respect to more sound methodology and generalizability, expanding the scope and regularity of research regarding postsecondary remediation and academic preparedness will benefit policy makers, educators, administrators, parents, and students. While current studies also employ sound methodology in examining the effects that depth and breadth of remedial need have on the success of traditional postsecondary students, similar empirical studies are needed to consider relationships between postsecondary CTE students’ performance and their developmental needs.

**Strategies to Address Lack of Preparedness**

The increase in remedial education interest is evident from the commitment of President Obama to devote substantial federal resources to the cause; the significant funding being dedicated by the Lumina Foundation for Education and the Carnegie Foundation for Advancement of Teaching to discover new methods and approaches for preparing students for postsecondary education; and the $110 million given by the Bill and Melinda Gates Foundation to fund advances in community college remedial education (Handel & Williams, 2011). It is evident from the increased interest in developmental education and number of students requiring remediation that improving current strategies and identifying new approaches to address students’ deficiencies are needed.

According to Zachry and Schneider (2010), the most encouraging approaches for advancing students more rapidly through remediation and into postsecondary coursework are
those that assist students in strengthening their abilities prior to entering postsecondary institutions; better assimilate students into postsecondary coursework; and/or offer substantive opportunities for students to develop their job-related and workforce skills. “Common interventions include early assessment programs or summer bridge programs for recent high school graduates” (p.12). Zachry and Schneider also suggest the advantages of strategies intended to fast-track students taking remedial courses. Fast-track approaches reduce the length of remedial courses into shorter timeframes in order to advance students more rapidly into college-level courses. “Key acceleration strategies include the modularization of traditional developmental education courses or ‘fast track’ courses that provide instruction in compressed time periods” (p.12). Sheldon and Durdella (2010) found that students in a large west coast two-year postsecondary institution – gender, age, ethnicity, and GPA notwithstanding – were able to perform better and achieve greater success in compressed developmental courses, as compared to full-semester courses. Sheldon and Durdella also recommended additional research and focus be given to students’ ability to retain information in compressed developmental courses. Examining student performance and outcomes in a series of developmental courses may help determine if compressed courses require greater commitment and motivation from students. The Virginia Community College System (VCCS) recently revised their developmental education to employ acceleration strategies that include a modular approach to math remediation. Some concerns with this strategy include reduced time for students with severe deficiencies to grasp concepts and retain material and computer-based versus instructor-led delivery methods. Although anecdotal at this point, student feedback suggests some concerns with the effectiveness of this new approach (Susan Pongratz, personal communication, November 14, 2012). Future research
in this area must consider the depth and breadth of student deficiencies in order to develop thoughtful remediation strategies that encourage student success.

A study conducted by Howell et al. (2010) on the influence of an Early Assessment Program (EAP) on students’ need for remediation at California State University revealed a 6.1% drop in students needing English remediation and a 4.1% drop in students requiring remedial math. EAP is considered an early intervention tool that gives “students the opportunity to make more informed decisions about their secondary school curriculum and postsecondary pathways” (p.746). Howell et al. posit that students participating in EAP improve their chances of avoiding remediation in college. However, greater evaluation of the EAP is needed for students in their 12th grade year to ensure they are taking full advantage of what the program has to offer with respect to offsetting the need for remediation.

Although significant attention has been given to strategies for enhancing the academic preparedness of students entering colleges and universities, little consideration has been given to the vocational preparedness of students entering the workforce or postsecondary CTE programs beyond high school. Lerman (2012) posits this lack of interest in work-related preparedness is not surprising considering the increased emphasis on preparing all students for traditional college opportunities. He also suggests that shifting focus away from work-related or CTE high school courses and curriculum has resulted primarily from the “college-for-all” philosophy and a concern that focusing on specific vocational areas or fields is premature for high school students.

**Career and Technical Education and Apprenticeship**

According to Christman (2012), the “common high school experience for all” (p.23) approach adopted by the United States during the mid-twentieth century resulted in a two-track
high school curriculum intended to place college-bound students and workforce-bound students on academic and vocational trajectories, respectfully. Christman further suggests that vocational education or CTE in secondary education continues to be regarded as an acceptable alternative for high school students considered less intelligent or ill-suited for college. This separation continues to perpetuate the stigma associated with vocational education and engenders an either-or philosophy with respect to college preparation and vocational training, suggesting the two are incompatible and unable to complement each other. Jones (2011) suggests academic and vocational paths are compatible when considered in the proper context of apprenticeships. Apprenticeships seek to employ a strategy that recognizes the benefits of both vocational training and related academic instruction. “Apprenticeships are postsecondary training programs that combine related academic instruction, trade theory, and hands-on practical experience in various craft, trade, or vocation under the guidance of a master practitioner” (Jones, 2011, p.52). While Jones suggests that apprenticeships are valuable because they afford students an opportunity to earn while they learn, while also providing on-the-job training that reinforces a related academic curriculum, he also acknowledges that apprenticeships are “undervalued by students, parents, educators, and policy makers” (p.53).

Because secondary education in the United States tends to segregate students in either academic or vocational curricula (Christman, 2012), students seeking postsecondary opportunities in vocational programs, particularly apprenticeships, are sometimes unprepared for the rigors associated with many apprentice programs (Filliettaz, 2010). Akinwumiju (2010), suggests that “in spite of the long-time recognition of and respect for vocational preparation at the secondary school level” (p.1), the extremely focused nature of vocational programs in the
United States unintentionally dissociates itself with general education in secondary education. As a result, students enrolling in apprentice programs, some of which include related academic coursework and theory on the two-year postsecondary level, are underprepared for the challenges of these apprentice programs. Consequently, “the chasm between related studies in the basics and vocational specialty training is not effectively bridged” (Akinwumiju, 2010, p.4), requiring students entering these apprentice programs to enroll in one or more remedial courses. Similar to students enrolling in traditional postsecondary programs, the quality of developmental education becomes a contributing factor to the success or failure of students enrolling in apprentice programs.

Another consideration when discussing the preparedness of individuals entering postsecondary CTE programs is the lack of attention these programs, particularly apprenticeships, receive in the United States. According to Lerman (2012), U.S. policymakers’ primary focus for resolving the current issues of high unemployment (adult and youth), high wage inequity, and little or no growth in the wages of workers possessing less than a bachelor’s degree, is directing resources toward increasing the number of people attending college, an approach that has proven to be costly and ineffective. Lerman (2010) posits that “federal support for apprenticeship training is meager” (p.3). This short-sighted focus on traditional postsecondary education opportunities for all by policymakers should continue to be challenged considering the fact that “half of all workforce vacancies in the next decade are likely to demand serious occupational skills that are generally acquired with a combination of postsecondary courses and learning on the job” (Lerman, 2009, p.8)
There is a limited body of research specifically related to the persistence and success of students in CTE programs or apprenticeships. Many of the original theoretical models intended to explain the troubling phenomenon of student attrition at the postsecondary level were grounded in the experiences of students attending residential, four-year institutions (Tinto, 1975). Later, research was expanded to consider student attrition at the postsecondary two-year level; however, models generated from these efforts were insufficient because they failed to address the various types of educational programs provided by community colleges (Bean & Metzner, 1985). Bailey, Alfonso, Scott, and Leinbach (2004) suggested two important reasons that reinforce the need for additional research concerning postsecondary CTE students’ persistence and attainment: the significant drop-out proneness rates of students enrolled in postsecondary CTE programs, and primary research theories concerning postsecondary student attrition and success that do not consider CTE programs.

**CTE Preparedness**

While research regarding the effect that previous work experience and/or training has on the vocational attainment of students completing postsecondary CTE programs is limited, a study by Rezin and McCaslin (2001) compared the vocational attainment of students completing a traditional postsecondary CTE program with students completing a cooperative apprenticeship, based on their level of preparedness when entering the programs. In their study, Rezin and McCaslin found that “all of the relationships of prior-related experience and prior-related training to employment status, related employment, and job title were found to be negligible” (p.89) within the context of each program. Rezin and McCaslin did find, however, that individuals completing a cooperative apprenticeship experienced more success with respect to
employment status, related employment, and job title, as compared with students completing a traditional CTE program.

According to The Center for Educational Testing and Evaluation (2011), the Career Pathways™ Collaborative, a group of three states including Colorado, Kansas, and Mississippi, is currently developing the Career Pathways Assessment System™ (cPass®). This system is intended to gauge high school students' preparedness for entering post-secondary education and/or the workforce. More specifically, students will use the assessment to determine their level of preparedness for entering postsecondary programs, apprenticeships, and entry-level employment in their areas of interest. Different than other instruments which typically measure students’ readiness for postsecondary programs with respect to academic prowess, cPass® will also measure the knowledge and skills needed for particular vocations using performance based tasks.

**Biblical Perspective on Student Preparedness**

As was previously mentioned, researchers and practitioners in education have expanded the original use of Merton’s (1968) Matthew Effect to describe academic attainment of students in postsecondary education: “For to everyone who has, more will be given, and he will have abundance; but from him who does not have, even what he has will be taken away” (Matthew 25:29, New King James Version). As children of God we are both unique and made in His image. “So God created man in His own image; in the image of God He created him; male and female He created them” (Genesis 1:27). Because we are unique, different approaches to learning and development are always a consideration for education practitioners and researchers, especially with respect to students requiring remediation. This position is consistent with
Calcagno et al. (2007) in that treating individuals uniquely regarding their educational needs, particularly the depth and breadth of their remedial need, can help students overcome the Matthew Effect and be successful. This is consistent with the truth that God has gifted us in countless ways: “Every good gift and every perfect gift is from above, and comes down from the Father of lights, with whom there is no variation or shadow of turning” (James 1:17, New King James Version).

While recent research suggests that remediation can have a positive impact on academic attainment and persistence, as Christian educators we must always be cognizant of those students who possess severe deficiencies in basic skills and knowledge. Consequently, we must look for better strategies and improve methods to help educate and train such students. However, it is equally incumbent upon us to encourage each student to realize their greatest potential. In reality, we partner with students on their educational journey, no matter where they may be on that journey.

Everyone helped his neighbor, and said to his brother, “Be of good courage!” So the craftsman encouraged the goldsmith; He who smooths with the hammer inspired him who strikes the anvil, Saying, ‘It is ready for the soldering’; Then he fastened it with pegs, That it might not totter (Isaiah 41:6-7).

God has a purpose for all our lives, including a level of contentment that only He can provide. As Christian educators and leaders we must convey to all of our students a level of satisfaction that only God can provide His children, regardless of their academic and vocational prowess.
Summary

A review of the literature concerning students’ academic preparedness for postsecondary education reveals mixed opinions from researchers, educators, parents, and students. In addition, it is unclear from the literature whether consistent negative or positive relationships exist between postsecondary students’ remedial needs and their ability to successfully remediate, complete first-level coursework, and complete two- or four-year postsecondary programs. While proponents and opponents argue concerning remediation’s efficacy with respect to student performance, graduation rates, academic attainment, and persistence, current research employing sound methodology has typically indicated that remediation has value for inadequately prepared students entering postsecondary education. However, comprehensive research is limited with respect to CTE students, specifically students enrolled in apprentice programs, when considering their lack of academic preparedness and ability to persist and successfully complete developmental courses, first-level program courses, and their apprenticeship overall.

The literature also suggests a significant deficiency concerning the impact that lack of vocational preparedness has on students entering postsecondary CTE programs and apprenticeships. Although the Career Pathways™ Collaborative is seeking to better ascertain the academic and vocational preparedness of students entering postsecondary education and apprenticeships, the research regarding the effect that vocational preparedness has on students’ performance and ability to persist is dated and inadequate. As a result, students, parents, educators, and policy makers are limited in their knowledge of what is needed to better prepare students for postsecondary CTE programs and apprenticeships. The purpose of this study is to
examine this existing gap and add to the body of knowledge in research and literature concerning the academic and vocational preparedness of students entering postsecondary CTE programs.
CHAPTER 3 - METHODOLOGY

Separation of related academics and vocational training in secondary education continues to perpetuate the stigma associated with vocational education and lack of preparedness of individuals entering apprenticeships (Christman, 2012). Consequently, these programs are “undervalued by students, parents, educators, and policy makers” (Jones, 2011, p.52). This study used a quantitative design to examine the effects that students’ lack of preparedness academically and vocationally have on their performance in a postsecondary CTE program (apprenticeship) and their post-program vocational attainment.

