Fall 12-2018

The Impact of the Dual-Enrollment Modality on Subsequent Collegiate Performance

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This dissertation, directed and approved by the candidate's committee, has been accepted by the College of Graduate and Professional Studies of Abilene Christian University in partial fulfillment of the requirements for the degree

Doctor of Education in Organizational Leadership

Dr. Joey Cope, Dean of the College of Graduate and Professional Studies

Date: October 10, 2018

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A dissertation submitted in partial satisfaction

of the requirements for the degree of

Doctor of Education in Organizational Leadership

by

Daniel Archer

October 2018

Acknowledgments

First and foremost, I want to recognize my beautiful wife, Lindsay. From taking on a larger role with our children to always being there for me when I needed a pep talk, you have been amazing throughout this entire program. I cannot thank you enough for your selfless attitude the last three years. Your love and support provided me with the encouragement needed to complete this arduous journey.

Second, I want to acknowledge my wonderful parents, Dave and Ruth. From the beginning, you all taught me that grit, above all, was the key to both academic and professional success. You couldn't have been more right. Thank you for always believing in me, even when I sometimes did not believe in myself.

Third, I want to recognize my committee chair, Dr. Irma Harper. Your positive comments, constructive criticism, and timely feedback provided the perfect combination of support and guidance that I needed. Thank you for being a terrific mentor to me over the last year and a half. Lastly, I also want to acknowledge my other committee members, Dr. Dodd and Dr. Morris. Your attention to detail, expertise, and encouragement were instrumental over the last several months. I appreciate the time and effort you devoted to helping me.

Abstract

Dual-enrollment College Algebra is offered in three modalities: at the college, at the high school, and online. The purpose of this study was to examine if the dual-enrollment College Algebra modality impacts early collegiate performance. A program evaluation was conducted using a causal-comparative design to explore potential cause-and-effect relationships between the dual-enrollment College Algebra modalities and five outcomes. The population included Oklahoma State System of Higher Education students who completed dual-enrollment College Algebra and subsequently earned freshman College Algebra postrequisite math grades, freshman College Algebra postrequisite science grades, or college credit in the fall semester after high school graduation. One-way ANOVA and chi-square analyses were applied to determine if there were statistically significant differences among students who completed College Algebra within the three dual-enrollment modalities using: freshman College Algebra postrequisite math grades and D, F, and Withdraw (DFW) grade rates; freshman College Algebra postrequisite science grades and DFW grade rates; and first-semester freshman grade point averages (GPAs). No statistically significant differences were observed in the four aforementioned freshman College Algebra postrequisite outcomes. These results suggest that the dual-enrollment College Algebra modality may not influence College Algebra postrequisite math and science performance. Conversely, significant differences were observed in first-semester freshman GPAs. Students who completed dual-enrollment College Algebra at the high school earned significantly lower first-semester freshman GPAs than students who completed dual-enrollment College Algebra online and at the college. These results suggest that the high school dual-enrollment College Algebra modality may negatively influence first-semester freshman GPAs.

Keywords: dual enrollment, college preparation, knowledge transfer, College Algebra

Table of Contents

Acknowledgments i

Abstract iii

List of Tables vi

Chapter 1: Introduction 1

- Statement of the Problem 4
- Purpose Statement 5
- Research Questions and Hypotheses 5
- Population Overview 7
- Definitions of Key Terms 8
- Summary 9

Chapter 2: Literature Review 11

- Historical Background and Evolution of Dual Enrollment 11
- Benefits of Dual Enrollment 15
- Online Versus Traditional Classroom Instruction 20
- Dual Enrollment in the Classroom and Online 28
- Transfer Learning 37
- Conceptual Framework Discussion 44
- Summary 46

Chapter 3: Research Method 50

- Research Design 51
- Population and Sampling 53
- Materials 55
- Data Collection and Analysis 56
- Operational Definitions of Variables 58
- Ethical Considerations 59
- Limitations 59
- Delimitations 60
- Assumptions 61
- Summary 61

Chapter 4: Results 63

- Summary of the Research Focus and Processes 63
- Presentation of the Findings 64
- Summary 77

Chapter 5: Discussion, Conclusions, and Recommendations 79

Evaluation of Findings and Implications 80
Recommendations 87
Conclusions 91

References 94

Appendix A: IRB Approval Letter 111

Appendix B: Oklahoma State Regents for Higher Education Data Request Form 112

List of Tables

Table 1. Freshman College Algebra Postrequisite Math Course Completion Classified by Dual-Enrollment College Algebra Modality 65

Table 2. Demographics of Freshman College Algebra Postrequisite Math Course Students, Classified by Dual-Enrollment College Algebra Modality 65

Table 3. One-Way ANOVA of Freshman College Algebra Postrequisite Math Grades, Classified by Dual-Enrollment College Algebra Modality 67

Table 4. Freshman College Algebra Postrequisite Math DFW and ABC Grades, Classified by Dual-Enrollment College Algebra Modality 68

Table 5. Freshman College Algebra Postrequisite Science Course Completion, Classified by Dual-Enrollment College Algebra Modality 69

Table 6. Demographics of Freshman College Algebra Postrequisite Science Course Students, Classified by Dual-Enrollment College Algebra Modality 70

Table 7. Welch's One-Way ANOVA of Freshman College Algebra Postrequisite Science Grades, Classified by Dual-Enrollment College Algebra Modality.....71

Table 8. Freshman College Algebra Postrequisite Science DFW and ABC Grades, Classified by Dual-Enrollment College Algebra Modality 73

Table 9. Students Who Earned College Credit in the Fall Semester after High School Graduation, Classified by Dual-Enrollment College Algebra Modality 74

Table 10. Demographics of Students Who Earned College Credit in the Fall Semester after High School Graduation, Classified by Dual-Enrollment College Algebra Modality.....74

Table 11. Welch's One-Way ANOVA of First-Semester Freshman GPAs, Classified by Dual-Enrollment College Algebra Modality 77

Table 12. Games-Howell Post Hoc Analysis of First-Semester Freshman GPAs, Classified by Dual-Enrollment College Algebra Modality 77

Chapter 1: Introduction

In the United States, many high school graduates do not possess the requisite skills and knowledge needed to succeed at the collegiate level, making the transition from high school to college difficult (ACT, 2007; Bailey, Hughes, & Karp, 2002; Hess, 2016; Moore et al., 2010; Southern Regional Education Board, 2015). One of the most significant reasons for this transition difficulty is the lack of math skills that many incoming college freshmen have at the outset of their collegiate career. Among other things, the lack of math skills is attributed to high schools offering limited advanced math courses and many advanced high school math courses lacking rigor. In a 2015 national survey of U.S. college math faculty, 44% of 4-year college faculty and 54% of 2-year college faculty reported that fewer than half of the recent high school graduates they taught lacked the skills and knowledge needed for collegiate-level math (Achieve, 2015). This lack of adequate preparation comprises a math skills gap, which is particularly problematic for college students because math is becoming an increasingly important skill set for the 21st century workforce.

Science, technology, engineering, and math (STEM) is one of the highest demand career cluster areas and is rooted in math skills (Carnevale, Smith, & Strohl, 2013; Vilorio, 2014). The number of STEM jobs is expected to grow by 26% between 2010 and 2020 (Carnevale et al., 2013; Vilorio, 2014). Additionally, math skills are predicted to be valued in a multitude of career clusters that extend beyond STEM, with employers projecting that math skills will be very important or extremely important in 70% of all occupations in 2020 (Carnevale et al., 2013). U.S. education administrators and policymakers have, therefore, devoted personnel and financial resources to bridge the college preparatory challenges and skill gaps that exist between high school and college (Barnett & Stamm, 2010; Tobolowsky & Allen, 2016).

One strategy used to improve students' transition from high school to college is dual enrollment. Dual enrollment is a course offering that enables high school students to enroll in a college course and earn both high school and collegiate credit simultaneously (Tobolowsky & Allen, 2016). Dual enrollment is an increasingly popular course offering in the United States: between 2000 and 2010, dual enrollment in the United States grew by 70% (Marken, Gray, & Lewis, 2013). By 2010-2011, nearly 1.4 million high school students (9% of all U.S. high school students) participated in dual enrollment (Marken et al., 2013). This offering creates a valuable growth and development opportunity because it exposes students to college level norms and expectations while in high school. In turn, the dual-enrollment experience provides an avenue for participating students to build time management skills, acquire new content knowledge, and establish study skills that are essential for postsecondary education success (Kanny, 2015; Karp, 2012; Lords, 2000).

Three common modalities for dual-enrollment delivery have emerged: *dual enrollment at the college*, *dual enrollment at the high school*, and *dual enrollment online*. Dual enrollment at the college integrates high school and college students in a traditional, on-campus college classroom setting (Barnett & Stamm, 2010). In contrast, dual enrollment at the high school places high school students in a high school classroom setting, with no mixing with college students (Barnett & Stamm, 2010). Dual enrollment online integrates both high school and college students in a digital learning environment (Barnett & Stamm, 2010).

This dissertation study was designed to examine dual enrollment at Oklahoma State System of Higher Education (OSS) institutions. The OSS institutions comprise the State of Oklahoma's 25 public colleges and universities; OSS institutions have experienced significant increases in dual enrollment in recent years, in line with a nationwide U.S. trend. In 2014-2015,

10,475 students participated in dual enrollment at OSS institutions—a 90% increase from 2005-2006 (Oklahoma State Regents for Higher Education [OSRHE], 2016). This dissertation study was specifically designed to examine dual enrollment in College Algebra at OSS institutions.

In recent years, College Algebra has been one of the highest enrolled courses among dual-enrollment students at OSS institutions. College Algebra is a high demand dual-enrollment course in part because it is the most commonly required math general education requirement and because College Algebra is a prerequisite course for students who pursue STEM majors (Herriott & Dunbar, 2009; Steen, 2007). STEM majors typically require students to take more advanced math and science courses that build upon College Algebra content knowledge (Herriott & Dunbar, 2009; Steen, 2007). College Algebra is also sought after by high school students because the math teacher shortage in Oklahoma at the time of this study has prevented many Oklahoma high schools from offering a math course above the rigor of Algebra 2, which is typically taken during the high school junior year (Felder, 2017; Palmer, 2016; U.S. Department of Education, 2014). As a result, dual-enrollment College Algebra is often the only math course option for many Oklahoma high school students who wish to take a math course between their junior year of high school and their freshman year of college.

Extent research on dual-enrollment College Algebra courses is limited to comparisons of nondual-enrollee College Algebra students to dual-enrollee College Algebra students. Speroni (2011) found that students who completed dual-enrollment College Algebra were 23% more likely to earn an associate's degree and 24% more likely to earn a bachelor's degree than students who completed nondual-enrollment College Algebra. Similarly, North and Jacobs (2008) observed that dual-enrollment College Algebra students earned significantly higher

grades than nondual-enrollment College Algebra students in a College Algebra postrequisite course, Precalculus.

Statement of the Problem

Several researchers have found that dual enrollment promotes college readiness and success on a multitude of measures. When comparing dual enrollees to nondual enrollees, dual enrollees have earned higher ACT scores (Eimers & Mullen, 2003; Radunzel, Noble, & Wheeler, 2014), exhibited lower remediation rates (An, 2013; Grubb, Scott, & Good, 2017; Speroni, 2011), and earned higher first-semester grade point averages (GPAs; Bailey, Calgano, Hughes, Jeong, & Karp, 2007). While the advantages of dual enrollment are documented when comparing dual-enrollment participants versus nondual-enrollment participants, there is limited research on the modalities through which dual-enrollment courses are delivered.

Some researchers have suggested that the online and high school dual-enrollment modalities may be less effective than the college campus modality. For example, Burns and Lewis (2000) argued that dual enrollment at the high school does not provide an authentic collegiate experience because such courses consist of high school students at an off-campus site. Similarly, Tobolowsky and Allen (2016) raised concerns about online dual enrollment, stating that such course offerings do not provide an outlet for students to engage in face-to-face conversations with peer students and experience the collegiate atmosphere.

Despite that these concerns exist, the literature review process for this dissertation study identified only one study that specifically examined the performance outcomes of each dual-enrollment modality. Arnold, Knight, and Flora (2017) compared grades earned in an unspecified math course within the three dual-enrollment modalities. Arnold et al. found that students who participated in the online dual-enrollment modality earned significantly higher

grades than students who took dual enrollment on the college campus, but did not earn significantly higher grades than students who took dual enrollment at the high school. Similarly, students who took dual-enrollment courses at the high school earned significantly higher grades than students who took dual enrollment on the college campus. While Arnold et al. addressed performance, they solely measured performance in the dual-enrollment course. As such, questions remain about the relationship between the dual-enrollment modality and subsequent performance after high school. Based on these issues, the central problem is that it is uncertain if the modality of a dual-enrollment College Algebra course impacts future college academic performance. Thus, research is warranted to determine if differences in subsequent collegiate academic achievement exist among students who participated in dual-enrollment College Algebra online, at the high school, or at the college.

Purpose Statement

The purpose of this study was to examine if the modality through which a dual-enrollment College Algebra course is delivered impacts freshman-year academic performance. More specifically, this study was conducted to assess if the dual-enrollment College Algebra modality affects freshman College Algebra postrequisite grades; College Algebra postrequisite D, F, and Withdraw (DFW) grade rates; and first-semester freshman GPAs. In this study, there were two postrequisite College Algebra math courses, Trigonometry and Elementary Calculus, and one College Algebra postrequisite science course, General Chemistry.

Research Questions and Hypotheses

Q1. Are there significant differences in freshman College Algebra postrequisite math grades earned among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

***H*$_0$.** There are no significant differences in freshman College Algebra postrequisite math grades earned among students who completed dual enrollment online, at a high school, or at a college.

***H*$_1$.** There are significant differences in freshman College Algebra postrequisite math grades earned among students who completed dual enrollment online, at a high school, or at a college.

Q2. Are there significant differences in freshman College Algebra postrequisite math DFW rates earned among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

***H*$_0$.** There are no significant differences in freshman College Algebra postrequisite math DFW grade rates among students who completed dual enrollment online, at a high school, or at a college.

***H*$_1$.** There are significant differences in freshman College Algebra postrequisite math DFW grade rates among students who completed dual enrollment online, at a high school, or at a college.

Q3. Are there significant differences in freshman College Algebra postrequisite science grades earned among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

***H*$_0$.** There are no significant differences in freshman College Algebra postrequisite science grades earned among students who completed dual enrollment online, at a high school, or at a college.

***H*1**. There are significant differences in freshman College Algebra postrequisite science grades earned among students who completed dual enrollment online, at a high school, or at a college.

Q4. Are there significant differences in freshman College Algebra postrequisite science DFW grade rates among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

***H*0**. There are no significant differences in freshman College Algebra postrequisite science DFW grade rates among students who completed dual enrollment online, at a high school, or at a college.

***H*1**. There are significant differences in freshman College Algebra postrequisite science DFW grade rates among students who completed dual enrollment online, at a high school, or at a college.

Q5. Are there significant differences in first-semester freshman GPAs among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

***H*0**. There are no significant differences in first-semester freshman GPAs among students who completed dual-enrollment College Algebra online, at a high school, or at a college.

***H*1**. There are significant differences in first-semester freshman GPAs among students who completed dual-enrollment College Algebra online, at a high school, or at a college.

Population Overview

The study population consisted of students who:

- completed a dual-enrollment College Algebra course at an OSS institution during the 2012-2013, 2013-2014, or 2014-2015 academic year; and

- subsequently completed one of the aforementioned enrollment sequences at an OSS institution during the 2013-2014, 2014-2015, 2015-2016, or 2016-2017 academic year.

More detailed information about the population, design, and methods are found in Chapter 3.

Definitions of Key Terms

Dual enrollment at the college campus. Dual enrollment in a college classroom setting that consists of both high school and college students (Barnett & Stamm, 2010).

Dual enrollment at the high school campus. Dual enrollment in a high school classroom setting that consists of high school students (Barnett & Stamm, 2010).

Dual enrollment online. Dual enrollment in a digital learning environment that consists of both high school and college students (Barnett & Stamm, 2010).

Lateral knowledge transfer. The process in which knowledge is acquired in an initial setting or activity and subsequently applied in an activity or setting that is of equal or lesser complexity (Gagne, 1970).

Oklahoma State Regents for Higher Education. The state coordinating board government agency that oversees the public colleges and universities in Oklahoma (OSRHE, n.d.b).

Oklahoma State System Institutions. The 25 public colleges and universities that fall under the auspices of the OSRHE. The compositional makeup of this system includes 12 community colleges, 10 regional universities, two research universities, and one liberal arts university (OSRHE, n.d.b).

Postrequisite course. A course in which enrollment eligibility is contingent upon successfully completing a specific course prior thereto (Wisneski, Ozogul, & Bichelmeyer, 2017).

Prerequisite course. A course that a student must successfully complete prior to enrolling in a more advanced course (Baard & Watts, 2008).

Vertical knowledge transfer. The process in which knowledge is acquired in an initial setting or activity and subsequently applied in a more advanced setting or activity (Gagne, 1970).

Summary

While dual enrollment has proven to be an effective mechanism to bridge the gap between high school and college, questions remain about the effectiveness of the dual-enrollment College Algebra modalities. Although the research on this topic is limited, researchers have expressed concerns that the high school and online modalities may be less effective because such modalities do not provide an authentic collegiate experience (Burns & Lewis, 2000; Tobolowsky & Allen, 2016). Despite that these concerns exist, prior to this dissertation study, no study had examined the impact of the modality on subsequent early collegiate performance. Thus, I conducted this study to measure if the dual-enrollment College Algebra modality affects freshman College Algebra postrequisite math and science grades, freshman College Algebra postrequisite math and science DFW grade rates, and first-semester freshman GPAs. This data analysis may assist OSS administrators and state policymakers in determining if the dual-enrollment College Algebra modality plays a significant factor in preparing students for STEM courses and overall early college success.

Chapter 2 addresses relevant topics pertaining to this study. Chapter 2 highlights the history and evolution of dual enrollment, the benefits of dual enrollment, and the differences between online and classroom teaching and learning. Additionally, Chapter 2 synthesizes research that is devoted to comparing online and classroom instruction performance outcomes, the three dual-enrollment modalities, and knowledge transfer. Chapter 2 concludes with a

discussion of the conceptual framework that influenced this study, Conley's college and career readiness framework.

Chapter 2: Literature Review

The purpose of this chapter is to provide a comprehensive overview of the literature that pertains to this study. This literature review begins with a review of core topics addressed in this study. The first section outlines the history and evolution of dual enrollment at both the national and state levels. This section addresses how dual enrollment has grown, as well as the common dual-enrollment funding models, with specific attention devoted to how dual enrollment has expanded in Oklahoma through a statutorily mandated dual-enrollment tuition waiver program. The second section addresses the advantages of dual enrollment, particularly as it relates to preparing students for college success. The third section highlights differences between the online and classroom modalities. This section details the roles of the faculty member and the student and summarizes studies that have investigated course performance and completion outcomes within each modality. The fourth section addresses online and classroom instruction in the dual-enrollment environments, including prior research on dual enrollment conducted at the college, at the high school, and online. The fifth section addresses knowledge transfer, providing a historical overview of knowledge transfer, factors that influence knowledge transfer, and studies that have examined knowledge transfer through the lens of a prerequisite/postrequisite course trajectory. Lastly, this chapter concludes with a discussion of the study's conceptual framework, Conley's college and career readiness framework.

Historical Background and Evolution of Dual Enrollment

Dual enrollment in the United States. In the early 1970s, a group of school districts in the Syracuse, New York area convened to discuss concerns that the high school senior year had become an apathetic experience for high-achieving students who had completed the majority of their high school curricular requirements (Diamond & Holloway, 1975). Administrators and

teachers from these districts concluded that the senior year had become a filler year between the junior year of high school and the first year of college, in which high-achieving students took mostly elective courses that lacked academic rigor. As a result of these concerns, the school districts looked to identify and implement an initiative to keep high-achieving seniors engaged and to help prepare them for the progression from high school to college. These conversations provided the framework for Project Advance, which was one of the earliest forms of what is today referred to as dual enrollment (Edmonds & Squires, 2016). Project Advance began in 1973 as a partnership with six school districts in the Syracuse, New York area and Syracuse University (Diamond & Holloway, 1975). This initiative was established to enhance the academic quality and rigor of the of the high school senior year through providing access to collegiate-level coursework.

After the success of dual-enrollment programs was established at the institutional level, dual enrollment permeated throughout the United States through the adoption of state dual-enrollment policies. In 1976, California became the first state to develop a statewide policy that detailed dual-enrollment standards (Mokher & McLendon, 2009). Between 1976 and 2000, 31 states adopted dual-enrollment policies, and by 2015, 47 states had dual-enrollment policies (Mokher & McLendon, 2009; Zinth, 2015). Today, these policies address a number of dual-enrollment criteria, including admission eligibility requirements, program quality assurance requirements, and the financial conditions to specify who is responsible for paying for tuition, fees, and books (Zinth, 2015). The majority of state policies limit dual-enrollment eligibility to high school seniors and juniors, while a smaller number make it available to sophomores and freshmen. While eligibility standards are more common among states, there is a greater degree of incongruity regarding financial arrangements. Among the most common systems, some states

specify that dual-enrollment funding is a local decision that is contingent upon an agreement between the school district and higher education institution, some states allocate monies to subsidize dual-enrollment costs, some states require school districts to pay for some or all of dual-enrollment costs, and some states specify that the onus is on the student and parent (Zinth, 2015).

The creation of state policies and use of public allocations in some states for dual-enrollment funding has made dual enrollment a more common offering among public institutions. In 2010-2011, Marken et al. (2013) noted that 98% of public 2-year institutions offered dual enrollment, 84% of public 4-year institutions offered dual enrollment, 49% of private nonprofit institutions offered dual enrollment, and 10% of private for-profit institutions offered dual enrollment. While each sector has experienced dual-enrollment growth since 2000, the majority of dual enrollment has occurred at 2-year public institutions. Of the nearly 1.4 million students who participated in dual enrollment in 2010-2011, 71% enrolled at public 2-year institutions, 21% enrolled at public 4-year institutions, 7% enrolled at private 4-year nonprofit institutions, and less than 1% enrolled at private for-profit institutions (Marken et al., 2013).

Dual enrollment in Oklahoma. The Oklahoma Concurrent Enrollment in High School and College or University Courses Act of 1988 established the foundation for dual enrollment in Oklahoma. This statute, which took effect in 1989, specified that the OSRHE would establish a dual-enrollment policy for OSS institutions and collaborate with its secondary education counterpart, the Oklahoma State Department of Education, to promote dual-enrollment opportunities to high-aptitude high school students. While students utilized this program in the years following its inception, the program did not experience monumental growth until 2005, which occurred by virtue of the Oklahoma Legislature amending the Oklahoma Concurrent

Enrollment in High School and College or University Courses Act of 1988. This amendment mandated that colleges and universities waive six hours of dual-enrollment tuition during the summer immediately after the junior year, as well as during the fall and spring semesters of the senior year. The inception of the tuition waiver program has widely been credited with increasing access to dual enrollment, as the number of participants increased by 112% between 2005 and 2015 (OSRHE, 2016). Much like with the national data, the vast majority of OSS dual enrollment has occurred at community colleges. The institutional breakdown of OSS dual enrollment by tier for 2014-2015 was: community colleges, 77.7%; regional universities, 20.0%; research universities, 2.0%; and one liberal arts university, 0.28% (OSRHE, 2017b).

Summary. Dual enrollment has experienced exponential growth both in Oklahoma and nationally. The earliest known form of dual enrollment was rooted in a partnership in which Syracuse University collaborated with local high schools to serve high-achieving high school seniors (Edmonds & Squires, 2016). Over time, dual enrollment permeated across the country through the establishment of state dual-enrollment policies (Zinth, 2015). By 2015, 47 states had a statewide dual-enrollment policy detailing the standards under which dual-enrollment programs are offered. These policies address a multitude of issues, including eligibility criteria, financial responsibilities, and program quality assurance principles.

The Oklahoma Concurrent Enrollment in High School and College or University Courses Act of 1988 established the foundation for dual enrollment in Oklahoma. While dual enrollment participation increased each year after its inception, the creation of a tuition waiver program in 2005 generated substantial dual-enrollment growth in more recent years. Between 2005 and 2015, the number of students participating in dual enrollment at OSS institutions increased by 112% (OSRHE, 2016).

Benefits of Dual Enrollment

College readiness. In many cases, high school students complete the majority of their high school graduation requirements and college entrance requirements prior to their senior year (Bailey et al., 2002). As a result, demanding high school curriculum often ends at the conclusion of the junior year. In many cases, this leads to high school seniors developing *senioritis*, which occurs when a student becomes disengaged and uninterested in rudimentary coursework during the last year of high school (An, 2013). The lack of rigor is problematic, because as Adelman (2006) found, there is a strong relationship between rigorous high school coursework and collegiate-level success. As such, by experiencing a gap year, students do not continue to hone academic skills, which in turn can hinder collegiate preparation. Dual enrollment has been shown to be an effective strategy to mitigate this obstacle because it provides students with opportunities to be challenged in rigorous collegiate coursework (Bailey et al., 2002). Students have articulated that dual enrollment creates stimulating educational experiences that require them to exert more effort than high school, which in turn helps them build the academic foundation needed to establish college readiness. Among many benefits, students have credited dual enrollment with helping them develop time management skills, acquire knowledge, and establish study skills (Kanny, 2015; Karp, 2012; Lords, 2000).

Several quantitative studies have also demonstrated that dual enrollment is associated with promoting college readiness. Eimers and Mullen (2003) analyzed the ACT scores of incoming University of Missouri freshmen by comparing students who participated in dual enrollment versus students who did not participate in dual enrollment. Eimers and Mullen revealed that dual-enrollment participants earned an average ACT score of 25.8, while nondual-enrollment participants earned an average ACT score of 24.7. Radunzel, Noble, and Wheeler

(2014) conducted a larger-scale comparison of ACT scores that yielded similar results, focusing on incoming freshmen at the University of Texas at Austin, Texas; A&M University at College Station, Texas; A&M University at Commerce; and University of Texas-Pan American. Radunzel et al. compared dual-enrollment participants to nondual-enrollment participants, finding that dual-enrollment participants earned an average ACT score of 23.6, whereas nondual-enrollment participants earned an average ACT score of 22.8.

In addition to the ACT studies, researchers have also shown that dual enrollment is linked to lower collegiate remediation rates. An (2013) analyzed a national U.S. dataset, finding that nondual enrollees were 6% more likely to need remediation than dual enrollees. Likewise, Grubb et al. (2017) conducted a longitudinal study of data from a community college in Tennessee and revealed that dual enrollees were nearly 3.4 times less likely to need remediation compared to their nondual-enrollee counterparts. The contrast in remediation rates between dual enrollees and nondual enrollees has also been shown to be present within each core academic skill area. When analyzing a dataset from Florida public high schools, Speroni (2011) found that 47% of nondual-enrollment participants versus 17% of dual-enrollment participants required math remediation, 27% of nondual-enrollment participants versus 6% of dual-enrollment participants required English remediation, and 35% of nondual-enrollment participants versus 9% of dual-enrollment participants required reading remediation.

College-going rates and first-semester performance. Dual enrollment has been associated with increased high-school-to-college going rates. Struhl and Vargas (2012) found that students who participated in dual enrollment in Texas were over twice as likely to enroll in a public college or university after high school graduation as students who did not participate in dual enrollment. Similarly, Lewis and Overman (2008) observed that students who participated

in a career and technical education dual-enrollment program were 16% more likely to enroll in college after high school graduation than students who did not participate in dual enrollment.

Dual-enrollment participation has also been linked with higher levels of early college performance. A number of studies have demonstrated that dual-enrollment students earned significantly higher first-semester GPAs than students who did not participate in dual enrollment. Bailey et al. (2007) conducted a study that analyzed first-semester GPA outcomes within two robust datasets. The first dataset revealed that students who participated in dual enrollment in Florida and subsequently enrolled at a Florida public college or university earned a 2.9 first-semester GPA, while Florida public college or university enrollees who did not participate in dual enrollment earned a 2.4 first-semester GPA. The second dataset, which compared the first-semester GPAs of students who enrolled at the City University of New York System after high school graduation, indicated that dual enrollees earned a 2.53 first-semester GPA and nondual enrollees earned a 2.28 first-semester GPA. The first-semester GPA advantage that dual-enrollment participants hold over nondual-enrollment participants was also shown to extend within racial groups. A longitudinal study at a southwest Texas community college indicated that Caucasian dual enrollees earned a significantly higher first-semester GPA (2.56) than Caucasian nondual enrollees (2.31), and African American dual enrollees earned a significantly higher first-semester GPA (1.96) than African American nondual enrollees (1.62; Young, Joyner, & Slate, 2013).

Persistence, credit-hour production, and degree completion. When a student performs well in academic coursework and continues enrollment thereafter, he/she exhibits persistence (Eisenback Henson, 2013). Thus, by attempting and completing courses, a student builds and applies momentum by persisting toward future enrollment and degree completion. Dual

enrollment has a positive impact on boosting persistence rates throughout the duration of an academic career. Compared to students who had not participated in dual enrollment, students who participated in dual enrollment are significantly more likely to persist from the first semester of college to the second semester of college, from the first year of college to the second year of college, and from the second year of college to the third year of college (Radunzel et al., 2014; Speroni, 2011; Swanson, 2010). The number of credit hours earned through dual enrollment has also shown to influence persistence rates. For example, Appleby et al. (2011) found that dual-enrollment students who earned fewer than 12 dual-enrollment credit hours exhibited an 85% first-to-second-year persistence rate, while students who earned 12 to 30 dual-enrollment credit hours exhibited a 90.3% first-to-second-year persistence rate. Speroni (2011) observed that dual-enrollment participation, coupled with higher credit-hour completion during the first semester of college, led to higher persistence rates. Compared to students who had not participated in dual enrollment, students who participated in dual enrollment and subsequently earned 20 or more college credit hours during their first semester were 28% more likely to persist to the second year of college (Speroni, 2011).

Dual-enrollment participation has been linked to increasing credit-hour production in semesters occurring in the first collegiate year. In a study conducted at four public universities in Texas, 95% of students who participated in dual enrollment earned at least 24 credit hours during their first year in college, compared to 71% of students who had not participated in dual enrollment (Radunzel et al., 2014). This finding is significant, because as Adelman (2006) found, students who failed to earn 20 credit hours during the first year of college were 22% less likely to earn a baccalaureate degree. The impact of dual enrollment on increased credit-hour production has also shown to extend throughout the collegiate career. Students who have

participated in dual enrollment accrue a higher number of credit hours than nondual enrollees at the end of the sophomore, junior, and senior years of college (Bailey et al., 2007; Radunzel et al., 2014).