Design

This quantitative study was conducted with an ex-post facto multivariate correlational design using binary logistic regression, multiple regression, and multinomial logistic regression methodologies. Multivariate correlational designs were chosen for this study in lieu of other research designs because they offer the most suitable approach for examining relationships between a combination of two or more predictor variables and a criterion variable (Howell, 2011); offer approximations of “the magnitude and statistical significance of relationships between variables” (Gall, Gall, & Borg, 2007, p.353); and provide a basis for accepting or rejecting null hypotheses (Peterson, 2010). This study examined the ability of students’ academic and vocational preparedness to predict their performance in a postsecondary career and technical education (CTE) program and their post-program vocational attainment.

In his study on postsecondary students’ academic attainment and their ability to complete two-year academic or vocational programs, Bahr (2010b) considered students’ academic preparedness and depth of remedial need in mathematics using a multinomial logistic regression
methodology similar to the one used in this study. In addition, ex-post facto multiple regression designs have been used to examine relationships between two or more predictor variables and academic attainment (GPA) during first-year attendance in a postsecondary two-year vocational program. Specifically, Guccione (1992) used multivariate correlational methodologies to study factors that predict in-program performance and achievement of postsecondary students in two-year technology programs. In considering the preparedness of students leaving high school vocational and technical programs to enter the workforce, Busch (2001) employed a multiple regression methodology in order to determine the relationship between multiple predictor variables and the two continuous criterion variables earnings and employment turnover. These studies demonstrate the appropriateness and value of using multivariate correlational designs to study the ability of students’ academic and vocational preparedness to predict performance and outcomes in postsecondary CTE programs.

**Research Questions and Hypotheses**

The following research questions and hypotheses guided this quantitative study:

RQ1: How well do students’ remedial need in mathematics (as measured by a pre-program math placement test), academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses), pre-program work experience (measured in years of related and non-related experience), and vocational education (vocational courses completed with a minimum grade of “B” during secondary or postsecondary education) predict their ability to complete a postsecondary CTE program?

RQ2: How well do students’ remedial need in mathematics (as measured by a pre-program math placement test) and academic preparedness (an algorithmic assessment of
students’ pre-program performance in qualifying courses) predict their academic attainment (in-program GPA) in a postsecondary CTE program?

RQ3: How well do students’ academic attainment (in-program GPA) and on-the-job training (OJT) performance (numerically averaged grade measuring five areas: technical knowledge and comprehension; quantity; quality, leadership and initiative; and conduct) in a postsecondary CTE program predict their post-program vocational attainment (vocational positions entered after completing a CTE program)?

H01: Students’ remedial need in mathematics (as measured by a pre-program math placement test), academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses), previous work experience (measured in years of related and non-related experience), and vocational education (vocational courses completed with a minimum grade of “B” during secondary or postsecondary education) do not predict their ability to complete a postsecondary CTE program.

H02: Remedial need in mathematics (as measured by a pre-program math placement test) and academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses) do not predict the academic attainment (in-program GPA) of students in a postsecondary CTE program.

H03: Students’ academic attainment (in-program GPA) and on-the-job training (OJT) performance (numerically averaged grade measuring five areas: technical knowledge and comprehension; quantity; quality; leadership and initiative; and conduct) in a postsecondary CTE program do not predict their post-program vocational attainment (vocational positions entered after completing a CTE program).
Participants

Participants for this study resulted from employing a convenience sample methodology that identified 721 students who entered a postsecondary CTE institution (CSL Institution – pseudonym) from 2005-2007. Students who entered the institution from 2005-2007 were chosen because they possessed the potential to complete one of the institution’s programs by the end of 2012, which supported some of the criterion variables being considered in this study. The demographic make-up of students in this study was 42% minority, 16% female, 78% were younger than 25 years old, 16% were 25-34 years old, and 6% were 35 years and older. More specifically, the population was 52% Caucasian male, 32% minority male, 6% Caucasian female, and 10% minority female. Although students were from various regions in the United States, 75% of the students were native Virginians. Students in the population possessed diverse educational backgrounds and work experiences. Based on the U.S. Department of Education 2007-2008 data regarding students enrolled in postsecondary CTE programs, 38% were minority, 61% were female, 60% were younger than 25 years old, 23% were 25-34 years old, and 17% were 35 and older (National Center for Education Statistics, 2010). Although a convenience sample approach was employed for this study and participants were enrolled at a single postsecondary institution, the characteristics of the sample population, with the exception of females, are analogous to the 2007-2008 student characteristics for postsecondary CTE programs identified by the National Center for Education Statistics.

Participants were, at a minimum, high school graduates or the equivalent – General Education Development (GED) completers. Although the academic backgrounds of students were diverse in that 36% entered a CTE program immediately following high school, 64%
possessed some postsecondary or military background, and approximately 9% possessed associate or bachelor degrees from varying fields of study, all students were required to complete the school’s mandatory academic curriculum with no transfer credit given from previously attended postsecondary institutions. Additionally, participants included in this study were required to complete the institution’s math placement test in order to determine their depth of remedial need in mathematics prior to beginning a program at the institution. Students achieving a score of 75 out of a possible 100 on the math placement test were considered adequately prepared to begin the required curriculum. Students scoring 45-70 or less than or equal to 40 on the math placement test were required to complete the school’s twelve-hour or ten-week developmental math courses, respectively. The aforementioned participant characteristics provided the required framework to support this study.

The sample population for RQ1 included the 721 students who entered the institution from 2005-2007 and were initially enrolled in one of the institution’s 19 apprentice programs. The sample for RQ2 consisted of 428 of the 721 students included in RQ1. The 428 students in RQ2 successfully completed one of the apprentice programs offered at the institution (59.3% completion rate). The population for RQ3 consisted of the same 428 students from RQ2 who successfully completed one of the institution’s programs. While participants for the study came from the same population of 721 students who entered CSL Institution from 2005-2007, some variance in the descriptive statistics of the sample population for RQ1 versus sample populations for RQ2 and RQ3 were inevitable because: the variables being considered in each research question were different in some instances, and only those students who successfully completed a program were included in the populations used for RQ2 and RQ3.
Setting

The population from which the research sample was selected were enrolled at a postsecondary CTE institution in the mid-Atlantic region of the United States. The institution was selected as the site for this study based on its proven ability to educate and train individuals in the manufacturing, production, and maintenance trades. Employing a traditional apprenticeship model, the school delivers OJT instruction with skilled craftsmen and instructors; a trade related education curriculum; and general education and technical academic curricula that use classroom-based instruction. The school offers 26 programs (apprenticeships) in the aforementioned trade categories. The programs are 8,000- to 10,000- hour apprenticeships (four-five years) containing 7,000-8,200 hours of on-the-job training and 1,000-1800 hours of technical, general, and trade-related education instruction. The institution and its programs have been accredited through the Commission of the Council on Occupational Education (COE) since 1982.

Instrumentation

Ex-post facto data for this quantitative study came from two primary sources maintained by CSL Institution. Information for students’ remedial need in mathematics (math placement test), academic preparedness (academic assessment instrument), previous work experience (admission application), and OJT performance (craft evaluation instrument) were collected from a Microsoft Access database. In-program academic attainment (grade point average – GPA) and post-program vocational attainment data were gathered from a Systems Applications and Products in Data Processing (SAP) program. All ex-post facto data was retrieved from these two databases, which were considered the institution’s official record keeping system. The integrity
of the data was maintained in accordance with the guidelines established by the Commission of the Council on Occupational Education, the organization through which CSL institution is accredited.

**Math Placement Test**

Remedial need in mathematics was measured by a math placement test administered during students’ first week on campus. The placement test contained twenty algebra problems, each having a value of five points, with a possible total of 100 points for the test. While all students’ work had to be shown on the math placement test to receive credit, no partial credit was granted based on the work students provided. In other words, problems were graded as correct or incorrect only. For the purposes of this study, remedial need in mathematics was measured as a continuous variable on an interval scale ranging from 0 to 100. This instrument has been used by CSL institution to measure students’ depth of remedial need in mathematics for approximately 12 years. Although Kuder-Richardson-20 (KR-20) analysis is an alternative for determining the reliability of instruments with dichotomous responses, either correct or incorrect as was the case with the math placement test, Cronbach’s alpha was chosen because KR-20 analysis normally results in lower reliability coefficients than would be achieved using other reliability analysis methods (Gall et al., 2007). When analyzing 500 individual test results from students at CSL institution, SPSS calculated a Cronbach’s alpha of .896 for the math placement test. The validity of the instrument was based on a content-related methodology. The instrument was developed by a CSL institution subject-matter expert who holds a master’s degree in computational mathematics and was adjudicated by two additional faculty members of the institution.
Academic Assessment Instrument

Academic preparedness of participants was calculated with an academic assessment instrument that used a mathematical algorithm to generate a numerical score based on student performance in qualifying courses completed in high school or previously attended postsecondary institutions. Qualified courses included algebra I, geometry, algebra II, trigonometry, advanced math (pre-calculus, calculus, and statistics), chemistry, physics, vocational/technical education, computer science, and principles of technology. Students’ academic preparedness was calculated during the admissions review process and was one of the factors in considering whether a candidate received an interview or was extended an offer to enter one of the school’s programs. For the purposes of this study, academic preparedness was measured as a continuous variable on an interval scale ranging from 0 to 40. This instrument has been used by the institution for approximately 12 years to determine students’ academic preparedness.

Admission Application

Previous work experience was collected from study participants’ admission applications. Students were provided an opportunity and sufficient space on their admission applications to self-disclose previous work experience. The reliability of this data resided completely with the personal integrity of students since previous work experience and references were not confirmed or contacted, respectively. Because applicants were required to provide dates of previous work experience on the application, data was measured in the form of a continuous variable. For the purposes of this study, previous work experience was measured in years as a continuous variable.
using an interval scale. The institution has provided applicants an opportunity to self-disclose previous work experience since its founding in 1919.

**Craft Evaluation Instrument**

OJT performance of study participants was calculated using a craft evaluation instrument. Students’ work-related performance was evaluated on a monthly basis in five specific categories: knowledge and comprehension, quantity, quality, leadership and initiative, and conduct. The craft evaluation instrument provided evaluative statements pertaining to students’ performance in each of the five categories. During the evaluation process, OJT instructors chose statements that best represented the performance of students in each of the five categories. The statements were associated with a Likert-scale that contained positive and negative numerical values ranging from –4 to +4. The numerical values assigned to statements in each category were added to an institutionally established grading standard of 80. The instrument assigned bi-monthly numerical scores ranging from 60 to 100. Participants in this study had up to 60 craft evaluation scores during their apprenticeship, depending on their particular program length (four to five years). For the purposes of this study, OJT performance of participants was the numerical average of all craft grades achieved during their program, and was measured as a continuous variable on an interval scale ranging from 60 to 100. This instrument has been used by the institution for approximately 18 years to assess the OJT performance of students.

**Procedures**

Predictor and criterion variable data required for this study resided in the institution’s databases to which the researcher had access. Data collection consisted of creating appropriate database queries and exporting the information to Microsoft Excel and SPSS software. Because
the data was institutional proprietary information, queries and spreadsheets containing raw data for participants in the study remained on the institution’s computer assets and network, both of which were password protected and accessible by the researcher. When the need to download data occurred, removable storage media was used. To provide the required level of security required for proprietary information, the institution’s information technology system provided encryption and password protection that was accessible to the researcher. As a result, the institution’s computer assets, network, and researcher’s protocol ensured the thorough protection and integrity of the data.

Since the school had SPSS software installed on several computer assets that were available to the researcher, data collection, retrieval, and analysis within the context of the study were easily accomplished. All data required to be used at locations outside CSL institution were encrypted and password protected. The use of SPSS outside the confines of the institution posed some threat to the protection of the data; however, the researcher safeguarded the data by having it on his person or locked up at all times while not in use.

Permission to conduct the research was granted by CSL Institution and the Liberty University Institutional Review Board (IRB). The first step taken to gain approval for the study and methodology was from the dissertation committee chair. Following approval from the committee chair, the researcher determined that the exempt application could be used based on the Research Exemption Request Guidelines. Care was taken to ensure that “No” was the appropriate response to the eight Exemption Screening Questions before submitting the exempt application to the dissertation chair for review and signing. The exempt application was chosen because the research involved the collection or study of ex-post facto data or records that could
not be directly or indirectly associated with the research participants. Once this was accomplished, the form and additional required documentation were submitted to the IRB in both hard copy and electronic formats.

**Data Analysis**

This study on the effects of students’ academic and vocational preparedness on their performance in a postsecondary CTE program and post-program vocational attainment used the International Business Machines (IBM) Statistical Package for the Social Sciences (SPSS) software to conduct binary logistic regression, multiple regression, and multinomial logistic regression analyses. The means, standard deviations, and ranges were calculated for the eight continuous predictor variables included in the study: remedial need in mathematics (as measured by a pre-program math placement test), academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses), previous related work experience (measured in years), previous and non-related work experience (measured in years), age when started the program (in years), vocational classes completed (with a “B” or better), academic attainment (in-program GPA), and OJT performance (numerically averaged grade measuring five areas: technical knowledge and comprehension; quantity; quality; leadership and initiative; and conduct).

**Research Question 1**

RQ1 used binary logistic regression to analyze the ability of remedial need in mathematics (as measured by a pre-program math placement test); academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses); previous related and non-related work experience (measured in years); vocational education (vocational
courses completed with a minimum grade of “B”); student age when started the program, ethnicity; and gender, to predict participants’ ability to complete a CTE program. Logistic regression was chosen because this methodology examines how well scores on multiple predictor variables that are continuous or categorical (logistic regression, 2006) can predict scores on criterion variables that are dichotomous (Gall, Gall & Borg, 2010). Logistic regression was also chosen because this methodology assists the researcher in overcoming the many limiting assumptions associated with using ordinary least squares (OLS) regression, two of which are the criterion variable being normally distributed and homoscedastic (Garson, 2012).

Because logistic regression uses maximum likelihood estimation (ML) requiring “large-sample asymptotic normality, which means that reliability of estimates declines when there are few cases for each observed combination of independent variables” (Garson, 2012, p.121), ensuring an adequate sample size for RQ1 was essential. While Hosmer and Lemeshow (2000) suggest a minimum of 10 cases for each predictor variable, RQ1 used a sample size of 721 participants, which well ensured that a minimum of 20 cases remained in the smaller of the two outcomes (completers or non-completers) after having divided the total number of cases by the number of predictor variables in the model (Harrell, 2001), which for RQ1 equaled eight predictor variables. Considering the historical 60-65% completion rate of students at CSL institution, using a sample of 721 easily yielded a minimum of 20 cases in the non-completer outcome category. This sampling approach also satisfied the requirements of goodness-of-fit measures in that all cell frequencies were greater than or equal to one and a minimum of 80% were greater than five (Garson, 2012). Additional assumptions for RQ1 included absence of collinearity, considered tenable if the Variance Inflation Factor (VIF) is less than three; linearity
in the logit – linearity of independent variables and log odds; lack of separation between participants; and standardized residuals of less than three at the .05 significance level were considered acceptable (Garson, 2012). Outliers identified during statistical analysis were removed from the model.

Results reported from RQ1 included statistics for the constant and each predictor variable: remedial need in mathematics (as measured by a pre-program math placement test); academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses); pre-program related and non-related work experience (measured in years); vocational education (vocational courses completed with a minimum grade of “B”), and age when started the program. Model fitting information and likelihood ratio tests and parameters estimates, including Wald and Hosmer & Lemeshow tests with their related chi-square, significance levels, and degrees of freedom, were also reported. Effect size was also examined using the model’s classification table; Nagelkerke’s R-squared, described as weak, moderate, or strong; and odds-ratios (exp (b)). The regression equation for the model was reported as $z = b_0 + b_1X_1 + b_2X_2 + b_3X_3$ where $z$ is the log odds of the dichotomous criterion variable (ability to complete a postsecondary CTE program – completer versus non-completer); $b_0$ is the constant or the “log odds (logit estimate) of the criterion variable when model predictors were evaluated at zero” (Garson, 2012, p.59); $X_1$ is remedial need in mathematics (as measured by a pre-program math placement test); $X_2$ is academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses); $X_3$ is pre-program related work experience (measured in years); $X_4$ is pre-program non-related work experience (measured in years); $X_5$ is
vocational education (vocational courses completed with a minimum grade of “B”); $X_6$ is student age when started the program; $X_7$ is ethnicity; and $X_8$ is gender.

**Research Question 2**

RQ2 used multiple linear regression to analyze how well remedial need in mathematics (as measured by a pre-program math placement test) and academic preparedness (an algorithmic academic assessment of students’ pre-program performance in qualifying courses) predict the academic attainment (in-program GPA) of students in a postsecondary CTE program. According to Tabachnick and Fidell (2005), the sample size of 428 used for RQ2 was more than sufficient to satisfy the recommended $N \geq 40*2$ (the number of predictor variables supporting RQ2).

Descriptive statistics were generated for all RQ2 variables and assumptions of normal distribution were considered tenable if a histogram produced a fitted normal curve. The appropriateness of using multiple linear regression was substantiated by analyzing scatterplots of predictor variables (remedial need in mathematics and academic preparedness) with the criterion variable (academic GPA) to determine linearity. The assumption of linearity between predictor variables and the criterion variable were tenable because scatterplots formed a relatively straight line of best fit. The assumption of homoscedasticity between each predictor variable and the criterion variable was considered tenable because scatterplots formed a cigar shape, indicating that bivariate distributions were equitably spread about the line of best fit (Gall et al., 2007). The level of multicollinearity was considered acceptable because the Variance Inflation Factors (VIF) were less than 3; Pearson’s $r$ among all predictor variables was less than .7; a factor analysis of the predictor variables yielded a condition index (CI) of less than 10; and Tolerance (T) level was not less than 0.3. An assumption of no multivariate outliers was considered tenable because
studentized deleted residual values did not exceed ± 3.0. Multivariate outliers identified during the analysis were removed from the regression model for RQ2 as necessary.

Results reported from RQ2 included descriptive statistics (means, standard deviations, and bivariate correlations); the Model Summary (squared multiple correlation ($R^2$), adjusted squared multiple correlation ($R^2_{adj}$), and Std. Error of the Estimate (SEE), which showed how well the linear combination of remedial need in mathematics (as measured by a pre-program math placement test) and academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses) predicted academic attainment (in-program GPA) of students in the postsecondary CTE program (Green and Salkind, 2011); ANOVA results showed degrees of freedom (df), F-test (testing the significance of the regression model), the significance level for the model; and Coefficients (two-tailed t-tests, regression coefficients, and confidence intervals). The regression equation for the model was reported as $\hat{Y} = b_1X + b_2Z + b_0$ (Howell, 2011) where $\hat{Y}$ is the true criterion variable academic attainment (in-program GPA) of students in the postsecondary CTE program; $X$ is remedial need in mathematics (as measured by a pre-program math placement test); $Z$ is academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses); $b_0$ is the intercept; and $b_1$ and $b_2$ are the regression coefficients for each predictor variable.

**Research Question 3**

RQ3 used multinomial logistic regression to analyze how well students’ academic attainment (in-program GPA) and on-the-job training (OJT) performance (numerically averaged grade measuring five areas: technical knowledge and comprehension; quantity; quality, leadership and initiative; and conduct) predict their post-program vocational attainment
Multinomial regression was selected for RQ3 because of its ability to analyze how well two or more predictor variables (academic attainment and OJT performance) can predict a criterion variable (post-program vocational attainment) that has multiple categorical outcomes: 1 = hourly tradesperson; 2 = salaried non-management; 3 = salaried management (Garson, 2012). Assumptions outlined for the binary logistic regression analysis of RQ1 were also applicable to RQ3. The sample of N = 428 for RQ3 was more than adequate to satisfy the requirement of the criterion variable having at least 10 cases per parameter in the model (Peduzzi, et al., 1996).

Results reported from RQ3 included statistics for the constant and each predictor variable: academic attainment (in-program GPA) and on-the-job training (OJT) performance (numerically averaged grade measuring five areas: technical knowledge and comprehension; quantity; quality, leadership and initiative; and conduct). Model fitting information and likelihood ratio tests and parameters estimates including Wald and Hosmer & Lemeshow tests with their related chi-square, significance levels, and degrees of freedom were also reported. The regression equation for the model was reported as

\[
Pr (y_i = \text{hourly tradesperson}) = \frac{\exp (x_i \beta_j)}{\sum \exp (x_i \beta_j)},
\]

where \( Pr (y_i = j) \) is the probability of belonging to the hourly tradesperson category, \( x_i \) is the vector of predictor variables, and \( \beta_j \) are the regression coefficients from the maximum likelihood estimation. This regression equation was used to calculate probability for each of the three categories (1 = hourly tradesperson; 2 = salaried non-management; 3 = salaried management) in the criterion variable post-program vocational attainment.
CHAPTER FOUR: FINDINGS

Research Questions

The purpose of this study was to consider the effect that academic and vocational preparedness has on students’ performance in a postsecondary CTE or apprenticeship program, and the relationship between their in-program performance and vocational attainment after program completion. The following predictor variables were included in this study: remedial need in mathematics (as measured by a pre-program math placement test); academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses); pre-program work experience (measured in years of related and non-related experience); vocational education (vocational courses completed with a minimum grade of “B” during secondary or postsecondary education); and participants’ gender, ethnicity, and age when they started the program. Criterion variables used in this study included students’ ability to complete a postsecondary CTE program (completers versus non-completers), academic attainment (in-program GPA), and post-program vocational attainment (vocational positions entered after completing a CTE program).

RQ1: How well do students’ remedial need in mathematics (as measured by a pre-program math placement test), academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses), pre-program work experience (measured in years of related and non-related experience), and vocational education (vocational courses completed with a minimum grade of “B” during secondary or postsecondary education) predict their ability to complete a postsecondary CTE program?
**RQ2**: How well do students’ remedial need in mathematics (as measured by a pre-program math placement test) and academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses) predict their academic attainment (in-program GPA) in a postsecondary CTE program?

**RQ3**: How well do students’ academic attainment (in-program GPA) and on-the-job training (OJT) performance (numerically averaged grade measuring five areas: technical knowledge and comprehension; quantity; quality, leadership and initiative; and conduct) in a postsecondary CTE program predict their post-program vocational attainment (vocational positions entered after completing a CTE program)?

**Null Hypotheses**

**H₀₁**: Students’ remedial need in mathematics (as measured by a pre-program math placement test), academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses), previous work experience (measured in years of related and non-related experience), and vocational education (vocational courses completed with a minimum grade of “B” during secondary or postsecondary education) do not predict their ability to complete a postsecondary CTE program.

**H₀₂**: Remedial need in mathematics (as measured by a pre-program math placement test) and academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses) do not predict the academic attainment (in-program GPA) of students in a postsecondary CTE program.

**H₀₃**: Students’ academic attainment (in-program GPA) and on-the-job training (OJT) performance (numerically averaged grade measuring five areas: technical knowledge and
comprehension; quantity; quality, leadership and initiative; and conduct) in a postsecondary CTE program do not predict their post-program vocational attainment (vocational positions entered after completing a CTE program).

**Null Hypothesis One**

**Description of Participants**

Participants used in this study consisted of 721 students who began a program of study at a postsecondary CTE institution (CSL institution) from 2005-2007. The demographic characteristics of the 721 participants in this study included the following: Caucasian males (51.46%), African American males (29.26%), other minority males (2.91%), Caucasian females (6.10%), African American females (9.71%), other minority females (0.55%), 18-24 years old (78.09%), 25-34 years old (15.81%), 35 years and older (6.10%).