The increased credit-hour production associated with dual enrollment is advantageous because it contributes to decreasing the time to degree completion. A national study conducted by Adelman (2004) revealed that students who participated in dual enrollment completed baccalaureate degrees in an average of 4.25 years, compared to an average of 4.65 years for students who had not participated in dual enrollment. Likewise, Marshall and Andrews (2002) found that students who participated in dual enrollment at an Illinois community college reduced their baccalaureate degree completion time by an average of 1.2 semesters. In addition to time to completion, scholarly research has also demonstrated that dual-enrollment participation significantly increases the probability of earning a degree. Three studies comparing dual-enrollment participants and nondual-enrollment participants revealed that dual-enrollment participants were more likely to earn an associate's degree (Grubb et al., 2017; Speroni, 2011; Struhl & Vargas, 2012). Similarly, Allen (2010), Community College Research Center (2012), Speroni (2011), Struhl and Vargas (2012), and Swanson (2010) found that dual-enrollment participants were more likely to earn a bachelor's degree than nondual-enrollment participants.

Summary. Many high school seniors develop *senioritis*, which occurs when a student becomes complacent because he/she is disengaged and uninterested in rudimentary coursework that is offered during the last year of high school (An, 2013). Dual enrollment is a potential avenue to ameliorate this obstacle, providing students with an opportunity to experience demanding coursework and build academic skills for college. Students who participate in dual enrollment have reported that it leads to building time management skills, acquiring knowledge,

and establishing study skills (Kanny, 2015; Karp, 2012; Lords, 2000). Over time, multiple research studies have indicated that dual enrollment promotes college readiness and success on a multitude of measures. Among other things, when comparing dual enrollees to nondual enrollees, dual enrollees have exhibited higher high-school-to-college going rates (Lewis & Overman, 2008; Struhl & Vargas, 2012), required less remediation (An, 2013; Grubb et al., 2017; Speroni, 2011), and earned higher first-semester college GPAs (Bailey et al., 2007; Young et al., 2013). Research has also indicated that dual enrollees are more successful than nondual enrollees on long-term academic performance measures. Bailey et al. (2007) and Radunzel et al. (2014) observed that dual enrollees accumulate more credit hours, and Allen (2010), Community College Research Center (2012), Grubb et al. (2017), Speroni (2011), Struhl and Vargas (2012), and Swanson (2010) found that dual enrollees exhibit higher graduation rates.

Online Versus Traditional Classroom Instruction

Roles. Research has indicated that the interaction within an online environment significantly differs from a traditional classroom environment. In a face-to-face course, the instruction is constructed primarily around the faculty member serving as the principal source of course information (Berger & Topol, 2001). Under this configuration, course information is disseminated primarily through lectures and conversations. This allows the faculty member to exhibit content expertise and provide real-time feedback and support (Sewell, 2016; Sweeney, Morrison, Jarratt, & Heffernan, 2009). The nature of this configuration impacts the manner in which students communicate with the faculty member and his/her peers. Under this format, the student processes information through a combination of listening and reading facial expressions and body language (Gregory & Lampley, 2016; Knapp, Hall, & Hogan, 2013). Additionally, the

student exhibits opinions and ideas verbally in a classroom environment and receives feedback in real time (Gregory & Lampley, 2016).

In an online course, the instruction is delivered through a learning management system, which allows students to access course content, interact with classmates on discussion forums, communicate with faculty, submit assignments, retrieve grades, and complete quizzes (Gautreau, 2011). As a result, the faculty member's role and the nature of the interaction is markedly different in online and classroom environments. In an online environment, the faculty member serves in more of a facilitator role. By serving in this capacity, the faculty member's central role is often to foster peer-to-peer engagement in an asynchronous, discussion board environment (Berger & Topol, 2001; Brindley, Walti, & Blaschke, 2009; Crawford-Ferre & Weist, 2012). Likewise, the online configuration also requires the student to play a different role than he/she would play in a traditional classroom. In an online environment, the student plays a more active learner role through commenting on discussion questions and critiquing and responding to peers (Finley, 2005). With the absence of verbal communication and body language, this configuration requires the student to comprehend feedback and express ideas and opinions in a written form (Abrami & Bures, 1996).

Course performance. The research that has investigated online and classroom instruction performance has yielded mixed results. In one of the most highly cited publications on this topic, Russell (1999) conducted a literature review in which he synthesized 355 articles that found no significant differences between distance education and traditional classroom instruction. This literature review highlighted research spanning from 1928 to 1998 that compared traditional instruction to correspondence radio, television, video, and online instruction. A multitude of research examining potential differences between online education

and classroom instruction has supported the findings cited within this literature review. Several of these comparison studies have focused on performance in an individual subject. As one example, quantitative performance analysis studies have indicated that there were no significant differences in grades earned between students who took a university statistics course online or in the classroom (Evans et al., 2007; Hurlburt, 2001; McLaren, 2004). Likewise, additional studies revealed that there were no significant differences in grades between online and classroom university students in a principles of economics course (Coates, Humphreys, Kane, & Vachris, 2004), a pharmacology course (Mirakian & Hale, 2007), a management information systems course (Larson & Sung, 2009), a business applications software course (Wagner, Garippo, & Lovaas, 2011), and a quantitative business analysis course (Jones & Long, 2013). Cavanaugh and Jacquemin (2015) advanced the notion that there were no significant differences in performance outcomes between the two modalities in a large-scale study. In contrast to the aforementioned studies, which focused on individual courses, Cavanaugh and Jacquemin compared all courses that were taught by the same faculty member in both an online and traditional format. Thus, course grades awarded by faculty members who taught the same course in both an online and classroom setting served as the dataset for this research. The results of this study, which analyzed over 5,000 courses taught at a large, urban university, revealed that no significant differences existed in grades earned between the online and classroom students (Cavanaugh & Jacquemin, 2015).

While several research contributions support that there are no significant differences between an online course and a traditional classroom course, other studies have found that students earn significantly higher grades in the traditional course modality. This has been found in studies that examined specific courses and subject areas. At the institutional level, studies

have revealed that traditional classroom students earned significantly higher grades in a psychology course (Garratt-Reed, Roberts, & Heritage, 2016), a college algebra course (Tanyel & Griffin, 2014), and an upper-division quantitative methods course (Verhoeven & Wakeling, 2011). On a larger scale, Johnson and Marisol (2014) conducted a statewide community college study in which they compared performance outcomes of the two modalities by discipline area. The results of this study showed performance gaps between the traditional classroom and online students within every discipline area. Among the core subject areas, the performance gaps between the classroom and online students were 6.7% in English, 7.5% in biology, 13.3% in math, and 13.4% in social sciences (Johnson & Marisol, 2014).

Going beyond courses and discipline outcomes, aggregated datasets have also indicated that students have performed better in traditional courses than in online courses. In a longitudinal study, Tanyel and Griffin (2014) examined the outcomes of courses that were taught by the same faculty member in both an online format and a traditional format. Tanyel and Griffin examined grades earned over a 10-year period at a regional university in the southeastern part of the United States. The results of this study indicated that students who participated in the traditional classroom modality earned a significantly higher GPA (2.80) than students earned in the online modality (2.65). Bettinger and Loeb (2017) observed similar outcomes in a study in which they compared the grades of DeVry University online and traditional classroom students. Bettinger and Loeb found that students in the traditional classroom courses earned a higher GPA (2.88) than the students in the online courses (2.44).

Completion rates. While the research on performance outcomes between the online and classroom modality have been incongruous, research has shown that completion rates are noticeably different within each modality. Early research on completion rates indicated that

online students exhibited markedly lower completion rates than traditional classroom students (Carr, 2000; Carter, 1996). These early findings have been substantiated in a multitude of studies that have investigated if potential completion differences existed between the two modalities. When comparing the two at the individual course level, Dutton, Dutton, and Perry (2001) observed that online students withdrew at significantly higher rates from an undergraduate computer science course at North Carolina State University. These results are similar to those found by Ni (2013), who reported that students in an online graduate public administration course had significantly higher failure/withdrawal rates in the online course than in the traditional course. When comparing the two modalities at the institutional level, Atchley, Wingenbach, and Akers (2013) observed that students in online courses at a regional university in the southeast had a significantly higher withdrawal rate (6.7%) than students in a traditional course (3.4%). Along the same lines, Tanyel and Griffin (2014) found that there was a 12% failure/withdrawal rate gap between students who participated in classroom and online instruction at a regional university in the southwest.

Lower online completion rates in online courses have also been documented at the community college level. In studies examining large-scale datasets, a sizable gap between traditional courses and online courses has been observed: 12% within Virginia community colleges (Jaggars & Xu, 2010), 12% within the California Community College System (California Community Colleges Chancellor's Office, 2011), and 13% in a state community college system in the southern region of the country (Jaggars, Edgecombe & Stacey, 2013). When disaggregating the southern state community college system data into course completion rates, Jaggars et al. (2013) observed that online students exhibited a 13% completion gap in math gateway courses and a 9% completion gap in English gateway courses.

Impact of the modality on future outcomes. Much like the studies involving performance outcomes, the studies that examined how the modality impacts future outcomes have produced mixed results. When looking at retention, Jaggars and Xu (2011) found that Washington community college students who took at least one online class yielded significantly lower fall-to-spring semester and first-year-to-second year persistence rates than students who only took classes in a traditional environment. Similarly, when comparing students who took a course in the traditional and online modality at DeVry University, Bettinger and Loeb (2017) observed that online students exhibited lower semester-to-semester persistence rates, as well as lower GPAs and less attempted credit hours in the subsequent semester.

In contrast to the aforementioned studies, which compared online students and classroom students, James, Swan, and Daston (2016) took a different approach by comparing a group of community college students and university students who fell within three subcategories: students who completed their classes in the online modality, students who completed their classes in the classroom modality, or students who completed their classes in a combination of both modalities. The researchers organized this study by identifying enrollment patterns of students in their first six months of enrollment and subsequently classifying them into the appropriate subcategory. The community college data revealed that students who took online courses were retained 12 to 18 months after initial enrollment at a significantly lower rate (30%) than students who only took courses in the classroom (51%) or students who participated in a combination of online and classroom courses (58%). Likewise, of the students within the university setting, online students exhibited a significantly lower retention rate (60%) than traditional classroom students (76%) and students who participated in a combination of both modalities (79%).

The research on the impact of the modality on graduation rates has also been incongruous. Two prior studies have indicated that online education has a negative impact on degree attainment. Jaggars and Xu (2010, 2011) observed that community college students in Virginia and Washington who took a higher portion of online courses were less likely to graduate or transfer to a university than students who took lower portions of online coursework. Conversely, a more recent study by Shea and Bidjerano (2014) found that online courses had a positive impact on degree completion. This study, which was based on a national dataset originally collected by the National Center for Education Statistics, revealed that community college students who took at least one online course were significantly more likely to earn a certificate or associate's degree than students who did not take an online course (Shea & Bidjerano, 2014). Shea and Bidjerano (2016) built on their 2014 study by using the same dataset to determine if the modality impacted whether community college students transferred to a university and completed a bachelor's degree. After the data were analyzed and assessed, the researchers observed that community college students who took an online course transferred to universities and completed bachelor's degrees at higher rates than community college students who did not take an online course.

Summary. A robust body of literature has investigated differences between the online and classroom modalities. One of the noticeable differences is the role that faculty and students play within each modality. In a classroom environment, the faculty member is often the primary source of course information and mostly communicates with students verbally; whereas in the online environment, the faculty member serves in more of a facilitator role (Berger & Topol, 2001; Brindley et al., 2009; Crawford-Ferre & Weist, 2012; Sewell, 2016; Sweeney et al., 2009). Conversely, when looking at the learning experience through the lens of the student, the student

learns through peer engagement in online courses and through listening to lectures in a classroom environment (Abrami & Bures, 1996; Finley, 2005; Gregory & Lampley, 2016; Knapp et al., 2013). Performance in online versus classroom courses has yielded mixed results, as some studies have indicated that there are no significant performance outcome differences between the two modalities (Cavanaugh & Jacquemin, 2015; Coates et al., 2004; Evans et al., 2007; Hurlburt, 2001; Jones & Long, 2013; Larson & Sung, 2009; McLaren, 2004; Mirakian & Hale, 2007; Wagner et al., 2011), while other studies have found that students perform significantly better in the classroom environment (Garratt-Reed et al., 2016; Johnson & Marisol, 2014; Tanyel & Griffin, 2014; Verhoeven & Wakeling, 2011).

Although the research on performance outcomes is incongruous, the research on course retention has consistently yielded more favorable outcomes for the classroom environment. As such, a number of studies have indicated that online students are more likely to withdraw or fail classes than students in a classroom environment (Atchley et al., 2013; California Community Colleges Chancellor's Office, 2011; Carr, 2000; Carter, 1996; Dutton et al., 2001; Jaggars & Xu, 2010; Jaggars et al., 2013; Ni, 2013; Tanyel & Griffin, 2014). Going beyond individual course performance and completion, the studies that have examined the impact of dual enrollment on future performance have yielded incongruous results. Some studies have linked online course participation to higher retention (James et al., 2016) and degree completion rates (Shea & Bidjerano, 2014, 2016), while other studies have linked online enrollment to lower levels of retention (Bettinger & Loeb, 2017; Jaggars & Xu, 201l) and degree completion (Jaggars & Xu, 2010, 2011).

Dual Enrollment in the Classroom and Online

Dual enrollment is offered online, at high school locations, and on college campuses (Tobolowsky & Allen, 2016). While dual enrollment delivered within each modality continues to grow, a national study conducted by Marken et al. (2013) revealed that the latter is the most common offering. In the Marken et al. study, 83% of colleges reported offering dual-enrollment courses at the college campus, 64% reported offering dual-enrollment courses at the high school campus, and 48% reported offering dual-enrollment courses online. While there is a growing body of research pertaining to dual enrollment, the research on the three dual-enrollment modalities is limited.

Dual enrollment at the college. Students who participate in dual enrollment at the college site are exposed to a collegiate experience before completing high school (Bailey et al., 2002; Tobolowsky & Allen, 2016). In contrast to students who participate in dual-enrollment online or at the high school, students who participate in dual enrollment at the college experience the collegiate atmosphere and its surroundings. This has been regarded as an effective learning environment because it creates a classroom setting in which dual-enrollment students integrate with collegiate students, which in turn provides dual-enrollment students with exposure to more diverse perspectives and deeper discussions (Jordan, Cavalluzzo, & Corallo, 2006). These interactions help dual-enrollment students broaden viewpoints and hone the critical thinking skills needed to succeed in collegiate-level coursework. Outside the classroom, students who participate in dual enrollment on a college campus have greater access to on-campus resources, such as tutoring, counseling, supplemental instruction, advising, and library services. The availability of these services is advantageous because researchers have observed a positive

relationship between the use of academic support services and academic persistence (Adelman, 1999; Pascarella & Terenzini, 2005; Roberts & Styron, 2010).

While researchers have cited the benefits of the collegiate experience in multiple studies, to date, only one study has evaluated if on-campus dual enrollment is associated with higher collegiate performance after high school. The Community College Research Center (2012) reported that students who participated in dual enrollment at the college campus were significantly more likely to attend college after high school graduation, pursue a baccalaureate degree, and attain a baccalaureate degree than those students who completed dual enrollment at the high school. While this study examined performance outcomes, it did not address if differences existed in early college performance after high school among students within the three dual-enrollment modalities. Thus, it is unknown if the modality impacts first-semester GPAs and performance in specific courses taken during the first year of college after high school. Additionally, the aforementioned study did not address the online modality.