**Descriptive Statistics**

Descriptive statistics for H_01 population are shown in Table 1 and Table 2. The sample consisted of the 721 students who started a program of study at CSL institution from 2005-2007. Table 1 provides descriptive statistics for categorical variables for H_01: ethnicity*gender*program completion – cross tabulation. Table 2 shows descriptive statistics for continuous predictor variables in H_01: remedial need in math, academic preparedness, age when started, number of vocational classes with a “B” or better, related work experience, and non-related work experience.
Table 1

*Descriptive Statistics for RQ1 Categorical Variables (Ethnicity*Gender*Program Completion)*

**Cross Tabulation**

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Program Completion</th>
<th>No</th>
<th>Yes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>Count</td>
<td>100</td>
<td>111</td>
<td>211</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>16.6%</td>
<td>18.4%</td>
<td>35.0%</td>
</tr>
<tr>
<td>Female</td>
<td>Count</td>
<td>34</td>
<td>36</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>28.8%</td>
<td>30.5%</td>
<td>59.3%</td>
</tr>
<tr>
<td>Caucasian</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>Count</td>
<td>130</td>
<td>241</td>
<td>371</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>21.6%</td>
<td>39.9%</td>
<td>61.5%</td>
</tr>
<tr>
<td>Female</td>
<td>Count</td>
<td>15</td>
<td>29</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>12.7%</td>
<td>24.6%</td>
<td>37.3%</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>Count</td>
<td>13</td>
<td>8</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>2.2%</td>
<td>1.3%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Female</td>
<td>Count</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>0.8%</td>
<td>2.5%</td>
<td>3.4%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>Count</td>
<td>243</td>
<td>360</td>
<td>603</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>40.3%</td>
<td>59.7%</td>
<td>100%</td>
</tr>
<tr>
<td>Female</td>
<td>Count</td>
<td>50</td>
<td>68</td>
<td>118</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>42.4%</td>
<td>57.6%</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>293</td>
<td>428</td>
<td>721</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>40.6%</td>
<td>59.4%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 2

*Descriptive Statistics for Continuous Predictor Variables in RQ1*

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Remedial Need in Math</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>211</td>
<td>0.00</td>
<td>95.00</td>
<td>30.85</td>
<td>20.71</td>
</tr>
<tr>
<td>Female</td>
<td>70</td>
<td>0.00</td>
<td>75.00</td>
<td>27.93</td>
<td>19.66</td>
</tr>
<tr>
<td>Caucasian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>371</td>
<td>0.00</td>
<td>95.00</td>
<td>39.10</td>
<td>22.48</td>
</tr>
<tr>
<td>Female</td>
<td>44</td>
<td>0.00</td>
<td>90.00</td>
<td>43.30</td>
<td>23.77</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>21</td>
<td>5.00</td>
<td>90.00</td>
<td>38.81</td>
<td>26.64</td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>35.00</td>
<td>95.00</td>
<td>68.75</td>
<td>24.96</td>
</tr>
<tr>
<td>Total</td>
<td>603</td>
<td>0.00</td>
<td>95.00</td>
<td>36.20</td>
<td>22.34</td>
</tr>
<tr>
<td>Male</td>
<td>118</td>
<td>0.00</td>
<td>95.00</td>
<td>35.04</td>
<td>23.37</td>
</tr>
<tr>
<td>Female</td>
<td>721</td>
<td>0.00</td>
<td>95.00</td>
<td>36.01</td>
<td>22.50</td>
</tr>
<tr>
<td>Academic Preparedness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>211</td>
<td>6.00</td>
<td>40.00</td>
<td>15.66</td>
<td>6.11</td>
</tr>
<tr>
<td>Female</td>
<td>70</td>
<td>6.00</td>
<td>36.60</td>
<td>15.99</td>
<td>5.35</td>
</tr>
<tr>
<td>Caucasian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>371</td>
<td>6.00</td>
<td>40.00</td>
<td>18.49</td>
<td>6.44</td>
</tr>
<tr>
<td>Female</td>
<td>44</td>
<td>10.00</td>
<td>30.00</td>
<td>19.29</td>
<td>4.85</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>21</td>
<td>6.00</td>
<td>35.20</td>
<td>17.23</td>
<td>6.27</td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>17.00</td>
<td>34.00</td>
<td>25.70</td>
<td>7.86</td>
</tr>
<tr>
<td>Total</td>
<td>603</td>
<td>6.00</td>
<td>40.00</td>
<td>17.45</td>
<td>6.45</td>
</tr>
<tr>
<td>Male</td>
<td>118</td>
<td>6.00</td>
<td>36.60</td>
<td>17.55</td>
<td>5.65</td>
</tr>
<tr>
<td>Female</td>
<td>721</td>
<td>6.00</td>
<td>40.00</td>
<td>17.47</td>
<td>6.32</td>
</tr>
<tr>
<td>Age When Started Program</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>211</td>
<td>18.00</td>
<td>47.00</td>
<td>21.37</td>
<td>5.27</td>
</tr>
</tbody>
</table>
### Descriptive Statistics for Continuous Predictor Variables in RQ1 (cont.)

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>70</td>
<td>18.00</td>
<td>46.00</td>
<td>23.30</td>
<td>5.80</td>
</tr>
<tr>
<td>Caucasian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>371</td>
<td>18.00</td>
<td>48.00</td>
<td>22.12</td>
<td>6.14</td>
</tr>
<tr>
<td>Female</td>
<td>44</td>
<td>18.00</td>
<td>47.00</td>
<td>25.07</td>
<td>7.49</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>21</td>
<td>18.00</td>
<td>31.00</td>
<td>22.67</td>
<td>4.78</td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>19.00</td>
<td>25.00</td>
<td>22.00</td>
<td>2.58</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>603</td>
<td>18.00</td>
<td>48.00</td>
<td>21.88</td>
<td>5.81</td>
</tr>
<tr>
<td>Female</td>
<td>118</td>
<td>18.00</td>
<td>47.00</td>
<td>23.92</td>
<td>6.44</td>
</tr>
<tr>
<td>Total</td>
<td>721</td>
<td>18.00</td>
<td>48.00</td>
<td>22.21</td>
<td>5.96</td>
</tr>
</tbody>
</table>

### Number of Vocational Classes w/ “B” or Better

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>211</td>
<td>0.00</td>
<td>2.00</td>
<td>.32</td>
<td>.50</td>
</tr>
<tr>
<td>Female</td>
<td>70</td>
<td>0.00</td>
<td>1.00</td>
<td>.11</td>
<td>.32</td>
</tr>
<tr>
<td>Caucasian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>371</td>
<td>0.00</td>
<td>3.00</td>
<td>.42</td>
<td>.57</td>
</tr>
<tr>
<td>Female</td>
<td>44</td>
<td>0.00</td>
<td>2.00</td>
<td>.25</td>
<td>.49</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>21</td>
<td>0.00</td>
<td>1.00</td>
<td>.24</td>
<td>.44</td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>0.00</td>
<td>1.00</td>
<td>.25</td>
<td>.50</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>603</td>
<td>0.00</td>
<td>3.00</td>
<td>.38</td>
<td>.54</td>
</tr>
<tr>
<td>Female</td>
<td>118</td>
<td>0.00</td>
<td>2.00</td>
<td>.17</td>
<td>.40</td>
</tr>
<tr>
<td>Total</td>
<td>721</td>
<td>0.00</td>
<td>3.00</td>
<td>.34</td>
<td>.53</td>
</tr>
</tbody>
</table>

### Related Work

### Experience (Years)

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>211</td>
<td>0.00</td>
<td>15.00</td>
<td>.40</td>
<td>1.57</td>
</tr>
<tr>
<td>Female</td>
<td>70</td>
<td>0.00</td>
<td>8.25</td>
<td>.30</td>
<td>1.25</td>
</tr>
<tr>
<td>Caucasian</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>371</td>
<td>0.00</td>
<td>3.00</td>
<td>.82</td>
<td>2.27</td>
</tr>
</tbody>
</table>
Assumption Testing

Logistic regression was used for $H_{01}$ to determine if students’ remedial need in mathematics, academic preparedness, pre-program work experience, vocational education, gender, and ethnicity could predict their ability to complete a postsecondary CTE program. According to Osborne (2015), logistic regression requires the examination of data and the model to ensure independence of observations; an acceptable level of multicollinearity among the predictor variables; the absence of sparse data; the measurement of predictor and criterion
variables is accurate; linearity on the logit; and the data or cases are not inappropriately influential. Although logistic regression is a nonparametric technique that “does not require any particular distributional assumptions” (Osborne, 2015, p.10), results in logistic regression may be more constant if predictor variables have multivariate normal distributions (IBM Regression SPSS 20, 2011).

**Multicollinearity.** The level of multicollinearity among all independent variables was found to be acceptable based on Variance Inflation Factor (VIF) values being less than 2.0 and Tolerance values being greater than 0.3 (See Table 3).

Table 3

*Collinearity Statistics for Predictor Variables*

<table>
<thead>
<tr>
<th>Collinearity Statistics</th>
<th>Tolerance</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remedial Need in Math</td>
<td>.688</td>
<td>1.453</td>
</tr>
<tr>
<td>Academic Preparedness</td>
<td>.644</td>
<td>1.553</td>
</tr>
<tr>
<td>Related Work Experience</td>
<td>.777</td>
<td>1.287</td>
</tr>
<tr>
<td>Non-Related Work Experience</td>
<td>.743</td>
<td>1.346</td>
</tr>
<tr>
<td>Number of Vocational Classes</td>
<td>.861</td>
<td>1.161</td>
</tr>
<tr>
<td>With “B” or Better</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age When Started Program</td>
<td>.637</td>
<td>1.570</td>
</tr>
<tr>
<td>Gender</td>
<td>.915</td>
<td>1.093</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>.908</td>
<td>1.101</td>
</tr>
</tbody>
</table>

**Outliers.** An examination of studentized deleted residuals revealed four cases with values that exceeded ± 3 standard deviations (1268, 1663, 1676 and 1700). While Osborne (2015) suggests a value of ± 4 standard deviations for conducting a logistic regression analysis, a more conservative value of ± 3 was used to determine outliers that needed to be addressed
Garson, 2012). Osborne (2015) posits that “a relatively small number of cases that are aberrant can mask an effect or cause it to be misrepresented” (p.106). As a result, cases 1268, 1663, 1676 and 1700 were removed from the data before running the logistic regression model for RQ1.

**Linearity in the Logit.** Continuous predictor variables remedial need in math, academic preparedness, pre-program related work experience, pre-program non-related work experience, number of vocational classes, and age when started program were examined to ensure they were linearly related to the logit of the dependent variable completed program. Table 4 shows the interaction terms as not statistically significant at $p < .01$, which is the significance level when applying a Bonferroni correction (Napierala, 2012). As a result, the continuous predictor variables were determined to be linearly related to the logit of the criterion variable.

Table 4

*Continuous Predictor Variables (Interactions)*

<table>
<thead>
<tr>
<th>Interaction</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>Remedial Need by ln_ Remedial Need</td>
<td>-.613</td>
<td>.355</td>
<td>2.987</td>
<td>1</td>
<td>.084</td>
<td>.542</td>
</tr>
<tr>
<td>Acad Preparedness by ln_ Acad Preparedness</td>
<td>2.074</td>
<td>1.858</td>
<td>1.246</td>
<td>1</td>
<td>.264</td>
<td>7.960</td>
</tr>
<tr>
<td>Age When Started by ln_Age When Started</td>
<td>-2.603</td>
<td>2.302</td>
<td>1.279</td>
<td>1</td>
<td>.258</td>
<td>.074</td>
</tr>
<tr>
<td>Related Work Exp by ln_ Related Work Exp</td>
<td>7.309</td>
<td>5.459</td>
<td>1.793</td>
<td>1</td>
<td>.181</td>
<td>1944.26</td>
</tr>
<tr>
<td>Non-Related Work Exp by ln_ Non-Related Work</td>
<td>-2.353</td>
<td>2.037</td>
<td>1.334</td>
<td>1</td>
<td>.248</td>
<td>.095</td>
</tr>
</tbody>
</table>

Note: $p < .01$

**Logistic Regression Results for Null Hypothesis One**

A logistic regression analysis was conducted using the entry method to determine the
effects that remedial need in mathematics, academic preparedness, pre-program related and non-related work experience, vocational education, age when started a program, ethnicity, and gender have on the likelihood that students will complete a postsecondary CTE program. The logistic regression model was statistically significant, $\chi^2(9) = 106.184$, $p < .0005$, thereby rejecting the null hypothesis $H_0$. Five of the eight predictor variables, shown in Table 5, were statistically significant at $p < .05$: remedial need in mathematics ($p = .000$), academic preparedness ($p = .045$), pre-program related work experience ($p = .011$), pre-program non-related work experience ($p = .020$), and ethnicity ($p = .044$). In addition, the five statistically significant predictors were associated with increased probabilities of completion based on their odds ratio values. For example, the odds that students would complete a program of study at CSL institution increased as math placement test scores increased, which indicates a lesser remedial need in math (odds ratio = 1.022 [95% CI = 1.013, 1.031]). Specifically, for every one unit increase in math placement test scores, students were 1.022 more times likely (2.2%) to complete a program of study at CSL institution. Students having more pre-program work related experience were also associated with an increased likelihood of completing a program. Based on an odds ratio of 1.219, the predicted probability of students completing a program increased by 21.9% for every one year increase in related work experience. Caucasi ans were 23% more likely to complete a program compared to minorities (odds ratio = 2.955 [95% CI = 1.200, 7.278]). The probability of students completing a program also increased as academic preparedness scores and number of years of pre-program non-related work experience increased. For every one unit increase in academic preparedness scores and years of non-related work experience, students’ predicted probability of completing increased by 3.4% and 9.1%, respectively.
Table 5

Predictor Variables in the Model

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>Sig.</th>
<th>Exp (B)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remedial Need in Math</td>
<td>.022</td>
<td>.005</td>
<td>22.783</td>
<td>1</td>
<td>.000</td>
<td>1.022</td>
<td>1.013 - 1.031</td>
</tr>
<tr>
<td>Academic Preparedness</td>
<td>.034</td>
<td>.017</td>
<td>4.031</td>
<td>1</td>
<td>.045</td>
<td>1.034</td>
<td>1.001 - 1.069</td>
</tr>
<tr>
<td>Related Work Experience</td>
<td>.198</td>
<td>.078</td>
<td>6.432</td>
<td>1</td>
<td>.011</td>
<td>1.219</td>
<td>1.046 - 1.421</td>
</tr>
<tr>
<td>Non-Related Work Experience</td>
<td>.087</td>
<td>.038</td>
<td>5.418</td>
<td>1</td>
<td>.020</td>
<td>1.091</td>
<td>1.014 - 1.175</td>
</tr>
<tr>
<td>No. of Vocational Classes with “B”</td>
<td>-.112</td>
<td>.167</td>
<td>.450</td>
<td>1</td>
<td>.503</td>
<td>.894</td>
<td>.644 - 1.240</td>
</tr>
<tr>
<td>Age When Started Program</td>
<td>.033</td>
<td>.019</td>
<td>3.176</td>
<td>1</td>
<td>.075</td>
<td>1.034</td>
<td>.997 - 1.072</td>
</tr>
<tr>
<td>Gender(1)</td>
<td>.183</td>
<td>.232</td>
<td>.624</td>
<td>1</td>
<td>.430</td>
<td>1.201</td>
<td>.763 - 1.890</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td>6.244</td>
<td>2</td>
<td></td>
<td></td>
<td>.044</td>
</tr>
<tr>
<td>Ethnicity(1) African American</td>
<td>.876</td>
<td>.468</td>
<td>3.504</td>
<td>1</td>
<td>.061</td>
<td>2.400</td>
<td>.960 - 6.004</td>
</tr>
<tr>
<td>Ethnicity(2) Caucasian</td>
<td>1.084</td>
<td>.460</td>
<td>5.553</td>
<td>1</td>
<td>.018</td>
<td>2.955</td>
<td>1.200 - 7.278</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.123</td>
<td>.505</td>
<td>17.688</td>
<td>1</td>
<td>.000</td>
<td>.120</td>
<td></td>
</tr>
</tbody>
</table>

Model Fit and Predictive Power

The goodness of fit for the model in this study was determined by examining predictive power using the model’s classification rate and conducting a Hosmer-Lemeshow test. The classification rate for the model in this study is shown in Table 6.

To explain this fitted model, the estimated log-odds of a Caucasian male completing a postsecondary CTE program who scored 70 on their math placement test (remedial need in
math); had an academic assessment score of 25 (academic preparedness); possessed five years of
related work experience (pre-program related work experience) prior to entering the program;
and three years of non-related work experience (pre-program non-related work experience) prior
to starting a program was:

\[
\ln \left( \frac{\hat{p}}{1 - \hat{p}} \right) = -2.123 + 0.022 (70) + 0.034 (25) + 0.198 (5) + \\
0.087 (3) + 0.876(0) + 1.084 (1) + 0.183 (1) = 2.785
\]

As a result, the predicted probability this individual would complete a postsecondary
CTE program was:

\[
\hat{p} = \frac{\exp\{2.785\}}{1 + \exp\{2.785\}} = .942
\]

This individual would be classified as having completed a postsecondary CTE program since the
probability was greater than 0.5.

Table 6
Classification Rate

<table>
<thead>
<tr>
<th>Predicted Completed Program</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed</td>
<td>Correct</td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Completed Program</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>153</td>
</tr>
<tr>
<td>Yes</td>
<td>84</td>
</tr>
<tr>
<td>Overall Percentage</td>
<td></td>
</tr>
</tbody>
</table>

*Note: The cut value is .500*
This model indicated that 344 of the 428 who completed one of the CTE programs at CSL institution were correctly classified as completing. As a result, sensitivity for the model was 80.4% (True Positives). Additionally, the model correctly predicted 153 of 289 participants not completing a program, which yielded a specificity of 52.9% (True Negatives). The positive predictive and negative predictive values for the model were 64.6% and 71.7% respectively.

In addition to analyzing the classification table, the Hosmer-Lemeshow test was analyzed to determine how well the model fit. The results of the Hosmer-Lemeshow test for this model were $X^2(8) = 9.547$, $p = 0.298$. Because this model was not significant at the 0.05 level of significance, no substantial evidence exists concerning lack of fit of the model.

**Null Hypothesis Two**

**Descriptive Statistics**

The population for $H_02$ consisted of 428 of the 721 students included in $H_01$ who started at CSL institution from 2005-2007 and successfully completed one of the programs of study offered by the institution (59.4% completion rate). The 428 students consisted of the following: Caucasian males (56.31%), African American males (25.93%), other minority males (2.57%), Caucasian females (6.78%), African American females (8.41%), and other minority females (0.70). Descriptive statistics for $H_02$ population are shown in Table 7.

Table 7

<table>
<thead>
<tr>
<th>Descriptive Statistics for Predictor and Criterion Variables in RQ2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n$</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td><strong>In-Program GPA</strong></td>
</tr>
<tr>
<td>African American</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
</tbody>
</table>
### Descriptive Statistics for Predictor and Criterion Variables in RQ2 (cont.)

<table>
<thead>
<tr>
<th></th>
<th>$n$</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Caucasian</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>241</td>
<td>1.43</td>
<td>4.00</td>
<td>3.10</td>
<td>.68</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>29</td>
<td>2.57</td>
<td>4.00</td>
<td>3.32</td>
<td>.48</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>8</td>
<td>1.61</td>
<td>3.75</td>
<td>2.68</td>
<td>.74</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>3</td>
<td>3.73</td>
<td>4.00</td>
<td>3.85</td>
<td>.14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>360</td>
<td>1.30</td>
<td>4.00</td>
<td>2.93</td>
<td>.72</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>68</td>
<td>1.54</td>
<td>4.00</td>
<td>3.04</td>
<td>.61</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>428</td>
<td>1.30</td>
<td>4.00</td>
<td>2.94</td>
<td>.70</td>
</tr>
<tr>
<td><strong>Remedial Need</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>in Math</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>African American</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>111</td>
<td>0.00</td>
<td>95.00</td>
<td>36.53</td>
<td>21.64</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>36</td>
<td>0.00</td>
<td>70.00</td>
<td>28.33</td>
<td>19.46</td>
</tr>
<tr>
<td><strong>Caucasian</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>241</td>
<td>0.00</td>
<td>95.00</td>
<td>43.71</td>
<td>21.68</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>29</td>
<td>10.00</td>
<td>90.00</td>
<td>51.03</td>
<td>21.81</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>8</td>
<td>10.00</td>
<td>65.00</td>
<td>29.38</td>
<td>18.79</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>3</td>
<td>35.00</td>
<td>95.00</td>
<td>66.67</td>
<td>30.14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>360</td>
<td>0.00</td>
<td>95.00</td>
<td>41.18</td>
<td>21.88</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>68</td>
<td>0.00</td>
<td>95.00</td>
<td>39.71</td>
<td>24.11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>428</td>
<td>0.00</td>
<td>95.00</td>
<td>40.95</td>
<td>22.23</td>
</tr>
<tr>
<td><strong>Academic Preparedness</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>African American</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>111</td>
<td>7.00</td>
<td>40.00</td>
<td>17.43</td>
<td>6.01</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>36</td>
<td>10.00</td>
<td>36.60</td>
<td>17.04</td>
<td>5.68</td>
</tr>
<tr>
<td><strong>Caucasian</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td>241</td>
<td>6.00</td>
<td>40.00</td>
<td>19.15</td>
<td>6.46</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>29</td>
<td>12.60</td>
<td>30.00</td>
<td>19.97</td>
<td>4.70</td>
</tr>
</tbody>
</table>
Descriptive Statistics for Predictor and Criterion Variables in RQ2 (cont.)

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>8</td>
<td>6.00</td>
<td>22.00</td>
<td>15.61</td>
<td>4.69</td>
</tr>
<tr>
<td>Female</td>
<td>3</td>
<td>17.00</td>
<td>30.40</td>
<td>22.93</td>
<td>6.83</td>
</tr>
<tr>
<td>Total</td>
<td>428</td>
<td>6.00</td>
<td>40.00</td>
<td>18.54</td>
<td>6.21</td>
</tr>
</tbody>
</table>

Age When Started Program

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td>111</td>
<td>18.00</td>
<td>47.00</td>
<td>22.71</td>
<td>6.20</td>
</tr>
<tr>
<td>Female</td>
<td>36</td>
<td>18.00</td>
<td>46.00</td>
<td>24.75</td>
<td>6.99</td>
</tr>
<tr>
<td>Caucasian</td>
<td>241</td>
<td>18.00</td>
<td>48.00</td>
<td>22.49</td>
<td>6.32</td>
</tr>
<tr>
<td>Female</td>
<td>29</td>
<td>18.00</td>
<td>47.00</td>
<td>26.03</td>
<td>8.39</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
<td>18.00</td>
<td>30.00</td>
<td>23.00</td>
<td>4.57</td>
</tr>
<tr>
<td>Female</td>
<td>3</td>
<td>21.00</td>
<td>25.00</td>
<td>23.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Total</td>
<td>360</td>
<td>18.00</td>
<td>48.00</td>
<td>22.57</td>
<td>6.24</td>
</tr>
<tr>
<td>Female</td>
<td>68</td>
<td>18.00</td>
<td>47.00</td>
<td>25.22</td>
<td>7.46</td>
</tr>
<tr>
<td>Total</td>
<td>428</td>
<td>18.00</td>
<td>48.00</td>
<td>22.99</td>
<td>6.51</td>
</tr>
</tbody>
</table>

Assumption Testing

Multiple linear regression was used for RQ2 to determine if students’ remedial need in mathematics and academic preparedness could predict their academic attainment in a postsecondary CTE program. Assumption testing was conducted to determine if independence of residuals, linearity, homoscedasticity, multicollinearity, studentized deleted residuals, leverage values, Cook’s distance and normality for the predictor and criterion variables were acceptable to support predictions resulting from this study.
**Independence of Residuals.** Independence of residuals was shown to be acceptable based on a Durbin-Watson statistic of 1.869.

**Linearity.** The assumption of the linearity was found to be tenable because residuals formed a horizontal band in the scatterplot (Figure 1). Additionally, the continuous independent variables of academic preparedness, remedial need in mathematics, and age when started apprenticeship indicated linear relationships with the dependent variable in-program GPA in scatterplots (Figures 2, 3 and 4).

*Figure 1. Scatter plot (In-program GPA – Standardized Residuals)*
Figure 2. Scatter plot (Remedial Need in Math and In-program GPA)

Figure 3. Scatter plot (Academic Assessment and In-program GPA)
Figure 4. Scatter plot (Age When Started Apprenticeship and In-program GPA)

**Homoscedasticity.** The assumption of homogeneity of variance (homoscedasticity) was also satisfied based on residuals being equally spread over the predicted values of the dependent variable (in-program GPA).