Dual enrollment at the high school. High school dual enrollment is a course offering at the high school that is taught by a qualified high school instructor or college faculty member (Barnett & Stamm, 2010). A basic assumption, pertinent to the study of dual enrollment at the high school, is based on the notion that it increases access (Edwards, Hughes, & Weisberg, 2011). By offering the courses at the high school location during the school day, students who participate in dual enrollment at the high school are not required to secure transportation to the college campus. As a result, this modality has been noted as a way to expand opportunities for low-socioeconomic students to participate in dual enrollment (Catron, 2001; Edwards et al., 2011; Khazem & Khazem, 2012).

The employment of dual enrollment at the high school campus also has been used as an outlet to expand access to students who live in isolated areas. Catron (2001) observed that high school campus offerings were valuable because such offerings created opportunities for rural Virginia high school students who did not reside close to a community college to participate in dual enrollment. In addition to enhancing access, the high school location has also been noted as a beneficial modality because it creates an opportunity for students to pursue college in a familiar environment. As such, by experiencing dual enrollment in a high school classroom setting that is comprised of their high school peers, Mace (2009) noted that dual enrollment at the high school provides a less intimidating experience, which in turn can ease the transition.

Although the research devoted to dual enrollment at the high school has pointed out many benefits, there is also a body of research that has addressed concerns with this modality. Above all, many researchers have criticized dual enrollment at the high school because of a concern that it lacks academic quality. Clark (2001) observed that high school dual enrollment instructed by a high school faculty member is problematic because it leads to lower levels of rigor and creates an inauthentic collegiate atmosphere. Similarly, in a study comparing student experiences in the high school and college modalities, Burns and Lewis also (2000) expressed apprehensions about the effectiveness of the high school modality. In this study, the students in the dual enrollment at the college modality reported higher levels of rigor and higher levels of satisfaction, whereas students in the dual enrollment at the high school modality found the courses less challenging and compared them to high school courses. A qualitative study by Karp (2012) advanced the notion that there are concerns associated with offering dual enrollment at the high school locations. After observing several dual-enrollment courses in the high school classroom setting, Karp concluded that the courses in this modality were either authentic or inauthentic. The

authentic courses provided a platform for students to engage in role-related learning by practicing how to become a college student. The study showed that students in the authentic environment gained study skills and became more independent learners over the course of the semester. In contrast, the inauthentic courses greatly reduced the probability of role-related learning opportunities, which resulted in a greater dependence on the instructor, a lower quantity of assignments, and less academic-related discussions (Karp, 2012).

The concerns regarding rigor have led policymakers to believe that dual enrollment at the high school is "watered down to help students be more successful" (Karp & Hughes, 2008, p. 15). The lack of quality control that some believe exists has made it more difficult for students to transfer dual-enrollment courses, particularly for students who took dual-enrollment courses at the high school. In a national survey of 388 higher education institutions conducted by Kilgore and Taylor (2016), 33% of institutions reported that the location of the dual-enrollment course was a factor in determining whether a dual-enrollment course transferred to the receiving institution.

While researchers have expressed that the use of high school faculty is a concern regarding dual enrollment at the high school, there is one research study that refutes this assertion. When analyzing Florida students who completed dual enrollment at a high school site, Hébert (2001) found that students who completed a dual-enrollment math course taught by a high school instructor earned significantly higher grades in college math courses after dual enrollment than students who had completed a dual-enrollment math course taught by a college faculty member. Overall, these outcomes suggested that students who completed dual-enrollment math courses at the high school that were taught by high school instructors were more prepared for college math courses after dual enrollment compared to students who completed

dual-enrollment math courses at the high school that were taught by college faculty (Hébert, 2001). While this study found differences in math performance after high school, it focused solely on students who participated in dual enrollment at the high school. Thus, it is unknown if there are differences in collegiate performance after high school among students who participate in the three dual-enrollment modalities.

Online dual enrollment. As previously noted, online dual enrollment utilizes a learning management system platform that enables students to access course materials and submit assignments, quizzes, and tests (Danver, 2016). Much like dual enrollment at the high school, one of the most significant advantages of online dual enrollment is accessibility. In rural areas, students often attend a high school that is not within close proximity of a college and reside in areas that lack residents who possess the academic credentials necessary to teach a college course at the high school (Barnett & Stamm, 2010; Lukes, 2014). As an electronic medium, online education creates an avenue to remove these obstacles by electronically connecting students and faculty within the context of a digital course environment. In one example, Harris and Stovall (2013) noted that the online modality provided a means for Stephen F. Austin University to deliver College Algebra and Trigonometry to dual-enrollment students who resided in small Texas communities who had previously not had access to dual-enrollment math opportunities.

The research concerning dual enrollment has noted that two populations benefit from the online modality. In a mixed-methods study that explored students who took online math courses, Harris and Stovall (2013) found that the online dual-enrollment modality was advantageous for students who participated in extracurricular activities. The use of asynchronous communication afforded student athletes the ability to work ahead in advance of upcoming weeks in which they

planned to devote more time to practice and training. In addition to providing flexibility to students who are involved in extracurricular activities, online dual enrollment can also be advantageous for students with special needs. The online modality has become a popular option for students with visual and hearing impairments (U.S. Department of Education, Office of Innovation and Improvement, 2007). This modality has also been shown to be a more comfortable environment for autistic students, since these students sometimes struggle with the social interactions in a traditional classroom environment.

While online dual enrollment has created opportunities to expand access and flexibility, technological challenges and limitations have also emerged within this modality. For example, some students who reside in rural areas do not have access to broadband internet service (Child Trends, 2015). The lack of reliable high-speed internet capability is problematic because it can prevent students from accessing videos and other online medium components that are essential for student success (Danver, 2016). Another access challenge exists for low-socioeconomic status students because they are far less likely to own a computer and have home internet access compared to students from middle- and upper-socioeconomic backgrounds (Child Trends, 2015). In addition to access issues, online dual-enrollment students have also experienced technical difficulties. In a qualitative study that explored the experiences of online dual-enrollment students in New Mexico, Wallace (2015) found that students reported problems with password retrieval and software compatibility. Harris and Stoval (2013) examined high school students taking dual enrollment using communal high school computers and revealed that high-level firewalls and security features on the communal computers prevented students from accessing certain online course materials.

Much like dual enrollment at the high school, researchers have criticized online dual enrollment because it does not provide students with an opportunity to experience the collegiate atmosphere. In online courses, the student-to-student communication and faculty-to-student communication is primarily textual (Danver, 2016). The lack of face-to-face contact can create communication challenges because there is no body language, facial expression, or vocal tone to convey attitudes. As such, the online modality has been noted as problematic for dual-enrollment students because it does not "socialize or introduce students" to the collegiate experience, which has long been regarded as one of the fundamental advantages of dual enrollment (Tobolowsky & Allen, 2016, p. 34). The concern that dual enrollment may not be as effective in familiarizing students with college also extends to the use of academic resources. By not being on campus, online dual-enrollment students are often either unaware of campus resources or do not receive adequate instruction to detail how to use such resources (Stimpson, 2016). The lack of social environment, coupled with the challenges associated with using campus resources, has created an assertion that the online dual-enrollment modality does not adequately prepare students for collegiate success. Despite that this assertion exists, current research does not validate such a view. In a qualitative dual-enrollment study, Wallace (2015) found that online dual-enrollment students at a community college in New Mexico gained many benefits from participating in online dual enrollment. These students reported that online dual enrollment provided a favorable experience that enhanced college preparation, fostered discipline, and strengthened technology skills (Wallace, 2015).

To date, few studies have compared online dual enrollment with the other two modalities. In a survey-based study, Wallace (2017) found that there were no significant differences in self-efficacy among dual-enrollment students who took courses online, on the college campus, or at

the high school. Another study conducted by Arnold et al. (2017) compared dual-enrollment grades earned in an unspecified math course within the three dual-enrollment modalities. Arnold et al. indicated that students who participated in the online dual-enrollment modality did not earn significantly higher grades than students who took dual enrollment at the high school, but did earn significantly higher grades than students who took dual enrollment on the college campus. Although this study measured dual-enrollment performance, it only included students from one community college; thus, it may be difficult to generalize these findings to a broader population. Additionally, Arnold et al. did not address performance after high school. As such, it is unknown if there are significant differences in early college performance after high school between online dual-enrollment students and dual-enrollment students at the high school or between online dual-enrollment students and dual-enrollment students on the college campus. While the qualitative studies noted above have contradicted some of the perceptions about online dual enrollment, it is uncertain if this modality impacts early college performance after high school. Therefore, further quantitative analysis is needed to analyze and assess the effectiveness of online dual enrollment.

Summary. Dual enrollment is offered online, at the high school, and at the college (Tobolowsky & Allen, 2016). While the research on these modalities is limited, researchers have noted both advantages and disadvantages within the three modalities. The first modality, dual enrollment at the college, has been regarded as an advantageous learning environment because it allows students to experience college norms and values by learning how to navigate college processes, utilize campus resources, and engage in direct, face-to-face conversations with collegiate faculty (Bailey et al., 2002; Tobolowsky & Allen, 2016). Additionally, students who participate in dual enrollment at the college campus have an opportunity to interact with college

students, which in turn allows them to be exposed to diverse perspectives and engage in deeper discussions (Jordan et al., 2006).

The second modality, dual enrollment at the high school, increases access to low-socioeconomic status students because it eliminates transportation barriers (Khazem & Khazem, 2012). Although researchers have noted access as an advantage of the high school dual-enrollment modality, other researchers have also expressed concerns about this modality. The common use of high school faculty, the absence of college students, and the lack of rigor regarding dual enrollment at the high school have led researchers to harbor doubts about the effectiveness of this modality (Burns & Lewis, 2000; Clark, 2001; Karp, 2012).

Researchers have made similar conclusions about the third modality, online dual enrollment. This modality has been noted as a favorable option because it provides access and increases flexibility (Harris & Stovall, 2013). Conversely, online dual enrollment has also been noted as problematic because of internet accessibility challenges, technical difficulties, and social limitations of the learning environment (Child Trends, 2015; Danver, 2016; Wallace, 2017).

Despite the concerns about the high school and online modalities, few studies have examined performance differences. A study comparing grades in an unspecified math course at a community college revealed that students who participated in the online and high school dual-enrollment modalities earned significantly higher grades than students who participated in the college modality (Arnold et al., 2017). To date, only one study is known to have addressed the impact of the modality on subsequent collegiate performance. In this study, the Community College Research Center (2012) found that community college students who participated in the college environment were more likely to enroll in college immediately after high school and earn

degrees than were students who participated in the high school modality. While this study investigated the link between dual-enrollment modalities and college success, it did not include the online modality nor did it examine early collegiate performance measures.

Transfer Learning

Gagne (1970) proposed that learning transfer occurs through two distinct processes: lateral transfer and vertical transfer. Lateral transfer is based on one mastering a competency in an initial activity and transferring the prior knowledge to a subsequent activity that is of equal or lesser complexity. By contrast, vertical transfer emphasizes that learning transfer occurs when one masters a basic competency and subsequently transfers prior knowledge toward learning a more advanced competency within the same domain. As an example, an elementary school student would need to master a basic skill within the math domain, addition and subtraction, in order to acquire a more advanced skill in the math domain, division (Parmar, 2003). The use of domain as the structure under which vertical learning transfer occurs provides a way to examine the transfer process within curricular categories that share content, instructional procedures, and mental activities (Park & Black, 2007).

Types of prior knowledge. Domain learning is largely contingent upon possessing prior knowledge within at least one of two areas: declarative knowledge and procedural knowledge. Declarative knowledge is based on the concepts, rules, facts, and principles within a particular subject area (Star & Stylianides, 2013). This knowledge provides a foundational background that is necessary prior to one pursuing a subsequent learning opportunity within a domain. As an example, a student who is studying finance must comprehend concepts such as loans and savings before he/she learns advanced finance skills (Marson & Hebert, 2005). In many instances, this knowledge is processed, retrieved, and verbally illustrated shortly after the individual initially

acquires it (ten Berge & van Hezewijk, 1999). Procedural knowledge is based on applying step-by-step processes or rules within a domain (Star & Stylianides, 2013). This knowledge is developed over an extended period of time and exhibited through performance rather than explanation. In contrast to declarative knowledge, which focuses on know-what knowledge as a requisite for subsequent learning, procedural knowledge emphasizes the know-how knowledge as a requisite for subsequent learning. As an example, a student who is studying computer programming must understand how to write syntax coding prior to creating an algorithm (Shneiderman & Mayer, 1979).

Knowledge transfer outcomes. Positive transfer occurs when one accurately employs prior knowledge in a subsequent learning situation (Chi & VanLehn, 2012). As one example, a student who has exhibited algebra skills in a subsequent college chemistry course has positively transferred his/her math skills therein. While positive knowledge transfer is the goal in situations that require an individual to apply prior knowledge, two barriers can also adversely impact the knowledge transfer process. One such barrier, transfer failure, occurs when a learner fails to employ applicable prior knowledge to solve a new problem (Novick, 1988). In these cases, an individual has acquired prior knowledge, but has not established its link to a target problem in a new setting. As an example, a student who learned a skill in the classroom and failed to apply it effectively in a work environment exhibits transfer failure. A second barrier, negative transfer, is exhibited when an individual employs nonapplicable prior knowledge to a subsequent learning situation (Schwartz, Chase, & Bransford, 2012). Under this output, an individual does not fail to transfer; instead, the individual transfers knowledge to a situation in which the prior knowledge is not suitable. As an example, an elementary school math student who has learned rudimentary fractions and division may miss-apply prior knowledge by interpreting that a simple fraction,

7/8, requires him/her to identify what is one half of 7/8 (Hunter, 1967). This is a common case in which negative transfer occurs because many young students revert to the earliest fraction and division lessons, which required them to split numbers in half.

Factors influencing knowledge transfer. Researchers have identified two factors that influence knowledge transfer: cognitive ability and motivation. Cognitive ability has been addressed primarily in studies involving learning within a trainer and trainee relationship. Clark and Voogel (1985) noted that cognitive ability is the most powerful predictor of knowledge transfer under any circumstance. Consistent with this premise, several studies have indicated that trainees who possess a higher cognitive ability processed, retained, and applied skills learned in an initial learning situation to a subsequent learning situation better than trainees who had lower cognitive ability (Baldwin & Ford, 1988; Burke & Hutchins, 2007; Colquitt, LePine, & Noe, 2000). These findings have been supported within the context of academic environments, as well. High cognitive ability coupled with prior domain knowledge has been found to be a reliable predictor of success in a college general chemistry course (Cracolice & Busby, 2015) and an introduction to psychology course (Thompson & Zamboanga, 2004).

A second factor, motivation, has been shown to stimulate positive transfer between initial learning and target tasks in multiple research settings. In a study examining short-term knowledge transfer, Belenky and Nokes-Malach (2012) found that goal-oriented students performed better than students who were not goal oriented on a math exercise that required them to apply prior knowledge in a subsequent activity. In much the same way, Chiaburu and Marinova (2005) conducted a study in which they examined how the motivation to participate in training impacted short-term knowledge transfer in a corporate training environment. Chiaburu and Marinova found that individuals who were highly motivated to participate in training

experienced higher levels of knowledge transfer compared to individuals who were not highly motivated to participate in the training. Axtell, Maitlis, and Yearta (1997) discovered similar results in a corporate training study that examined the impact of motivation on long-term knowledge transfer. Axtell et al. observed that nonmanagerial technical staff members who exhibited a high desire to apply training knowledge to the workplace setting demonstrated higher levels of prior knowledge application one month after the training than individuals who exhibited low levels of desire to apply the training. In these instances, motivation is a critical facet within the process of applying knowledge transfer because it has shown to drive the learner to examine his/her knowledge base to detect if there is a potential connection between prior knowledge and the existing problem (Perkins & Salomon, 2012).