**Multicollinearity.** The level of multicollinearity among all independent variables was found to be acceptable based on Pearson $r$ values being less than 0.7, VIF values were less than 2.0, and Tolerance values were greater than 0.3.

**Outliers.** An examination of studentized deleted residuals in the SPSS output revealed no values that exceeded $\pm 3$ standard deviations. As a result, the assumption of no multivariate outliers was found to be tenable.

**Leverage Values.** Leverage values examined in SPSS revealed no high leverage points, based on a value of less than 0.2 being considered safe for the data used in this study.
**Influential Cases.** Cook’s distance values for cases in RQ2 were less than 1.0, which satisfied the assumption of no influential cases in the sample data (Cook and Weisberg, 1982).

**Normality.** The assumption of normality was also considered acceptable based on an examination of the histogram for the dependent variable in-program GPA (Figure 5) and the P-P Plot (Figure 6) showing residuals aligned along the diagonal indicating a normal distribution.

![Figure 5. Histogram (In-Program GPA)](image-url)
Multiple Regression Results for Null Hypothesis Two

A multiple regression analysis was conducted to determine the effect that remedial need in mathematics, academic preparedness, age when started program, ethnicity and gender have on students’ academic attainment in a postsecondary CTE program. The multiple regression model was statistically significant at $F(5, 422) = 69.12, p < .001$, thereby rejecting null hypothesis $H_02$. Additionally, the multiple correlation coefficient for the model was $R = .671$, $R^2 = .450$, and adj. $R^2 = .443$. Consequently, these five predictor variables explain 44.3% of the model’s variance. Table 8 shows that four of the five predictor variables were statistically significant predictors of criterion variable in-program GPA at $p < .01$: remedial need in math ($p = .000$), academic preparedness ($p = .000$), age when started ($p = .000$), ethnicity ($p = .000$), and gender ($p = .059$). Remedial need in math had a large effect (.548) and was positively correlated with in-program
GPA, meaning as scores on the math placement test increased (indicating less of a remedial need in math), students in-program GPA increased. Academic preparedness also showed a large effect (.475) and positive correlation with in-program GPA. Consequently, as students’ academic preparedness scores increased, their in-program GPA also increased. Ethnicity had a medium effect and positive correlation with in-program GPA. Although positively correlated with in-program GPA, students’ ages when they started the program revealed a small effect (.192).

Table 8

_Contribution of Predictor Variables for Criterion Variable In-Program GPA (n=428)_

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>t</th>
<th>Sig</th>
<th>Zero-order Correlation</th>
<th>Partial Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remedial Need in Math</td>
<td>.012</td>
<td>.001</td>
<td>.379</td>
<td>9.159</td>
<td>.000</td>
<td>.548</td>
<td>.407</td>
</tr>
<tr>
<td>Academic Preparedness</td>
<td>.031</td>
<td>.005</td>
<td>.270</td>
<td>6.589</td>
<td>.000</td>
<td>.475</td>
<td>.305</td>
</tr>
<tr>
<td>Age When Started</td>
<td>.020</td>
<td>.004</td>
<td>.187</td>
<td>5.126</td>
<td>.000</td>
<td>.192</td>
<td>.242</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>.314</td>
<td>.050</td>
<td>.231</td>
<td>6.225</td>
<td>.000</td>
<td>.322</td>
<td>.291</td>
</tr>
<tr>
<td>Gender</td>
<td>-.135</td>
<td>.071</td>
<td>-.070</td>
<td>-1.896</td>
<td>.059</td>
<td>-.056</td>
<td>-.092</td>
</tr>
</tbody>
</table>

Note: p < .01

_Null Hypothesis Three_

_Descriptive Statistics_

The population for H₀3 consisted of the 428 students included in H₀2 who started at CSL institution from 2005-2007 and successfully completed one of the programs of study offered by the institution. Descriptive statistics for H₀3 are shown in Table 9 and Table 10.
### Table 9

*Descriptive Statistics for RQ3 Categorical Variables (Ethnicity*Gender*Vocational Attainment)*

**Cross-Tabulation**

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Gender</th>
<th>Vocational Attainment</th>
<th>Hourly Tradesperson</th>
<th>Salaried Non-Mgmt.</th>
<th>Salaried Mgmt.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minority</td>
<td>Male</td>
<td>Count</td>
<td>61</td>
<td>31</td>
<td>27</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% of Total</td>
<td>16.9%</td>
<td>8.6%</td>
<td>7.5%</td>
<td>33.1%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>Count</td>
<td>7</td>
<td>23</td>
<td>9</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% of Total</td>
<td>10.3%</td>
<td>33.8%</td>
<td>13.2%</td>
<td>57.4%</td>
</tr>
<tr>
<td>Non-Minor</td>
<td>Male</td>
<td>Count</td>
<td>98</td>
<td>81</td>
<td>62</td>
<td>241</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% of Total</td>
<td>27.2%</td>
<td>22.5%</td>
<td>17.2%</td>
<td>66.9%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>Count</td>
<td>5</td>
<td>17</td>
<td>7</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% of Total</td>
<td>7.4%</td>
<td>25.0%</td>
<td>10.3%</td>
<td>42.6%</td>
</tr>
<tr>
<td>Total</td>
<td>Male</td>
<td>Count</td>
<td>159</td>
<td>112</td>
<td>89</td>
<td>360</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% of Total</td>
<td>44.2%</td>
<td>31.1%</td>
<td>24.7%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>Count</td>
<td>12</td>
<td>40</td>
<td>16</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% of Total</td>
<td>17.6%</td>
<td>58.8%</td>
<td>23.5%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>Count</td>
<td>171</td>
<td>152</td>
<td>105</td>
<td>428</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% of Total</td>
<td>40.0%</td>
<td>35.5%</td>
<td>24.5%</td>
<td>100%</td>
</tr>
</tbody>
</table>

### Table 10

*Descriptive Statistics for Continuous Predictor Variables in RQ3*

<table>
<thead>
<tr>
<th>Academic Attainment (In-Program GPA)</th>
<th>n</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minority</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>119</td>
<td>1.30</td>
<td>4.00</td>
<td>2.57</td>
<td>.68</td>
</tr>
<tr>
<td>Female</td>
<td>39</td>
<td>1.54</td>
<td>4.00</td>
<td>2.83</td>
<td>.62</td>
</tr>
<tr>
<td>Non-Minorality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>241</td>
<td>1.43</td>
<td>4.00</td>
<td>3.10</td>
<td>.68</td>
</tr>
<tr>
<td>Female</td>
<td>29</td>
<td>2.57</td>
<td>4.00</td>
<td>3.32</td>
<td>.48</td>
</tr>
</tbody>
</table>
Descriptive Statistics for Continuous Predictor Variables in RQ3 (cont.)

<table>
<thead>
<tr>
<th></th>
<th>$n$</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>428</td>
<td>1.30</td>
<td>4.00</td>
<td>2.94</td>
<td>.70</td>
</tr>
<tr>
<td>Male</td>
<td>360</td>
<td>1.30</td>
<td>4.00</td>
<td>2.93</td>
<td>.72</td>
</tr>
<tr>
<td>Female</td>
<td>68</td>
<td>1.54</td>
<td>4.00</td>
<td>3.04</td>
<td>.61</td>
</tr>
<tr>
<td>OJT Performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minority</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>119</td>
<td>77.20</td>
<td>98.30</td>
<td>91.15</td>
<td>3.47</td>
</tr>
<tr>
<td>Female</td>
<td>39</td>
<td>84.40</td>
<td>95.00</td>
<td>90.29</td>
<td>2.74</td>
</tr>
<tr>
<td>Non-Minority</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>241</td>
<td>76.60</td>
<td>99.10</td>
<td>93.06</td>
<td>3.00</td>
</tr>
<tr>
<td>Female</td>
<td>29</td>
<td>82.40</td>
<td>95.20</td>
<td>91.02</td>
<td>3.75</td>
</tr>
<tr>
<td>Total</td>
<td>360</td>
<td>76.60</td>
<td>99.10</td>
<td>92.43</td>
<td>3.28</td>
</tr>
<tr>
<td>Female</td>
<td>68</td>
<td>82.40</td>
<td>95.20</td>
<td>90.60</td>
<td>3.20</td>
</tr>
<tr>
<td>Total</td>
<td>428</td>
<td>76.60</td>
<td>99.10</td>
<td>92.14</td>
<td>3.33</td>
</tr>
</tbody>
</table>

Assumption Testing

Because multinomial logistic regression does not assume linearity, normality, and homogeneity of variance, data for H0.3 were examined for outliers, leverage and influential cases only. In addition, because SPSS does not provide diagnostic statistics for multinomial logistic regression, binary logistic regression analyses were conducted to determine the presence of outliers in the data (Osborne, 2012). Two binary logistic regressions were performed comparing two different groups: (1) hourly tradesperson and salaried management as criterion variable outcomes and (2) salaried non-management and salaried management as criterion variable outcomes. Gender, ethnicity, in-program GPA, and OJT performance were included in both binary logistic regressions as predictor variables.

Outliers. An examination of studentized deleted residuals for the binary logistic regressions that included hourly tradesperson, salaried non-management, and salaried...
management as the criterion variables, and gender, ethnicity, in-program GPA and OJT performance as predictor variables revealed the following: the regression that included hourly tradesperson and salaried management as criterion variable outcomes had two cases (1292 and 1549) where studentized deleted residuals exceeded ± 2 standard deviations; and the regression that included salaried non-management and salaried management as outcomes also had two cases (1045 and 1549) where studentized residuals exceeded ± 2 standard deviations.

**Leverage Values.** Similar to the $H_0:2$ analysis, leverage values of less 0.2 were considered safe for the data used in the regression model for $H_0:3$. Using this criteria, no high leverage values were identified in the two binary logistic regressions using hourly tradesperson, salaried non-management and salaried management as the criterion variables. Consequently, no cases were considered for removal from the data used in $H_0:3$ before conducting the multinomial logistic regression.

**Influential Cases.** Influential cases for $H_0:3$ were examined using the two binary logistic regressions that included hourly tradesperson, salaried non-management and salaried management as the criterion variables. Because regressions conducted revealed Cook’s distance values that were less than 1.0, the assumption of no influential cases in the $H_0:3$ data was satisfied (Cook and Weisberg, 1982).

The two binary logistic regressions revealed no cases as having undue influence after examining leverage and Cook’s distance values; however, three cases were found to be outliers in the regression models (1045, 1292 and 1549). As previously stated, even a small number of outlying or influential cases can have an undesirable impact on a regression model (Osborne, 2015). However, because the difference between the accuracy rate of the multinomial logistic
regression model that included the outlying cases identified above (57.0% accuracy) versus the model that excluded the outlying cases (57.9% accuracy) yielded a less than a 2.0% difference predicting accuracy (Osborne, 2015), the final model for this study did not exclude the three outlying cases.

**Multinomial Logistic Regression Results for Null Hypothesis Three**

A multinomial logistic regression was conducted to determine the effects that academic attainment (in-program GPA), OJT performance, gender, and ethnicity have on postsecondary CTE students’ post-program vocational attainment (vocational positions entered after completing a CTE program). The multinomial logistic regression model was statistically significant, $\chi^2(4) = 134.510$, $p < .0005$. In addition, the -2 Log Likelihood with predictor variables in the model was 786.286 as compared to 920.797 when predictor variables were not included in the model (intercept only). Thus, null hypothesis $H_03$ was rejected. Table 11 shows that predictor variable academic attainment (in-program GPA) was statistically significant at $p < .05$ when comparing vocational attainment categories hourly tradesperson to salaried non-management, and predictor variable OJT performance was statistically significant at $p < .05$ when comparing hourly tradesperson to salaried management. Therefore, the model predicted that higher in-program GPA was associated with salaried non-management vocational outcomes and higher OJT performance was associated with salaried management outcomes. Females were also statistically significant at $p < .05$ when comparing hourly tradesperson to salaried non-management and salaried management. Here, the model’s predicted probability of females who complete the program entering salaried non-management and salaried management vocational outcomes was significantly greater than entering or remaining in an hourly tradesperson position.
Table 11

*Results of the Multinomial Logistic Regression – Effects of Predictor Variables on Vocational Attainment*

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>Sig.</th>
<th>Exp (B)</th>
<th>95% CI Lower</th>
<th>95% CI Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2) Salaried Non-Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>-1.269</td>
<td>3.699</td>
<td>.118</td>
<td>1</td>
<td>.732</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-Prog GPA</td>
<td>1.888</td>
<td>.238</td>
<td>62.802</td>
<td>1</td>
<td>.000</td>
<td>6.606</td>
<td>4.141</td>
<td>10.537</td>
</tr>
<tr>
<td>OJT Perf</td>
<td>-.054</td>
<td>.041</td>
<td>1.728</td>
<td>1</td>
<td>.189</td>
<td>.947</td>
<td>.874</td>
<td>1.027</td>
</tr>
<tr>
<td>Female</td>
<td>1.518</td>
<td>.390</td>
<td>15.151</td>
<td>1</td>
<td>.000</td>
<td>4.565</td>
<td>2.125</td>
<td>9.805</td>
</tr>
<tr>
<td>Minority</td>
<td>.443</td>
<td>.295</td>
<td>2.247</td>
<td>1</td>
<td>.134</td>
<td>1.003</td>
<td>.565</td>
<td>1.781</td>
</tr>
<tr>
<td>(3) Salaried Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>-</td>
<td>4.326</td>
<td>14.008</td>
<td>1</td>
<td>.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-Prog GPA</td>
<td>.107</td>
<td>.209</td>
<td>.261</td>
<td>1</td>
<td>.610</td>
<td>1.113</td>
<td>.739</td>
<td>1.676</td>
</tr>
<tr>
<td>OJT Perf</td>
<td>.165</td>
<td>.047</td>
<td>12.110</td>
<td>1</td>
<td>.001</td>
<td>1.180</td>
<td>1.075</td>
<td>1.295</td>
</tr>
<tr>
<td>Female</td>
<td>1.184</td>
<td>.427</td>
<td>7.692</td>
<td>1</td>
<td>.006</td>
<td>3.268</td>
<td>1.415</td>
<td>7.546</td>
</tr>
<tr>
<td>Minority</td>
<td>.003</td>
<td>.293</td>
<td>.000</td>
<td>1</td>
<td>.991</td>
<td>1.003</td>
<td>5.65</td>
<td>1.781</td>
</tr>
</tbody>
</table>

Note: The reference category is (1) Hourly Tradesperson

**Model Equations**

The following multinomial logistic regression equations and probabilities resulted from the model:

\[
P(Y_i = \text{Hourly Tradesperson}) = \frac{1}{1 + \sum_{h=2}^{M} \exp(Z_{hi})} = \frac{1}{1 + \exp(Z_2) + \exp(Z_3)}
\]

Consequently, a student completing one of the programs at CSL institution with an in-program GPA of 3.0 and an OJT performance grade average of 85 would have an hourly tradesperson vocational outcome probability of the following:

\[
P(Y_i = \text{Hourly Tradesperson}) =
\]
\[
P(Y_i = \text{Hourly Tradesperson}) = 0.5049 \text{ or } 50.49\
\]
The same student would have a salaried non-management vocational outcome probability of the following:

\[
P(Y_i = \text{Salaried Non-Management}) =
\]

\[
\frac{\exp(Z_2)}{1 + \sum_{h=2}^{M} \exp(Z_{hi})}
\]

\[
= \frac{\exp(Z_2)}{\exp(-1.269 + (1.888*3.0) + (-.054*85))}
\]

\[
= \frac{\exp(-1.269 + (1.888*3.0) + (-.054*85))}{(1 + \exp(-1.269 + (1.888*3.0) + (-.054*85)) + (\exp(-16.193 + (.107*3.0)) + (.165*85)))}
\]

\[
P(Y_i = \text{Salaried Non-Management}) = 0.4155 \text{ or } 41.55\
\]
The same student would have the following probability of attaining a salaried management vocation:

\[
P(Y_i = \text{Salaried Management}) = 1.00 - P(Y_i = \text{Hourly Tradesperson}) - P(Y_i = \text{Salaried Non-Management})
\]

\[
P(Y_i = \text{Salaried Management}) = 1.00 - 0.5049 - 0.4155 = 0.0796 \text{ or } 7.96%.
\]
The proportional by-chance accuracy rate for the model was calculated by squaring and summing the proportion of cases in each group (Table 12) in the criterion variables (hourly tradesperson) \(0.40^2\) + (salaried non-management) \(0.355^2\) + (salaried management) \(0.245^2\) = 43.26%. The benchmark used in this study to characterize the multinomial logistic regression model as
useful was a 25% improvement over the rate of accuracy achievable by chance alone (White, 2013). As a result, the proportional by chance accuracy criteria was calculated as $43.26\% \times 1.25 = 54.08\%$.

Table 12

*Case Processing Summary for Model*

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Marginal Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocational Attainment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hourly Tradesperson</td>
<td>171</td>
<td>40.0%</td>
</tr>
<tr>
<td>Salaried Non-Management</td>
<td>152</td>
<td>35.5%</td>
</tr>
<tr>
<td>Salaried Management</td>
<td>105</td>
<td>24.5%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>68</td>
<td>15.9%</td>
</tr>
<tr>
<td>Male</td>
<td>360</td>
<td>84.1%</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minority</td>
<td>158</td>
<td>36.9%</td>
</tr>
<tr>
<td>Non-Minority</td>
<td>270</td>
<td>63.1%</td>
</tr>
<tr>
<td>Valid</td>
<td>428</td>
<td>100.00%</td>
</tr>
<tr>
<td>Missing</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>428</td>
<td></td>
</tr>
</tbody>
</table>

Table 13 shows an overall accuracy rate of 57.0%, which is greater than the proportional by chance accuracy rate of 54.08%. Therefore, the model was deemed useful when considering the ability of academic attainment (in-program GPA), OJT performance, gender and ethnicity to predict vocational attainment of postsecondary CTE students. However, as with all multinomial logistic regression models, violating the Independence from Irrelevant Alternatives property can
produce unreliable parameter estimates and biased predictions (McFadden & Talvitie, 1977).

Table 13

Classification for Model

<table>
<thead>
<tr>
<th>Observed</th>
<th>Predicted</th>
<th></th>
<th></th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hourly Tradesperson</td>
<td>Salaried Non-Management</td>
<td>Salaried Management</td>
<td></td>
</tr>
<tr>
<td>Hourly Tradesperson</td>
<td>114</td>
<td>45</td>
<td>12</td>
<td>66.7%</td>
</tr>
<tr>
<td>Salaried Non-Management</td>
<td>35</td>
<td>112</td>
<td>5</td>
<td>73.7%</td>
</tr>
<tr>
<td>Salaried Management</td>
<td>59</td>
<td>28</td>
<td>18</td>
<td>17.1%</td>
</tr>
<tr>
<td>Overall Percentage</td>
<td>48.6%</td>
<td>43.2%</td>
<td>8.2%</td>
<td>57.0%</td>
</tr>
</tbody>
</table>

Independence from Irrelevant Alternatives

Another assumption that must be satisfied when conducting a multinomial logistic regression is the Independence from Irrelevant Alternatives property. This property suggests “that the ratio of probabilities of choosing any two alternatives (i and h) from the choice set (C) is independent of the attributes or the availability of a third alternative j...” (McFadden & Talvitie, 1977, p.223). To ensure the model did not violate this property, a comparison of a binary logit that included hourly tradesperson and salaried non-management, and hourly tradesperson and salaried management to the multinomial logit for H₃ was conducted. Comparing the binary logit that included hourly tradesperson and salaried non-management as criterion variable outcomes to the multinomial logit, no
significant change in model values for predictor variables in-program GPA and OJT performance was noted. Additionally, no significant change in model values for the predictor variables was found when comparing the binary logit that included hourly tradesperson and salaried management to the multinomial logit.
CHAPTER FIVE: DISCUSSION

This chapter discusses the purpose of the study; conclusions from study findings; implications for students, parents, educators, practitioners, and postsecondary CTE programs overall; limitations of study findings with respect to postsecondary students’ persistence and performance; and recommendations for future research to further enhance and add to the body of knowledge regarding the importance of students’ preparedness when entering postsecondary CTE programs.

Levin and Calcagno (2008) suggest a considerable number of students entering postsecondary programs are underprepared for the rigorous subject matter and challenging coursework; specifically, they lack foundational skills in mathematics. However, research from Bettinger and Long (2009) indicate that students with greater remedial need in mathematics are not necessarily adversely impacted when considering their ability to persist and complete a postsecondary program. On the other hand, the preponderance of research on students’ under preparation and remedial need lacks generalizability to postsecondary CTE programs, primarily because most studies include sample populations from a limited number of institutions; fail to control for students’ level of preparedness; and do not consider other factors that may influence success (Handel & Williams, 2011). Some of these factors include ethnicity, gender, socioeconomic status, and student ability (Bettinger and Long, 2009). Consequently, generalizing study findings to broader populations of postsecondary students is challenging. Additionally, research is scant when considering the remedial need and lack of preparedness of postsecondary students’ in CTE programs or apprenticeships.
Research on vocational preparedness and its impact on student performance and ability to complete postsecondary CTE programs is also limited and lacks generalizability to wider populations. However, research by Rezin and McCaslin (2001) found that prior-related experience, training and employment were non-factors in determining students’ success in CTE programs. Research that includes students’ vocational training and courses completed in high school is also limited with respect to quantity, quality, and generalizability.

The purpose of this quantitative correlational study was to consider the effects that academic and vocational preparedness have on students’ performance in a postsecondary CTE or apprenticeship program, and the relationship between students’ in-program performance and vocational attainment after program completion. Specifically, this study incorporated factors that have been absent or sparsely included in other studies on CTE postsecondary success and attainment. Three types of statistical analyses were used in the study: binary logistic regression was used to investigate the effects that remedial need in mathematics, academic preparedness, pre-program work experience (related and non-related), vocational education, gender, and ethnicity have on students’ ability to complete a postsecondary CTE or apprenticeship program (RQ1); multiple regression was employed to examine the effects that postsecondary students’ remedial need in mathematics and academic preparedness have on their academic attainment (in-program academic performance) in a CTE or apprenticeship program (RQ2); and multinomial logistic regression was used to study the effects that students’ academic attainment (in-program academic performance) and on-the-job training (OJT) performance have on their post-program vocational attainment (RQ3).
Findings for Research Question One

How well do students’ remedial need in mathematics (as measured by a pre-program math placement test), academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses), pre-program work experience (measured in years of related and non-related experience), and vocational education (vocational courses completed with a minimum grade of “B” during secondary or postsecondary education) predict their ability to complete a postsecondary CTE program?

Findings from research question one revealed that five of the nine predictor variables (remedial need in mathematics, academic preparedness, pre-program related work experience, pre-program non-related work experience and ethnicity) used in the study were statistically significant and positive predictors of program completion within a regression model that was determined to be a good fit. Consequently, students’ performance or classification with respect to these variables can be considered valuable and reliable information for predicting students’ ability to complete a postsecondary CTE program. With respect to academic preparedness, findings from this study are consistent with the position that lack of preparedness and insufficient academic skills, particularly in math, can present obstacles to students completing a postsecondary CTE program (Gonzalez, 2010). Findings from this study are inconsistent with Bahr (2010a), whose research indicated students requiring math remediation were able to complete postsecondary programs at the same or higher rates than students who did not require remediation. It should be noted that Bahr’s research did not include students enrolled in postsecondary CTE programs. However, study results for research question one are also consistent with findings from a study that suggested students who enter two-year institutions
inadequately prepared from high school, are less likely to complete a postsecondary program (Attewell et al., 2006).

Pre-program related work experience was a positive predictor of program completion in this study. These results are inconsistent with Rezin and McCaslin’s (2001) findings that previous related vocational experience (i.e. previous experience in the trade or vocation that students enter upon program completion) was not a predictor of students’ success in a related trade or vocation. Pre-program non-related work experience was also a positive predictor of students’ ability to complete a program. These findings support Lerman’s (2013) position that employability skills (i.e. skills that are required in most jobs or vocations), some of which include “listening, working effectively in teams, maintaining work discipline, and reliability” (p.2), may be particularly important to an individual’s success in a work-based CTE program or vocation.