Early prior knowledge performance. Early research on the application of prior knowledge focused primarily on comparing outcomes of individuals who had expertise in a domain area versus those who did not have expertise. When comparing these two groups, the outcomes demonstrated that experts exhibited stronger memory problem solving skills in playing chess (Chase & Simon, 1973), writing computer programs (Jeffries, Turner, & Atwood, 1981), and solving algebra problems (Sweller & Cooper, 1985). Researchers in the late 1980s examined prior knowledge through a different lens by assessing if cognitive ability or prior knowledge had a significant effect on task completion. Recht and Leslie (1988) found that prior baseball knowledge had a significant effect on whether a junior high student was able to articulate a verbal and written summary of a baseball story after reading it. Conversely, the cognitive variable in this study, reading proficiency, did not have a significant effect on the student's ability to provide a verbal and written account of the baseball story after reading it. A study conducted by Schneider, Körkel, and Franz (1989), which examined the impact of prior

knowledge and general cognitive ability, revealed similar results. In this study, low-aptitude soccer experts exhibited significantly higher results than high-aptitude soccer novices on a test that was administered to assess memory performance after students listened to a story about a soccer player's experiences. Thus, the outcomes observed by Recht and Leslie and Schneider et al. suggested that prior knowledge can atone for one's lack of cognitive ability.

Prerequisite and postrequisite courses. Much of the research concerning prior knowledge and subsequent domain learning since 2000 has revolved around prerequisite and postrequisite course sequencing. A prerequisite and postrequisite course sequence aligns with the vertical knowledge transfer trajectory because it is contingent on applying prior knowledge acquired in a less advanced course to a subsequent, more advanced course (Gagne, 1970; Wisneski et al., 2017). Accordingly, many studies have indicated that acquiring prior domain knowledge is essential for students to succeed in a multitude of advanced subject areas. When comparing students who completed a prerequisite course versus students who did not complete a prerequisite course, the students who completed the prerequisite course have performed significantly better in a subsequent postrequisite course. This was the case in an upper-division postrequisite biology course in which an introductory biology course was waived for students (McCoy & Pierce, 2004), an upper-division accounting management course in which a prerequisite accounting course was waived for some students (Drennan & Rohde, 2002), and a finance course in which a prerequisite business statistics course was waived for some students (Baard & Watts, 2008). Additionally, prerequisite courses have also been shown to predict subsequent performance in postrequisite courses. Bealing, Staley, and Baker (2008) found that accounting prerequisite course performance was a reliable predictor of performance in subsequent postrequisite accounting courses. Similarly, a study conducted by Richards (2012)

revealed that an introductory communications prerequisite course was a reliable predictor of student performance in subsequent communication theory courses, regardless of the student's cognitive ability.

College Algebra prerequisite and postrequisite courses. Research on how a College Algebra prerequisite course impacts subsequent performance is limited. In one study, Ellington (2005) compared the College Algebra math postrequisite grades of Virginia Commonwealth University students who participated in a College Algebra class emphasizing modeling versus a College Algebra class that did not emphasize modeling. While the topics covered in these courses were similar, the modeling course under study emphasized different pedagogical strategies and placed a higher concentration on developing procedural knowledge (Ellington, 2005). Ellington's statistical analysis revealed that the students who participated in the College Algebra modeling course performed as well in the postrequisite math course as the students who took the traditional College Algebra course. In a second study, Donovan and Wheland (2009) compared chemistry course outcomes at an urban, open-access university before and after a College Algebra prerequisite course was implemented. Donovan and Wheland found that taking a prerequisite College Algebra math course was positively correlated with successful performance in the subsequent General Chemistry course. Donovan and Wheland also demonstrated that the General Chemistry withdrawal rates were noticeably lower among the students who had completed a College Algebra prerequisite course (8%) than those who had not completed a College Algebra prerequisite course (23.7%).

Impact of prerequisite modality on postrequisite performance. Only one study was identified that examined the impact of the modality of a prerequisite course on specific subsequent postrequisite performance. Wisneski et al. (2017) examined if offering a prerequisite

accounting course in an online or traditional modality impacted postrequisite accounting course performance at six campuses within a large university system. The results of this study indicated that the academic performance did not differ based on the delivery modality. Thus, the modality did not appear to influence the knowledge transferred from the prerequisite to the postrequisite course. While Wisneski et al. found no significant differences in postrequisite course grades based on the modality, a study conducted by Bettinger and Loeb (2017) revealed different results. In this study, DeVry University students who took a prerequisite course online earned significantly lower grades on the subsequent postrequisite course. Bettinger and Loeb utilized aggregated data; thus, it is unknown if there were statistically significant differences in postrequisite grades within specific subject areas.

Summary. Many researchers have examined if knowledge acquired in an initial setting impacts subsequent learning in a more advanced setting. Researchers have investigated the application of prior knowledge in a multitude of environments, which include, but are not limited to, elementary schools, corporate training settings, and higher education institutions. Many of the studies conducted in higher education environments have examined the impact of a prerequisite course on a postrequisite course, as measured by course grade (Baard & Watts, 2008; Bealing et al., 2008; Drennan & Rohde, 2002; McCoy & Pierce, 2004; Richards, 2012). While these studies have validated the effectiveness of the prerequisite course in many instances, to date, only Wisneski et al. (2017) has examined the impact of the modality on subsequent academic performance in a specific postrequisite course. While this study found no differences within a specific prerequisite and postrequisite course sequence, Bettinger and Loeb (2017) observed different results in an aggregated dataset of postrequisite course grades. The results of Bettinger and Loeb's study revealed that DeVry University students who completed a

prerequisite course in the college classroom earned significantly higher grades in a subsequent postrequisite course than students who completed a prerequisite course online.

Conceptual Framework Discussion

This study was influenced by Conley's college and career readiness conceptual framework, which emphasizes that four-core academic preparation components foster a successful high-school-to-college transition (Conley, 2008). Three of these components were present within this study. The first component, cognitive strategies, is contingent upon a student developing the requisite intellectual behavior patterns that one must exhibit within the context of complex, content-specific learning situations. According to Conley (2010), cognitive strategies provide a valuable academic foundation that allows students to "learn, understand, retain, and apply content" within core academic disciplines (p. 32). Students exhibit cognitive strategies through creating and applying approaches and methodologies to solve routinized and nonroutinized problems, critically analyzing instruction, formulating logical conclusions based on evidence-based research, and constructing thoughtful arguments. In the second component, content knowledge, a student applies cognitive strategies through developing the foundational content knowledge and skills that adequately prepares him/her for collegiate-level coursework. This knowledge base is comprised of five core academic subject areas: English, math, social studies, art, and world languages. When looking at math content knowledge specifically, it is critical for students to comprehend and apply math concepts and principles, as well as algebraic methods, in order to succeed in advanced mathematics courses.

One of the most popular dual-enrollment offerings, College Algebra, serves as a prerequisite course to subsequent courses in STEM fields (Herriott & Dunbar, 2009; Steen, 2007). While dual enrollment is viewed as an effective college preparation strategy on multiple

measures, questions remain about whether the modality influences subsequent college performance. Despite that this research gap exists, higher education institutions have continued to offer dual-enrollment College Algebra in each modality at a time in which it is unknown if the modality impacts outcomes in postrequisite courses taken during the first year of college. Based on these issues, the cognitive strategies and content knowledge components of Conley's (2008) college and career readiness framework were appropriate for this study because these components provided an avenue to examine whether content knowledge transfers from a dual-enrollment experience to the first year of college. As such, I employed the cognitive strategies and content knowledge components by examining if the modality of the dual-enrollment College Algebra course impacts the content knowledge exhibited in postrequisite College Algebra courses during the freshman year of college, as measured by course grades and DFW grade rates.

The third component, academic behaviors, is largely based on a student developing quintessential study skills, which include time management skills, exam preparation strategies, utilizing effective resources, and class notetaking (Conley, 2008). In contrast to cognitive strategies, study skills are not content specific, as these are requisite foundational skills that all students need to succeed in collegiate-level courses. Conley (2014) noted that study skills influence GPA because study skills are a quantitative measure of all coursework, regardless of academic discipline. While participating in dual enrollment has been shown to improve study skills (Kanny, 2015; Karp, 2012), no prior studies have examined if the dual-enrollment modality influences the application of these skills in college. Thus, the academic behaviors component of the college and career readiness conceptual framework was appropriate for this study because it provided a lens to examine whether dual enrollment influences the subsequent application of academic behaviors in college. As such, I employed the academic behavior component by

examining if the modality of the dual-enrollment College Algebra course influences academic behaviors during the first semester of college, as measured by first-semester freshman GPA.

Summary

Research has indicated that dual enrollment is an effective college preparatory strategy. When comparing dual enrollees to nondual enrollees, dual enrollees have higher ACT scores (Eimers & Mullen, 2003; Radunzel et al., 2014), lower remediation rates (An, 2013; Grubb et al., 2017; Speroni, 2011), higher high-school-to-college going rates (Lewis & Overman, 2008; Struhl & Vargas, 2012), higher college GPAs (Bailey et al., 2007; Young et al., 2013), higher persistence rates (Radunzel et al., 2014; Speroni, 2011; Swanson, 2010), more credit hours (Bailey et al., 2007; Radunzel et al., 2014), and higher degree completion rates (Allen, 2010; Community College Research Center, 2012; Grub et al., 2017; Speroni, 2011; Struhl &Vargas, 2012; Swanson, 2010). While researchers have substantiated the effectiveness of dual enrollment on a number of short-term and long-term measures, based on the lack of research on the dual-enrollment modalities, it is uncertain if the modality impacts collegiate preparation. The lack of dual-enrollment modality performance outcomes exists at a time when many have expressed concerns about the effectiveness of the online and classroom modalities. Despite multiple research teams noting some apprehensions about different modalities, at the time of this dissertation study, only one prior study (Arnold et al., 2017) had examined course performance differences among the three dual-enrollment modalities.

While this study investigated dual-enrollment outcomes within the three modalities, it did not address subsequent collegiate performance. To date, one study has addressed the impact of the modality on subsequent collegiate performance. In this study, the Community College Research Center (2012) found that community college students who participated in the college

modality were significantly more likely to enroll in college immediately after high school and earn degrees than students who participated in the high school modality. While this study investigated the link between dual-enrollment modalities and college success, it did not include the online modality nor did it examine early collegiate performance measures.

Although the research examining differences within the three dual-enrollment modalities is lacking, there is a robust body of literature that has examined performance rate differences of college students who participated in the online versus classroom environment. The studies addressing performance have yielded mixed results. Some researchers have found no significant differences between online and classroom performance (Cavanaugh & Jacquemin, 2015; Coates et al., 2004; Evans et al., 2007; Hurlburt, 2001; Jones & Long, 2013; McLaren, 2004; Mirakian & Hale, 2007; Wagner et al., 2011), while other researchers have observed that students in the classroom modality have performed significantly better than students in the online modality (Bettinger & Loeb, 2017; Garratt-Reed et al., 2016; Johnson & Marisol, 2014; Tanyel & Griffin, 2014; Verhoeven & Wakeling, 2011).

In contrast to studies that have compared course grades between the two modalities, which have produced incongruous results, the studies on completion rates have consistently indicated that students in the online modality have exhibited significantly lower completion rates (Atchley et al., 2013; Carter, 1996; Carr, 2000; California Community Colleges Chancellor's Office, 2011; Dutton et al., 2001; Jaggars & Xu, 2010; Jaggars et al., 2013; Ni, 2013; Tanyel & Griffin, 2014). While individual course grades and completion rates have been the most common measure to examine the effectiveness of the modality, two researchers who conducted studies in more recent years opted to employ a different approach. Rather than relying on one course, these studies were constructed to investigate whether the modality of the prerequisite

course influenced knowledge transfer, as measured by the final grade in the postrequisite course. A study examining the impact of the prerequisite accounting delivery mode on a subsequent accounting postrequisite course revealed that there were no significant differences in postrequisite course grades earned based on the modality of the prerequisite instruction, suggesting that the modality did not have an impact on knowledge transfer (Wisneski et al., 2017). Conversely, a study examining all prerequisite and postrequisite course sequences at DeVry University revealed that the students who took prerequisite courses in the classroom environment earned significantly higher grades in the postrequisite course (Bettinger & Loeb, 2017). In contrast to Wisneski et al. (2017), the outcomes observed by Bettinger and Loeb (2017) suggested that taking a prerequisite course in an online format may adversely impact the knowledge transfer exhibited in a postrequisite course.

In addition to course grades and postrequisite course grades, other research has examined the impact of the modality on retention and graduation. Much like with studies examining grades, the studies that have examined the modality's impact on these measures have produced varying results, as some studies have indicated that taking an online course has been linked to higher retention rates (James et al., 2016) and graduation rates (Shea & Bidjerano, 2014, 2016), while others have indicated online education is linked to lower retention and graduation rates (Jaggars & Xu, 2010, 2011). Based on the paucity of research concerning dual-enrollment modalities, coupled with the incongruous outcomes that have been found in studies examining online and classroom modes of instruction, there is a need to conduct research to examine whether the dual-enrollment modality impacts subsequent course performance and early collegiate academic performance.

I employed Conley's (2008) college and career readiness conceptual framework, which emphasizes that four-core academic preparation components foster a successful high school-to-college transition. In this study, I emphasized three of the four components. I employed the first and second components, cognitive strategies and content knowledge, to examine if the dual-enrollment College Algebra modality impacts content knowledge transfer into a postrequisite College Algebra course during the first year of college. Additionally, I employed the third component, academic behaviors, to examine if the dual-enrollment modality influences the application of academic behaviors during the first semester of college.

Chapter 3 addresses the study's research design and methodology. Additionally, Chapter 3 details the population studied, data collection and analysis method, variable definitions, ethical considerations, assumptions, limitations, and delimitations.

Chapter 3: Research Method

Dual enrollment is an effective college preparatory strategy because it provides students with an opportunity to participate in rigorous coursework and build academic skills for college (Kanny, 2015; Karp, 2012; Lords, 2000). When comparing outcomes of dual enrollees to nondual enrollees, research has indicated that dual enrollees perform better on a number of success measures. Among other things, dual enrollees have earned higher first-semester GPAs (Bailey et al., 2007), accumulated more credit hours (Radunzel et al., 2014; Speroni, 2011; Swanson, 2010), and attained degrees at higher rates (Allen, 2010; Speroni, 2011; Struhl & Vargas, 2012; Swanson, 2010). While researchers have established a link between dual-enrollment participation and collegiate success, no previous studies have investigated if there is a link between dual-enrollment modalities and early collegiate performance. As such, the purpose of this study was to examine if the dual-enrollment modality through which College Algebra is delivered impacts freshman-year academic performance.

Five research questions guided this study:

Q1: Are there significant differences in freshman College Algebra postrequisite math grades earned among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

Q2: Are there significant differences in freshman College Algebra postrequisite math DFW grade rates among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

Q3: Are there significant differences in freshman College Algebra postrequisite science grades earned among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

Q4: Are there significant differences in freshman College Algebra postrequisite science DFW grade rates among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

Q5: Are there significant differences in first-semester freshman GPAs among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

This chapter outlines the research design and method, population and sampling, research materials, quantitative data collection and analysis procedures, ethical considerations, assumptions, limitations, and delimitations. Lastly, the chapter concludes with a summary and a preview of Chapter 4.