The number of vocational classes completed with a “B” or better was the only predictor that negatively correlated with students’ ability to complete a postsecondary CTE program. In other words, completing a greater number of vocational classes with a minimum grade of “B” negatively impacted students’ ability to successfully complete a program. From their research, Rezin and McCaslin (2001) found that previous vocational training or courses was not a predictor of students’ vocational success. Consequently, findings from this study are consistent with Rezin and McCaslin’s findings. That is, completing vocational courses (with a minimum grade of “B”) prior to entering a postsecondary CTE program was not a predictor of students’ ability to complete a program.
Findings for Research Question Two

How well do students’ remedial need in mathematics (as measured by a pre-program math placement test) and academic preparedness (an algorithmic assessment of students’ pre-program performance in qualifying courses) predict their academic attainment (in-program GPA) in a postsecondary CTE program?

Findings for research question two revealed that four of the five predictor variables used in the regression model (remedial need in math, academic preparedness, age when started program, and ethnicity) were statistically significant predictors of academic attainment. Remedial need in math (math placement test scores) and academic preparedness had large effects and were positive predictors of in-program GPA. As math placement test scores increased (indicating a lesser remedial need in math) and as students’ academic preparedness scores increased, students’ in-program grade point averages increased. Stated differently, students’ possessing a greater remedial need in math were associated with poorer academic attainment (i.e. lower in-program grade point averages). Students who were better prepared academically when entering one of the institution’s programs of study (i.e., possessing higher academic assessments) performed better academically than their counterparts with lower academic assessments.

Although positively correlated with in-program GPA, students’ age when starting CSL institution revealed a small effect in the regression model. However, results from this study indicating a moderate predictive relationship between increase in age and higher academic attainment are consistent with the position of Calcagno et al. (2007), who suggest that older students may simply be “rusty” versus being severely deficient in a particular subject such as mathematics. Consequently, their academic attainment is not necessarily adversely affected by
what appears to be a greater remedial need when entering a postsecondary CTE program.

Calcagno et al. (2007) suggest that these minor remedial needs are typically resolved with short-term remediation efforts.

**Findings for Research Question Three**

How well do students’ academic attainment (in-program GPA) and on-the-job training (OJT) performance (numerically averaged grade measuring five areas: technical knowledge and comprehension; quantity; quality; leadership and initiative; and conduct) in a postsecondary CTE program predict their post-program vocational attainment (vocational positions entered after completing a CTE program)?

Findings for research question three revealed that in-program GPA and OJT performance were statistically significant predictors of salaried non-management and salaried management vocational outcomes, respectively. Specifically, for every one standard deviation unit increase in students’ in-program GPA, the odds of a salaried non-management vocational outcome were 6.6 times greater than an hourly tradesperson outcome. Additionally, for every one standard deviation unit increase in students’ OJT performance, the odds of a salaried management vocational outcome were 1.18 (18%) times greater than an hourly tradesperson outcome. Study findings also indicated that women were 4.6 and 3.3 times more likely to attain salaried non-management and salaried management positions, respectively, versus remaining in an hourly tradesperson position.

Although research in the area of vocational attainment of individuals completing a postsecondary CTE program is very limited, Rezin and McCaslin (2001) found in their research that individuals completing a cooperative apprenticeship experienced more success with respect
to employability and related employment, as compared with students completing a traditional CTE program. However, Rezin and McCaslin did not compare students’ performance within a postsecondary CTE program or apprenticeship to their vocational attainment, nor did they include gender in the study.

**Conclusions**

The findings from this study indicate that academic and vocational preparedness are relevant factors when considering students’ ability to complete a postsecondary CTE program, level of performance in a CTE program, and vocational attainment or outcome after completing a CTE program. More specifically, the combination of predictor variables that include remedial need in math, academic preparedness, pre-program related and non-related work experience, vocational classes completed with a minimum grade of “B” (prior to entering a postsecondary program), ethnicity and gender, provides a more comprehensive view of factors that affect postsecondary CTE students’ ability to complete a program, as compared to the limited body of current research, which typically focuses on academic preparedness only when considering postsecondary success.

A particularly salient point from findings in this study is the negative relationship identified between the number of vocational classes completed with a minimum grade of “B” and program completion. This may be considered consistent with the stigma associated with vocational education in high schools. Specifically, those students enrolled in secondary CTE classes or programs are regarded as less intelligent (Christman, 2012). One conclusion that can be drawn from this negative relationship between secondary vocational classes completed with a minimum grade of “B” and students’ ability to complete a postsecondary CTE program is that
student performance in these secondary CTE classes is not being accurately assessed. Consequently, using completion of vocational classes as a predictor of postsecondary success may be misleading because it assumes accurate data with respect to students’ performance assessments or grades.

**Implications**

The findings indicate that variables used in this study are valuable in predicting students’ ability to persist and complete a postsecondary CTE program, in-program academic attainment, and vocational attainment after program completion. Consequently, greater focus should be placed on preparing students academically and vocationally for the challenges associated with postsecondary CTE programs.

Findings from this study are an indication that the dissociation of secondary CTE and college preparatory curricula or paths is undesirable. Consistent with Jones (2011), results from this study suggest the importance of delivering high quality academic and vocational curricula in high schools, ensuring that students are adequately prepared for postsecondary CTE programs. Both are desirable and must equally coexist in that they support the two major components of CTE programs: related academic instruction and vocational training and development.

Additionally, placing equal importance on these areas in secondary programs facilitates parallel paths for students, broadening their options beyond secondary education, including successful transition to the workforce, certificate or two-year programs, apprenticeships, and four-year colleges and universities. Additionally, the two paths coexisting inherently have the potential to reduce or eliminate the stigma associated with two-track systems (Christman, 2012).
Study findings also inform educators (secondary and postsecondary), employers, and business and industry partners regarding an increased need to collaborate and agree on the essential knowledge, skills and abilities that individuals must possess when completing high school to be successful in postsecondary CTE programs and the workforce. This is consistent with the U.S. Department of Education’s (2012) report on vocational and adult education, which suggests that alignment, collaboration, accountability and innovation are necessary for the aforementioned groups to improve outcomes (e.g. in-program performance and successful completion, successful transition to additional CTE programs or the workforce, etc.) associated with secondary and postsecondary CTE programs.

This study also serves to inform students and parents regarding variables and areas of preparedness that are predictors of students’ ability to successfully complete postsecondary CTE programs. Specifically, parents should consider enrolling their students in mathematics through their senior year versus merely meeting the minimum requirements to graduate. For example, to graduate with a standard diploma in the state of Virginia, students must earn three units of credit in math (with one being verified) beginning their freshman year (Virginia Department of Education, 2012). Students meeting the minimum math requirements to graduate from high school may be at a disadvantage when considering their ability to perform well in, and complete a postsecondary CTE program.

Study findings also inform students regarding the value of pre-program related and non-related work experience. Internships can provide students with valuable work-related experiences in a field of study or vocation for which they are interested. Summer jobs and part-time employment are excellent opportunities for students to develop and enhance employability
skills such as listening, punctuality, developing a solid work ethic, reliability, and teamwork, as suggested by Lerman (2012).

**Limitations**

1. This quantitative study did not take into account the effect that life events may have on students’ ability to persist, perform at a desired level, or achieve a particular outcome. This qualitative dimension, and its effect on performance and attainment, was not considered in this quantitative study. Lent (2013) suggests that “preparedness for plan-altering events can add a valuable dimension to plans that may implicitly assume benign, if not overtly supportive, conditions” (p.8). Consequently, not including such qualitative factors, which could have considerable impact on students’ attainment, limits the generalizability of this study.

2. This study was conducted using a convenience sample that included students who entered a single postsecondary CTE institution from 2005-2007. This convenience sample was primarily used to support the research question pertaining to vocational attainment (RQ3), which allowed a minimum time period of two-years beyond program completion to consider students’ vocational attainment. Although study participants, to some extent, had similar characteristics to students entering CTE programs nationally (National Center for Education Statistics, 2010), generalizing study findings to a broader postsecondary CTE population has limitations.

3. Some instruments used in the study (academic assessment instrument and math placement test) were unique to CSL institution. This condition limits generalizing study findings to broader populations of postsecondary CTE students attending institutions that use other instruments to evaluate academic prowess of incoming students.
4. The vocational outcomes hourly tradesperson, salaried non-management and salaried management used in this study were limited to a specific company within a unique industry. While these vocations are like and similar to many organizations in business and industry overall, the ability to generalize study findings has limitations.

5. CSL institution is an entity that is sponsored by a company that hires or places all students who complete one of the programs of study. Although all students are hired upon completion within their field of study (which includes all three criterion variable outcomes used in this study), they must compete for promotion opportunities to attain the salaried non-management and salaried management positions beyond the ones to which they were hired or placed upon program completion. This also limits the generalizability of study outcomes.

**Recommendations for Future Research**

To further enhance knowledge regarding the preparedness of students entering postsecondary CTE programs and factors that may impact their success, the following additional research is recommended:

1. Qualitative or mixed-methods studies that consider the effect that life preparedness or events have on students’ ability to persist, perform well and complete CTE programs. Additional research in this area may help further expose the importance of “anticipating and preparing for what one can reasonably expect to happen – and in cultivating a decidedly proactive approach to one's own career management…” (Lent, 2013, p.10), with respect to pursuing postsecondary CTE opportunities and vocational attainment. While the current study holds some value for generalizing results to a broader population of students in postsecondary CTE programs, qualitative and/or
mixed-method research approaches could greatly enhance the education community’s understanding of additional factors that influence students’ ability to persist and complete a postsecondary CTE program, in-program performance and vocational outcomes beyond program completion.

2. Longitudinal studies that include secondary CTE program outcomes (student performance and persistence) and how these outcomes relate to students’ ability to perform and persist in postsecondary CTE programs. This study contained a diverse group of students, which helps inform the postsecondary CTE and apprenticeship community. However, future research that focuses on individuals entering postsecondary CTE programs and apprenticeships immediately following high school could add to the body of knowledge pertaining to the relationship between students’ performance in secondary CTE programs and their ability to perform well in, and complete postsecondary CTE programs.

3. Quantitative, qualitative and/or mixed-methods studies on the importance of employability skills (e.g. teamwork, reliability, work-ethic, problem solving, listening, etc.) as they relate to CTE students’ academic and vocational attainment. While this study indicated a positive, predictive relationship between pre-program non-related work experience and students’ ability to perform well in a postsecondary CTE program, additional studies may better inform students, parents, educators and policy makers on the importance of programs that develop these skills further.
References


http://thomas.loc.gov/cgi-bin/query/z?c101:H.R.7.ENR:

Center for Educational Testing and Evaluation (n.d.), Retrieved from
http://www.careerpathways.us/public/aboutassessment/overview.html


doi:10.1080/10824661003635044


February 21, 2014

Walter Warren
IRB Application 1793: The Effects of Students’ Academic and Vocational Preparedness on Their Performance in a Postsecondary Career and Technical Education (CTE) Program and Post-Program Vocational Attainment

Dear Walter,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study does not classify as human subjects research. This means you may begin your research with the data safeguarding methods mentioned in your approved application.

Your study does not classify as human subjects research because your study involves deidentified archival data.

Please note that this decision only applies to your current research application, and that any changes to your protocol must be reported to the Liberty IRB for verification of continued non-human subjects research status. You may report these changes by submitting a new application to the IRB and referencing the above IRB Application number.

If you have any questions about this determination, or need assistance in identifying whether possible changes to your protocol would change your application’s status, please email us at irb@liberty.edu.

Sincerely,

[Signature]

Fernando Garzon, Psy.D.
Professor, IRB Chair
Counseling

(434) 592-4054

Liberty University | Training Champions for Christ since 1971
Appendix B: CSL Institution Permission Letter

PERMISSION TO CONDUCT RESEARCH

February 18, 2014

Dear Dissertation Committee:

The purpose of this letter is to inform you that I give Walter V. Warren permission to conduct research titled *The Effects of Students’ Academic and Vocational Preparedness on their Performance in a Postsecondary Career and Technical Education (CTE)* Program and Post-Program Vocational Attainment at The Apprentice School.

Identifying information will be completely removed for all archival data provided to Mr. Warren for this research. Mr. Warren has provided me with a brief description of his proposal.

Sincerely,

Everett H. Jordan Jr
Director, Education
The Apprentice School