Research Design

In this study, I investigated if there were differences among dual-enrollment modalities by examining performance outcomes through the context of a causal-comparative design. This design is based on a process whereby, "the researcher investigates the effect of an independent variable on a dependent variable by comparing two or more groups of individuals" (Salkind, 2010, p. 125). In causal-comparative studies, individuals are classified into groups based on a common categorical element (Schenker & Rumrill, 2004). As such, I classified students into three groups based upon the modality through which they completed dual-enrollment College Algebra: online, at the high school, or on the college campus. By comparing the outcomes produced by groups, a causal-comparative design aims to identify a link between the categorical element and performance (Martella, 2013). In turn, this enables the researcher to make a preliminary inference about the potential cause of an educational outcome.

I employed the causal-comparative design by conducting quantitative research. By investigating dual-enrollment College Algebra modalities through the lens of a causal-

comparative design, I examined if the input, the dual-enrollment College Algebra modality, was linked with positive or negative outputs, the performance outcomes. When quantitative data are used to evaluate a program or a portion of a program, the statistical analysis supplies objective information that can help identify potential strengths and weaknesses (Weiss, 1972). In this study, a data-driven comparison of the performance outcomes allowed me to deduce if the modality was a potential cause of a performance outcome. In the end, the application of a quantitative-based program evaluation is an effective strategy because it can help higher education administrators and policymakers pinpoint programs that need to be expanded, eliminated, or reconstructed (Ewell, 2011; Weiss, 1972). Accordingly, the results of the quantitative analysis herein may potentially shape future policies or arrangements that specify the conditions for offering dual-enrollment College Algebra.

Causal-comparative studies are conducted after an activity or event has concluded (Salkind, 2010). As a result, causal-comparative based research designs are considered nonexperimental because the researcher does not manipulate variables. Consistent with these foundational principles, I utilized an archived dataset, which was initially reported to the OSRHE, to conduct this study. Thus, no students were preassigned into the modalities or manipulated because the students completed the course sequences that I examined in this research prior to the outset of this study.

The causal-comparative research design has been a common scholarly-based research design employed in studies comparing performance outcomes among students who took courses in different modalities. Arnold et al. (2017) employed a causal-comparative design when they investigated if there were grade outcome differences in dual-enrollment courses taught online, at a high school, and at a college. Likewise, Atchley et al. (2013), Cameron (2013), and Amro,

Mundy, and Kupczynski (2015) utilized a causal-comparative design to determine if there were grade differences between online students and traditional classroom students. Thus, like the aforementioned studies, I utilized this design to detect if there were differences among the modalities and discern if potential cause-and-effect relationships existed between each modality and its performance outcomes.

Population and Sampling

The purpose of this study was to examine if the dual-enrollment modality through which College Algebra is delivered impacts freshman-year academic performance. Accordingly, it was necessary to detail specific parameters to ensure that the population examined aligned with the intent of the study. Investigating a large-scale archived dataset that encompasses all students who meet requisite criteria, rather than relying on a subset of students who meet the requisite criteria, puts the researcher in a position to conduct a more robust analysis (Smith, 2008). As such, I employed a purposive, total population sample, which is based on examining all individuals in a population who meet specific criteria (Etikan, Musa, & Alkassim, 2016). This allowed me to focus on a clearly defined subpopulation of individuals who share common characteristics that were pertinent to the research study. As a result, I predicted that the findings in this study would allow me to formulate valid generalizations about the impact of the dual-enrollment College Algebra modality on OSS institutions' freshmen student performance outcomes.

I established two fundamental criteria to identify the population examined in this study. First, the students were required to have earned OSS dual-enrollment College Algebra credit and subsequently earned credit at an OSS institution after high school graduation under one of three sequences that are detailed in the subsequent paragraph. Second, to ensure that the college

courses were equivalent in content, the dual-enrollment College Algebra course and the subsequent postrequisite course were required to be listed on the OSRHE's Course Equivalency Project (CEP). The CEP is a database of over 8,000 courses determined to be equivalent through an OSS faculty-driven review process (OSRHE, n.d.a; Western Interstate Commission for Higher Education, n.d.). This resource is organized in a manner in which each course has a master course title, a number, and an associated list of the institutions that accept the course (OSRHE, n.d.a). When an OSS institution is listed under the master course, the institution agrees to teach predetermined course content and accept the course for credit from any OSS institution that is also listed under that same master course.

For Q1 and Q2, I analyzed students who completed in a dual-enrollment College Algebra course during the 2012-2013, 2013-2014, or 2014-2015 academic year and subsequently earned a Trigonometry or Elementary Calculus course grade as a college freshman student during the 2013-2014, 2014-2015, 2015-2016, or 2016-2017 academic year. For Q3 and Q4, I analyzed students who completed a dual-enrollment College Algebra course during the 2012-2013, 2013-2014, or 2014-2015 academic year and subsequently earned a General Chemistry course grade as a college freshman student during the 2013-2014, 2014-2015, 2015-2016, or 2016-2017 academic year. The freshman year for Q1 through Q4 encompassed postrequisite College Algebra grades earned during the summer, fall, or spring semester following high school graduation. Lastly, for Q5, I analyzed students who completed a dual-enrollment College Algebra course during the 2012-2013, 2013-2014, or 2014-2015 academic year and subsequently earned collegiate credit in the fall semester after high school graduation during the 2013-2014, 2014-2015, 2015-2016, or 2016-2017 academic year. For each question, I disaggregated the

student data into three groups based upon the dual-enrollment modality through which the College Algebra course was completed: online, at the high school, or at the college.

Materials

Archived OSS institution data that were collected initially by the OSRHE served as the dataset for this study. As such, I conducted a secondary analysis of an existing dataset because OSS institutions reported these data to OSRHE for another purpose. The OSS institutions are required to submit annual data to OSRHE through its unitized data system (UDS), a secure electronic data exchange system (OSRHE, 2017a). Among the approximately 75 data elements submitted in the annual report, OSS institutions are required to report credit hours accumulated, course grades earned, and degrees awarded (OSRHE, n.d.c). These reported data are utilized to produce statewide reports regarding degree completion, enrollment, and retention.

There are a multitude of benefits associated with utilizing archived data to conduct quantitative research. Archived data are advantageous because they provide a cost-effective and convenient way for the researcher to access and analyze data (Clarke & Cossette, 2000; Glaser, 1963). Additionally, archived datasets are often comprehensive because the scope of the data consists of submissions that are typically from multiple entities within different geographic settings (Shultz, Hoffman, & Reiter-Palmon, 2005). Accordingly, an archived dataset is a pragmatic research tool for a large-scale program evaluation dissertation study because it meets "the research needs of persons with macro-interests and micro-resources" (Glaser, 1963, p. 11). In this study, the use of an archived dataset provided access to a large-scale, statewide dataset. This enabled me to examine the impact of the dual-enrollment College Algebra modality on the performance of all OSS students who met the aforementioned criteria.

Data Collection and Analysis

I requested the dataset by completing an OSRHE data request form. Upon receipt of the OSRHE data request form, an OSRHE data analyst conducted a series of queries in the UDS system to identify the students who completed the course sequences that I investigated in this study. After the OSRHE data analyst identified the students who completed dual-enrollment College Algebra in each modality, a student identification number element in UDS was used to link each dual-enrollment College Algebra modality to the postrequisite course grade and first-semester GPA. Upon receiving the dataset, I uploaded it into the Statistical Package for the Social Sciences (SPSS) program, which is a statistical analysis software package.

ANOVA was used as the statistical analysis to address Q1, Q3, and Q5. An ANOVA statistical analysis is applied under the assumption that the variances of the populations are equal and the populations are normally distributed (George & Mallery, 2010). As such, I conducted a Levene's test for equality of variances to check the latter assumption and skewness and kurtosis testing to check the former assumption. ANOVA is appropriate for a causal-comparative design because it provides an opportunity to determine if differences exist among three or more population means that are classified based upon one independent variable (Jackson, 2011). Thus, I applied a one-way ANOVA to establish if there were statistically significant differences in freshman College Algebra postrequisite course grades and first-semester freshman GPAs among students who completed College Algebra within the three dual-enrollment modalities.

I examined Q2 and Q4 by virtue of conducting a chi-square test because it allows a researcher to determine if there are significant differences among groups based upon proportionate or percentage figures (DePoy & Gitlin, 2015). Thus, I applied a chi-square test to determine if there were statistically significant differences in freshman College Algebra

postrequisite DFW math and science grade rates among students who completed College Algebra within the three dual-enrollment modalities. All statistical analyses for this study were conducted using a predetermined alpha level of .05 level of probability, which is a commonly utilized quantitative value to test significance in academic research (Leahey, 2005).

In this study, I designated the dual-enrollment modalities as the independent variables and the five performance outcomes as the dependent variables. More specifically, the College Algebra math postrequisite grades and College Algebra postrequisite science grades served as the dependent variables in Q1 and Q3. The College Algebra postrequisite math DFW grade rates and College Algebra postrequisite science DFW grade rates served as the dependent variables for Q2 and Q4. Lastly, the first-semester freshman GPA served as the dependent variable for Q5.

I designated the final course grade as the dependent variable for Q1 and Q3 because it is the most common indicator of collegiate success (Fina, Welch, Dunbar, & Ansley, 2015). For clarification purposes, a final course grade system employs a 4-point grading scale in which a student receives four points for an A, three points for a B, two points for a C, one point for a D, and zero points for an F. In addition to grades, I established the DFW grade rate as the dependent variable for Q2 and Q4 because it is viewed as a valuable metric that allows educators to pinpoint cases of wide-scale low academic achievement in a course or set of related courses (Bloemer, Day, & Swan, 2017; Education Advisory Board, 2010). A DFW grade rate is defined as the percentage of students who earn a D, F, or Withdraw grade. Going beyond individual course grades and DFW grade rates, I designated the first-semester GPA as the dependent variable for Q5 because it is the first comprehensive early success outcome that a student produces within his/her collegiate academic career (Bailey et al., 2007; Gershenfeld, Hood, & Zhan, 2016; Sullivan-Ham, 2011). Accordingly, the first-semester GPA was an appropriate

measure for Q5 because it allowed me to examine whether the modality influenced initial college achievement.

Operational Definitions of Variables

The operational definitions used in this study are detailed below.

College Algebra postrequisite math DFW grade rate. The percentage of freshmen students who earned a D, F, or W grade in a trigonometry or elementary calculus course after completing dual-enrollment College Algebra with a D or higher (Chambers, 2017).

College Algebra postrequisite science DFW grade rate. The percentage of freshmen students who earned a D, F, or W grade in a General Chemistry course after completing dual-enrollment College Algebra with a D or higher (Chambers, 2017).

College Algebra postrequisite math course grade. A freshman grade in a trigonometry or elementary calculus course earned after the student completed dual-enrollment College Algebra with a D or higher. A point value was assigned to each letter grade based on a standard, 4-point grading scale: A = 4, B = 3, C = 2, D = 1, and F = 0 (American Association of Collegiate Registrars & Admissions Officers, 2015).

College Algebra postrequisite science course grade. A freshman grade in a General Chemistry course earned after the student completed dual-enrollment College Algebra with a D or higher. A point value was assigned to each letter grade based on a standard, 4-point grading scale: A = 4, B = 3, C = 2, D = 1, and F = 0 (American Association of Collegiate Registrars & Admissions Officers, 2015).

Dual-enrollment College Algebra modality. One of three possible ways in which a dual-enrollment course can be offered: as a college campus course that integrates dual-enrollee students and college students in one setting, as a high school campus course that solely enrolls

dual-enrollee students, or as an online course that enrolls both dual-enrollee and college students (Barnett & Stamm, 2010).

First-semester freshman GPA. The quantitative measure of a student's first collegiate semester of academic performance after high school. This measure is calculated by dividing the total points earned by the total number of academic credit hours earned in the first semester of college after high school graduation (American Association of Collegiate Registrars & Admissions Officers, 2015).

Ethical Considerations

I received approval from Abilene Christian University's Institutional Review Board prior to obtaining the dataset from OSRHE. Although the risk associated with this study was negligible, I took steps to ensure that confidentiality of the students investigated was maintained and the data were protected. Prior to releasing the dataset, OSRHE eliminated all identifiable student information, which included the name, identification number, and social security number. Upon receiving the dataset on a universal serial bus (USB) disk, I saved it on a password-protected laptop and subsequently stored the USB disk in a fireproof safe in my home office. At the conclusion of the study, I deleted the dataset from my computer. I will keep the USB disk in the fireproof safe for five years. When the five-year poststudy period expires, I will destroy the USB disk.

Limitations

According to Terrell (2016), limitations are restrictions that cannot be controlled by the researcher that may impact the results. As with many research studies, this study had limitations that should be acknowledged. The first limitation was that the racial makeup of the overall Oklahoma dual-enrollment population is predominately White (OSRHE, 2016). Because of this

limitation, the study results are unlikely to be generalizable to other state systems in which there is a greater degree of ethnic diversity among dual-enrollment participants. The second limitation is that the instructor status was not available in the study dataset; as a result, it was unknown if the faculty members teaching dual-enrollment courses were high school instructors, tenured or tenure-track college professors, full-time college instructors, or part-time college instructors. This is a noteworthy limitation because some have questioned the effectiveness of high school instructors teaching collegiate courses (Clark, 2001; Karp, 2012).

The third limitation was the use of a course grade as a dependent variable. A course grade is a subjective measure of performance that may vary based on instructor or institution. Additionally, the use of the 4-point scale for course grading may lack precision because it places an equal numeric value on performance outcomes that may vary by as much as 10 percentage points. Lastly, data were only available for students who completed OSS dual-enrollment College Algebra and subsequently enrolled at an OSS institution; thus, it is unknown if the dual-enrollment College Algebra modality impacts the collegiate performance of students who subsequently attended a private institution or an out-of-state public institution after high school graduation.

Delimitations

Delimitations are parameters established by the researcher that may impact the findings (Creswell, 2014). In this study, I aimed to establish whether the dual-enrollment College Algebra modality impacted subsequent collegiate performance. As such, other factors, such as cognitive ability and motivation, which have been found to influence knowledge transfer, were not addressed in this study (Bahri & Corebima, 2015; Baldwin & Ford, 1988; Belenky & Nokes-Malach, 2012; Burke & Hutchins, 2007; Chiaburu & Marinova, 2005; Colquitt et al., 2000;

Cracolice & Busby, 2015; Thompson & Zamboanga, 2004). Similarly, other factors, such as teaching effectiveness, parent education levels, and socioeconomic status, which could also potentially impact performance outcomes, were also not examined herein. Thus, my focus on one variable should be recognized as a limitation because the aforementioned factors may have also influenced the outcomes that I examined. Additionally, while I examined the impact of the dual-enrollment modality on subsequent performance, I focused only on one dual-enrollment subject area, College Algebra. Accordingly, these findings are not generalizable to other dual-enrollment subject areas. Lastly, I only assessed first-year college outcomes. As a result, it is unknown if the dual-enrollment College Algebra modality impacts success on long-term performance measures, such as first-to-second-year retention rates, upper-division grades, and graduation rates.

Assumptions

I conducted this study under the premise of two core assumptions. First, I assumed that all student data analyzed in this study included students who met any applicable course placement standards that were necessary to enroll in College Algebra. Second, I assumed that OSS institutions reported the data accurately, including the dual-enrollment College Algebra modality of instruction, course sequencing, postrequisite grades, and first-semester freshman GPAs, during the initial data collection process**.**

Summary

In scholarly research, the purpose statement conveys the intent of the study and establishes the fundamental objective in which the researcher wishes to accomplish (Creswell, 2014). The purpose of this study was to examine if the dual-enrollment modality through which College Algebra is delivered impacts freshman-year academic performance. In order to

investigate the purpose in a research context, it is imperative that a researcher aligns the intent of the study with an appropriate design, which establishes the foundation under which a study is constructed (James & Slater, 2014; Rajasekar, Philominaathan, & Chinnathambi, 2013). Consistent with this premise, I employed a causal-comparative design to compare group outcomes and determine if groups exhibited significantly higher or lower performance outcomes (Martella, 2013). This allowed me to determine if there were potential cause-and-effect relationships between the modalities and the performance outcomes.

I applied a causal-comparative design by utilizing two statistical analyses: a one-way ANOVA and chi-square. The results of the statistical analyses are presented in Chapter 4. These analyses enabled me to assess the effectiveness of dual-enrollment College Algebra modalities through the lens of a statewide perspective. In the end, these findings will help administrators and policymakers establish if the dual-enrollment College Algebra modality has an impact on students making the academic transition from high school to college.

Chapter 4: Results

The purpose of this study was to examine if the dual-enrollment College Algebra modality impacts freshman-year academic performance. As such, I conducted a series of quantitative analyses to determine if there was a link between each dual-enrollment College Algebra modality and freshman College Algebra postrequisite math performance, freshman College Algebra postrequisite science performance, and first-semester freshman collegiate success. This chapter details a summary of the research focus and processes and presents the findings of the statistical analyses that were applied to conduct this study. This chapter concludes with a chapter summary and preview of Chapter 5.

Summary of the Research Focus and Processes

A causal-comparative design was employed to detect if there were significant differences among the dual-enrollment College Algebra modalities and to discern if potential cause-and-effect relationships existed between each modality and its performance outcomes. I conducted this research by analyzing archived data that were reported initially to the OSRHE. The datasets consisted of students who completed OSS dual-enrollment College Algebra during the 2012-2013, 2013-2014, or 2014-2015 academic year and subsequently completed one of three OSS institution freshman enrollment trajectories during the 2013-2014, 2014-2015, 2015-2016, or 2016-2017 academic year.

I analyzed data of students who completed freshman College Algebra postrequisite math courses in Q1 and Q2, I analyzed data of students who completed freshman College Algebra postrequisite science courses in Q3 and Q4, and I analyzed data of students who earned college credit in the fall semester after high school graduation in Q5. For each research question, I disaggregated the data based upon the dual-enrollment College Algebra modality. One-way and

chi-square analyses were conducted to determine if there were statistically significant differences in freshman College Algebra postrequisite math and science grades, freshman College Algebra postrequisite math and science DFW grade rates, and first-semester freshman GPAs among students who completed dual enrollment online, at the college, or at the high school.

Presentation of the Findings

I constructed this study around investigating five research questions. For each question, I conducted an analysis to test the null hypothesis. This section provides background information regarding the student populations that were examined and presents the findings of the statistical analyses that were applied to investigate each research question.

Q1. Are there significant differences in freshman College Algebra postrequisite math grades earned among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

$\boldsymbol{H_0}$. There are no significant differences in freshman College Algebra postrequisite math grades earned among students who completed dual enrollment online, at a high school, or at a college.

$\boldsymbol{H_1}$. There are significant differences in freshman College Algebra postrequisite math grades earned among students who completed dual enrollment online, at a high school, or at a college.

A total of 2,170 students earned OSS dual-enrollment College Algebra credit during the 2012-2013, 2013-2014, or 2014-2015 academic year and subsequently earned an OSS College Algebra postrequisite math course grade of A, B, C, D, or F as a college freshman during the 2013-2014, 2014-2015, 2015-2016, or 2016-2017 academic year. The majority of these students completed dual-enrollment College Algebra at the college campus (n = 1,449), while smaller

subpopulations completed dual-enrollment College Algebra online (n = 403) and at the high school (n = 318; see Table 1). As indicated in Table 2, the majority of the students who completed the aforementioned sequence were White, while American Indian or Alaska Native represented the second largest ethnic subpopulation. Additionally, the number of females exceeded the number of males in each of the respective modality subpopulations.

Table 1

Freshman College Algebra Postrequisite Math Course Completion, Classified by Dual-Enrollment College Algebra Modality

Modality	*n*	%
College Campus	1,449	66.8
High School Campus	318	14.7
Online	403	18.6

Table 2

Demographics of Freshman College Algebra Postrequisite Math Course Students, Classified by Dual-Enrollment College Algebra Modality

Demographic Group	College Campus		High School Campus		Online	
	n	%	*n*	%	*n*	%
Gender						
Female	768	53.0	178	55.9	204	50.6
Male	681	46.9	140	44.0	199	49.4
Ethnicity						
American Indian or Alaska Native	133	9.2	34	10.7	30	7.4
Asian	67	4.6	17	5.3	16	3.9
Black or African American	31	2.1	9	2.8	7	1.7
Hispanic or Latino	80	5.5	21	6.6	20	4.9
Multiple	119	8.2	14	4.4	54	13.4
Native Hawaiian or Pacific Islander	2	0.1	0	0.0	1	0.2
Unknown	55	3.8	7	2.2	9	2.2
White	962	66.4	216	67.9	266	66.0

Descriptive statistics revealed that the students who completed dual-enrollment College Algebra at the high school earned higher freshman College Algebra postrequisite math grades (M = 1.95) than students who completed dual-enrollment College Algebra at the college (M = 1.91) and online (M = 1.89). A one-way ANOVA was conducted to determine if there were statistically significant differences in freshman College Algebra postrequisite math course grades among students who completed College Algebra within the three dual-enrollment modalities.

Prior to conducting the analysis, I applied tests to determine whether one-way ANOVA assumptions were violated. First, an ANOVA statistical analysis is applied under the assumption that the variances of the populations are equal and the populations are normally distributed (George & Mallery, 2010). Accordingly, I conducted a Levene's test for equality of variances to confirm the latter assumption and skewness and kurtosis testing to confirm the former assumption. The results of these tests revealed the college modality dataset exhibited a skewness of 0.23 (SE = 0.06) and a kurtosis of -0.71 (SE = 0.13), the high school modality dataset exhibited a skewness of 0.09 (SE = 0.14) and a kurtosis of -0.73 (SE = 0.27), and the online modality dataset exhibited a skewness of 0.28 (SE = 0.12) and a kurtosis of -0.67 (SE = 0.24). George and Mallery (2010) noted that data exhibit a normal distribution when each skewness and kurtosis value falls within a range of 2.0 and -2.0; thus, these data did not violate the normality assumption.

I assessed the second assumption, which presumes that there are equal variances among the groups, by conducting a Levene's test. This test yielded the following results: $F(2, 2167) = .004$, $p = .97$; thus, these data did not violate the equal variances assumption. The subsequent one-way ANOVA test indicated that there were no significant differences, as evidenced by $F(2, 2167) = .31$, $p = .73$. As such, I failed to reject the null hypothesis because I did not observe

statistically significant differences in freshman College Algebra postrequisite math grades among students who completed dual-enrollment College Algebra at the college, at the high school, or online.

Table 3

One-Way ANOVA of Freshman College Algebra Postrequisite Math Grades, Classified by Dual-Enrollment College Algebra Modality

Source of Variance	*SS*	*df*	*MS*	*F*	*p*
Between Groups	0.74	2	0.37	0.31	0.73
Within Groups	2601.66	2167	1.20		
Total	2602.39	2169			

Q2. Are there significant differences in freshman College Algebra postrequisite math DFW rates earned among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

H_0. There are no significant differences in freshman College Algebra postrequisite math DFW grade rates among students who completed dual enrollment online, at a high school, or at a college.

H_1. There are significant differences in freshman College Algebra postrequisite math DFW grade rates among students who completed dual enrollment online, at a high school, or at a college.

I analyzed students who earned OSS dual-enrollment College Algebra credit during the 2012-2013, 2013-2014, or 2014-2015 academic year and subsequently completed a College Algebra postrequisite math course as a college freshman during the 2013-2014, 2014-2015, 2015-2016, or 2016-2017 academic year through a different lens compared to Q1. Rather than focusing on grades earned, I conducted an analysis to determine if there were statistically significant differences in DFW freshman College Algebra postrequisite math grade rates. As

such, I applied a chi-square test to determine if there were statistically significant differences in freshman College Algebra postrequisite math DFW grade rates among the students who completed College Algebra within the three dual-enrollment modalities.

As indicated in Table 4, students who completed dual-enrollment College Algebra at the college exhibited a 47.2% DFW grade rate in freshman College Algebra postrequisite math courses, students who completed dual-enrollment College Algebra at the high school exhibited a 45.8% DFW grade rate in freshman College Algebra postrequisite math courses, and students who completed dual-enrollment College Algebra online exhibited a 46.8% DFW grade rate in freshman College Algebra postrequisite math courses. The results of the chi-square test indicated that there were no statistically significant differences in DFW grade rates, as evidenced by $X^2(2, N = 2{,}467) = .23$, $p = .89$. As such, I failed to reject the null hypothesis because I did not observe statistically significant differences in freshman College Algebra postrequisite math DFW grade rates based upon the modality through which the dual-enrollment College Algebra course was delivered (see Table 4).

Table 4

Freshman College Algebra Postrequisite Math DFW and ABC Grades, Classified by Dual-Enrollment College Algebra Modality

Modality	DFW Grades		ABC Grades	
	n	%	*n*	%
College Campus	779	47.2	871	52.8
High School Campus	171	45.8	202	54.2
Online	208	46.8	236	53.2

Q3. Are there significant differences in freshman College Algebra postrequisite science grades earned among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

***H*$_0$**. There are no significant differences in freshman College Algebra postrequisite science grades earned among students who completed dual enrollment online, at a high school, or at a college.

***H*$_1$**. There are significant differences in freshman College Algebra postrequisite science grades earned among students who completed dual enrollment online, at a high school, or at a college.

A total of 2,241 students earned OSS dual-enrollment College Algebra credit during the 2012-2013, 2013-2014, or 2014-2015 academic year and subsequently earned an OSS College Algebra postrequisite science grade of A, B, C, D, or F as a college freshman during the 2013-2014, 2014-2015, 2015-2016, or 2016-2017 academic year. The majority of these students completed dual-enrollment College Algebra at the college campus (n = 1,505), while smaller subpopulations completed dual enrollment online (n = 383) and at the high school (n = 353; see Table 5). As with the population examined in Q1, the majority of the students who completed the aforementioned sequence were White. Additionally, as indicated in Table 6, the majority of the students examined in this question were female (two out of every three students in each subpopulation).

Table 5

Freshman College Algebra Postrequisite Science Course Completion, Classified by Dual-Enrollment College Algebra Modality

Modality	*n*	%
College Campus	1,505	67.2
High School Campus	353	15.8
Online	383	17.0

Table 6

Demographics of Freshman College Algebra Postrequisite Science Course Students, Classified by Dual-Enrollment College Algebra Modality

Demographic Group	College Campus		High School Campus		Online	
	n	%	*n*	%	*n*	%
Gender						
Female	957	63.6	235	66.6	244	63.7
Male	548	36.4	118	33.4	139	36.3
Ethnicity						
American Indian or Alaska Native	183	12.2	48	13.6	44	11.5
Asian	66	4.4	26	7.4	20	5.2
Black or African American	24	1.6	7	1.9	5	1.3
Hispanic or Latino	82	5.4	25	7.1	19	4.9
Multiple	130	8.6	14	3.9	42	10.9
Native Hawaiian or Pacific Islander	2	0.1	0	0.0	0	0.0
Unknown	54	3.6	11	3.1	11	2.9
White	964	64.1	222	62.9	242	63.2

Students who completed dual-enrollment College Algebra at the college earned higher freshman College Algebra postrequisite science grades (M = 2.08) than students who completed dual-enrollment College Algebra at the high school (M = 2.03) or online (M = 1.99). A one-way ANOVA was identified as the appropriate analysis to determine if there were statistically significant differences in freshman College Algebra postrequisite science grades among students who completed a College Algebra course within the three dual-enrollment modalities. Prior to conducting the analysis, I applied tests to determine whether the one-way ANOVA assumptions were violated. I conducted tests for skewness and kurtosis to test the normality assumption. The results of these tests revealed the college campus modality dataset exhibited a skewness of .024 (SE = .063) and a kurtosis of -.75 (SE = .13), the high school modality dataset exhibited a

skewness of .000 (*SE* = .13) and a kurtosis of -.59 (*SE* = .26), and the online modality dataset exhibited a skewness of .22 (*SE* = .13) and a kurtosis of -.56 (*SE* = .25). Based on these results, these data did not violate the normality assumption.

The second assumption, which presumes that there are equal variances among the groups, was assessed through a Levene's test. The results indicated that the variances were unequal, as evidenced by $F(2, 2{,}238) = 5.07$, $p = .006$. Thus, these data violated the assumption of equal variances. Based on this violation, a Welch's one-way ANOVA was applied in lieu of a traditional one-way ANOVA because it allows a researcher to examine if there are significant mean differences among groups that have unequal variances (Schlotzhauer, 2007). The results of this test revealed the following: $F(2, 703.32) = 1.46$, $p = .23$ (see Table 7). Thus, I failed to reject the null hypothesis because I did not observe statistically significant differences in freshman College Algebra postrequisite science grades among students who completed College Algebra within the three dual-enrollment modalities.

Table 7

Welch's One-Way ANOVA of Freshman College Algebra Postrequisite Science Grades, Classified by Dual-Enrollment College Algebra Modality

Modality	*M*	*F*	*df1*	*df2*	*p*
		1.46	2	703.32	.23
College Campus	2.08				
High School Campus	2.03				
Online	1.99				

Q4. Are there significant differences in freshman College Algebra postrequisite science DFW grade rates among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

***H*0**. There are no significant differences in freshman College Algebra postrequisite science DFW grade rates among students who completed dual enrollment online, at a high school, or at a college.

***H*1**. There are significant differences in freshman College Algebra postrequisite science DFW grade rates among students who completed dual enrollment online, at a high school, or at a college.

I analyzed students who earned OSS dual-enrollment College Algebra credit during the 2012-2013, 2013-2014, or 2014-2015 academic year and subsequently completed an OSS College Algebra postrequisite science course as a college freshman during the 2013-2014, 2014-2015, 2015-2016, or 2016-2017 academic year through a different lens compared to Q3. Rather than focusing on grades earned, I conducted an analysis to determine if there were statistically significant differences in freshman College Algebra postrequisite science DFW grade rates. As such, I applied a chi-square test to determine if there were statistically significant differences in freshman College Algebra postrequisite science DFW grade rates among students who completed College Algebra within the three dual-enrollment modalities.

As indicated in Table 8, students who completed dual enrollment at the college exhibited a 40.5% DFW grade rate in freshman College Algebra postrequisite science courses, students who completed dual-enrollment College Algebra at the high school exhibited a 39.5% DFW grade rate in freshman College Algebra postrequisite science courses, and students who completed dual-enrollment College Algebra online exhibited a 40.8% DFW grade rate in freshman College Algebra postrequisite science courses. The results of the chi-square test indicated that there were no statistically significant differences in DFW grade rates, as evidenced by $X^2(2, N = 2{,}540) = .18$, $p = .92$. As such, I failed to reject the null hypothesis because I did

not observe statistically significant differences in freshman College Algebra postrequisite science DFW grade rates among students who completed dual-enrollment College Algebra at the college, at the high school, or online.

Table 8

Freshman College Algebra Postrequisite Science DFW and ABC Grades, Classified by Dual-Enrollment College Algebra Modality

Modality	DFW Grades		ABC Grades	
	n	%	*n*	%
College Campus	694	40.5	1,020	59.5
High School Campus	158	39.5	242	60.5
Online	174	40.8	252	59.2

Q5. Are there significant differences in first-semester freshman GPAs among students who completed dual-enrollment College Algebra online, at a high school, or at a college?

$\boldsymbol{H_0}$. There are no significant differences in first-semester freshman GPAs among students who completed dual-enrollment College Algebra online, at a high school, or at a college.

$\boldsymbol{H_1}$. There are significant differences in first-semester freshman GPAs among students who completed dual-enrollment College Algebra online, at a high school, or at a college.

A total of 5,841 students earned OSS dual-enrollment College Algebra credit during the 2012-2013, 2013-2014, or 2014-2015 academic year and subsequently earned OSS college credit in the fall semester following high school graduation during the 2013-2014, 2014-2015, 2015-2016, or 2016-2017 academic year. The majority of these students completed dual-enrollment College Algebra at the college campus (n = 3,930), while smaller subpopulations completed dual-enrollment College Algebra online (n = 1,022) and dual-enrollment College Algebra at the high school (n = 889; see Table 9). As indicated in Table 10, the majority of the students who completed the aforementioned sequence were White. Students classified as Native American or

Alaska Native, Latino or Hispanic, and Multiethnic served as the highest represented minority groups. Additionally, the number of females exceeded the number of males in each scenario in which a student completed a dual-enrollment College Algebra course before earning credit in the fall semester after high school graduation.

Table 9

Students Who Earned College Credit in the Fall Semester after High School Graduation, Classified by Dual-Enrollment College Algebra Modality

Modality	*n*	%
College Campus	3,930	67.3
High School Campus	889	15.2
Online	1,022	17.5

Table 10

Demographics of Students Who Earned College Credit in the Fall Semester after High School Graduation, Classified by Dual-Enrollment College Algebra Modality

Demographic Group	College Campus		High School Campus		Online	
	n	%	*n*	%	*n*	%
Gender						
Female	2,385	60.7	542	60.9	619	60.6
Male	1,545	39.3	347	39.3	403	39.4
Ethnicity						
American Indian or Alaska Native	381	9.7	109	12.3	121	11.8
Asian	104	2.6	22	2.5	21	2.1
Black or African American	80	2.0	14	1.6	20	1.9
Hispanic or Latino	215	5.5	54	6.1	57	5.6
Multiple	349	8.9	81	9.1	79	7.7
Native Hawaiian or Pacific Islander	6	0.2	1	0.1	1	0.1
Unknown	156	3.9	39	4.4	34	3.3
White	2,639	67.2	569	64.5	689	67.4

Descriptive statistics revealed that the students who completed dual-enrollment College Algebra online (M = 3.13) and at the college (M = 3.12) earned higher first-semester freshman GPAs than students who completed dual enrollment at the high school (M = 3.02). A one-way ANOVA was identified as the appropriate analysis to determine if there were statistically significant differences in first-semester freshman GPAs among students who completed College Algebra within the three dual-enrollment modalities. Prior to conducting the analysis, I applied tests to determine whether the one-way ANOVA assumptions were violated. I conducted tests for skewness and kurtosis to test the normality assumption. The results revealed the college campus modality dataset exhibited a skewness of -1.49 (SE = .039) and a kurtosis of 2.51 (SE = .078), the high school modality dataset exhibited a skewness of -1.67 (SE = .08) and a kurtosis of 2.68 (SE = .16), and the online modality dataset exhibited a skewness of -1.38 (SE = .077) and a kurtosis of -2.17 (SE = .15). Although the skewness calculations were acceptable, the kurtosis calculations fell outside the scope of the allowable range to substantiate a normal distribution. While these data did not meet this assumption, sample sizes of 30 or larger are robust to the normality violation (Weinberg & Abramowitz, 2008). As such, a normality violation has a minimal effect on the accuracy of findings in larger population sizes (Rosenthal, 2011). As noted in Table 9, each subpopulation examined in Q5 significantly exceeded the aforementioned sample size criterion that is necessary to be robust to the normality violation.

The second assumption, which presumes that there are equal variances among the groups, was assessed through a Levene's test. This analysis yielded the following results: $F(2, 5{,}838) = 6.39$, $p = .002$. The results showed that these data violated the equal variances assumption. Based on this violation, a Welch's one-way ANOVA was applied in lieu of a traditional one-way ANOVA because it allows a researcher to examine if there are significant mean differences

among groups that have unequal variances (Schlotzhauer, 2007). The results of this test revealed that there were statistically significant differences, as evidenced by $F(2, 1{,}723.60) = 4.575$, $p = .01$. Thus, I rejected the null hypothesis because I observed statistically significant differences in first-semester freshman GPAs among students who completed dual-enrollment College Algebra at the college, at the high school, or online.

Based on the Welch's one-way ANOVA establishing that there were statistically significant differences, I conducted a post hoc analysis to identify where the significant differences in first-semester freshman GPAs existed among the students within the three respective dual-enrollment modalities (see Table 11). I applied a Games-Howell test as the post hoc analysis because it is appropriate for cases in which there are unequal variances (Vieira, 2017). Of the three modalities analyzed by virtue of the Games-Howell test, statistically significant differences in first-semester freshman GPAs were observed between students who completed dual-enrollment College Algebra at the college and at the high school ($p = .01$) and between students who completed dual-enrollment College Algebra online and at the high school ($p = .02$). No statistically significant differences were found in first-semester freshman GPAs earned between students who completed dual-enrollment College Algebra at the college and online ($p = .86$). Thus, the students who completed dual-enrollment College Algebra at the college and online earned significantly higher first-semester freshman GPAs than the students who completed dual-enrollment College Algebra at the high school (see Table 12).

Table 11

Welch's One-Way ANOVA of First-Semester Freshman GPAs, Classified by Dual-Enrollment College Algebra Modality

Modality	*M*	*F*	*df1*	*df2*	*p*
		4.56	2	1723.60	0.01*
College Campus	3.12				
High School Campus	3.02				
Online	3.13				

*Indicates a statistically significant different.

Table 12

Games-Howell Post Hoc Analysis of First-Semester Freshman GPAs, Classified by Dual-Enrollment College Algebra Modality

Modality	Comparison	*SE*	*p*
College Campus	High School	0.03	0.01*
	Online	0.03	0.86
High School Campus	College	0.03	0.01*
	Online	0.04	0.02*
Online	College	0.03	0.86
	High School	0.04	0.02*

*Indicates a statistically significant different.

Summary

In this chapter, I conducted a series of analyses to examine if there were statistically significant differences in early college success outcomes among students who completed College Algebra within the three dual-enrollment modalities. The statistical tests I applied to investigate Q1 and Q2 revealed that there were no statistically significant differences in freshman College Algebra postrequisite math grades and DFW grade rates among students who completed College Algebra within the three dual-enrollment modalities. Likewise, the analyses that I conducted to investigate Q3 and Q4 indicated that there were no statistically significant differences in freshman College Algebra postrequisite science grades and DFW grade rates among students who completed College Algebra within the three dual-enrollment modalities.

While I did not find statistically significant differences within the analyses that investigated Q1 – Q4, I found statistically significant differences in the Welch's one-way ANOVA that was conducted to investigate Q5. The results of this test revealed that statistically significant differences in first-semester freshman GPAs existed among students who completed dual enrollment at the college (M = 3.12), at the high school (M = 3.02), and online (M = 3.13). A subsequent post hoc test, the Games-Howell test, indicated that the statistically significant differences in first-semester GPAs existed between students who completed dual-enrollment College Algebra online and at the high school and between students who completed dual-enrollment College Algebra at the college and the high school. Thus, the students who completed dual-enrollment College Algebra online and at the college campus earned significantly higher first-semester freshman GPAs than students who completed dual-enrollment College Algebra at the high school campus.

Chapter 5 addresses the evaluation of the findings and implications, provides recommendations for future practice and research, and details conclusions.

Chapter 5: Discussion, Conclusions, and Recommendations

Today, colleges and universities offer dual enrollment to high school students through three modalities: dual enrollment at the college, dual enrollment at the high school, and dual enrollment online (Tobolowsky & Allen, 2016). Previous studies on dual enrollment have primarily investigated the impact of dual enrollment on college readiness and college success by comparing dual-enrollment students to nondual-enrollment students. Among other things, these studies have shown that dual-enrollment students:

- earn higher ACT scores (Eimers & Mullen, 2003; Radunzel et al., 2014),
- exhibit higher high-school-to-college-going rates (Lewis & Overman, 2008; Struhl & Vargas, 2012),
- earn higher first-semester college GPAs (Bailey et al., 2007),
- demonstrate higher freshman-to-sophomore persistence rates (Radunzel et al., 2014; Speroni, 2011; Swanson, 2010), and
- exhibit higher college graduation rates (Allen, 2010; Community College Research Center, 2012; Grubb et al., 2017; Speroni, 2011; Struhl & Vargas, 2012; Swanson, 2010).

While this prior research has established that dual-enrollment students outperform nondual-enrollment students, researchers have devoted minimal attention to investigating the three dual-enrollment modalities. In the only known study that compared dual-enrollment modality outcomes, Arnold et al. (2017) observed that high school and online students performed significantly better than the college campus students in an unspecified college math course. While Arnold et al. compared dual-enrollment outcomes, they did not address whether there was a link between the dual-enrollment modality and subsequent collegiate performance. Therefore,

based on the paucity of research, it was unknown prior to this dissertation study if the dual-enrollment modality affects subsequent collegiate performance after high school graduation. Thus, the core problem that prompted this dissertation study was that colleges and universities have offered dual-enrollment College Algebra without discerning if the dual-enrollment modality impacts the transition from high school to college. This dissertation was specifically designed to determine if the dual-enrollment College Algebra modality affects early collegiate performance.

I employed a causal-comparative design to examine whether there were cause-and-effect relationships between each modality and five performance measures. As such, I applied a series of statistical analyses to measure whether or not statistically significant differences existed in freshman College Algebra postrequisite math grades, freshman College Algebra postrequisite math DFW grade rates, freshman College Algebra postrequisite science course grades, freshman College Algebra postrequisite science DFW grade rates, and first-semester freshman GPAs among students who participated in three dual-enrollment College Algebra modalities.

This chapter details the evaluation of findings and implications and provides recommendations for future practice and research. Lastly, this study ends with a conclusions section.

Evaluation of Findings and Implications

Q1, Q2, Q3, and Q4. Conley (2008) noted that the college and career readiness conceptual framework emphasizes that students must develop content knowledge in order to succeed in core collegiate subject areas. Accordingly, I constructed Q1, Q2, Q3, and Q4 to investigate whether the dual-enrollment College Algebra modality had a potential influence on the transfer of math knowledge and skills from the dual-enrollment experience to the freshman

experience, as measured by freshman College Algebra postrequisite math and science grades and DFW grade rates.

For Q1, students who completed dual-enrollment College Algebra at the high school earned higher freshman College Algebra postrequisite math grades (M = 1.95) than students who completed dual-enrollment College Algebra at the college (M = 1.91) and online (M = 1.89). The results of the one-way ANOVA showed no statistically significant differences in freshman College Algebra postrequisite math grades earned among students who completed dual-enrollment College Algebra within the three modalities.

For Q2, students who completed dual-enrollment College Algebra at the college exhibited a 47.2% DFW grade rate in freshman College Algebra postrequisite math courses, students who completed dual-enrollment College Algebra at the high school exhibited a 45.8% DFW grade rate in freshman College Algebra postrequisite math courses, and students who completed dual-enrollment College Algebra online exhibited a 46.8% DFW grade rate in freshman College Algebra postrequisite math courses. The results of the chi-square test revealed that there were no statistically significant differences in freshman College Algebra postrequisite math DFW grade rates among students who completed dual-enrollment College Algebra within the three modalities.

For Q3, students who completed dual-enrollment College Algebra at the college earned higher freshman College Algebra postrequisite science grades (M = 2.08) than students who completed dual-enrollment College Algebra at the high school (M = 2.03) and online (M = 1.99). The results of the one-way Welch's ANOVA indicated that there were no statistically significant differences in College Algebra postrequisite science grades among students who completed dual enrollment within the three modalities.

For Q4, students who completed dual enrollment at the college exhibited a 40.5% DFW grade rate in freshman College Algebra postrequisite science courses, students who completed dual-enrollment College Algebra at the high school exhibited a 39.5% DFW grade rate in freshman College Algebra postrequisite science courses, and students who completed dual-enrollment College Algebra online exhibited a 40.8% DFW grade rate in freshman College Algebra postrequisite science courses. The results of the chi-square test revealed that there were no statistically significant differences in freshman College Algebra postrequisite science DFW grade rates among students who participated within the three modalities.

Given that this research investigated one independent variable, the dual-enrollment College Algebra modality, these results must be interpreted with caution because other factors may have also influenced performance in the freshman College Algebra postrequisite math and science courses. With these issues in mind, these analyses did not produce evidence to support that a potential cause-and-effect relationship exists between the dual-enrollment College Algebra modality and freshman College Algebra postrequisite math and science performance. Therefore, these findings suggest that the dual-enrollment College Algebra modality does not appear to impact performance in freshman College Algebra postrequisite math and science courses. As such, it is possible that the dual-enrollment modality may not influence the transfer of math knowledge and skills from the dual-enrollment College Algebra course to freshman College Algebra postrequisite math and science courses. While this study opened up a new avenue for dual-enrollment scholarly research, in the end, further research is needed before robust conclusions can be made about the impact of the dual-enrollment College Algebra modality on freshman College Algebra postrequisite math and science performance.

While further research is warranted, these findings do not support the perception in the literature that the online and high school dual-enrollment modalities are inferior to the college modality. Burns and Lewis (2000) and Tobolowsky and Allen (2016) expressed concerns that the online and high school modalities might be less effective than the college campus modality in preparing students for subsequent collegiate success. The analyses used to answer Q1 – Q4 provide evidence that challenges these concerns because the outcomes indicated that students within the three modalities performed at comparable levels in freshman math and science coursework.

Although the research comparing the dual-enrollment modalities is limited, there is a robust body of literature that has been devoted to examining the differences between individual course grades in traditional and online classroom environments. While some of these studies have found significant differences in individual course grades between students in the two modalities (Bettinger & Loeb, 2017; Garratt-Reed et al., 2016; Johnson & Marisol, 2014; Tanyel & Griffin, 2014; Verhoeven & Wakeling, 2011), other studies have revealed that there were no significant differences in course grades (Cavanaugh & Jacquemin, 2015; Coates et al., 2004; Evans et al., 2007; Hurlburt, 2001; Jones & Long, 2013; McLaren, 2004; Mirakian & Hale, 2007; Wagner et al., 2011). The findings observed in Q1 – Q4 are consistent with the latter and give credence to the argument that the modality may not influence academic performance.

While the aforementioned studies were pertinent to this research, a study conducted by Wisneski et al. (2017) had a greater degree of congruity to this particular study because it was constructed to examine the impact of the modality within the context of a prerequisite-postrequisite course sequence. Much like the findings that I uncovered after analyzing Q1 – Q4, Wisneski et al. (2017) observed that there were no significant differences in postrequisite

accounting course grades between students who completed the prerequisite accounting course online and in the classroom modalities. Thus, the findings from Q1 – Q4 were consistent with Wisneski et al. (2017) and thereby advance the notion that the modality of delivery may not influence the transfer of knowledge and skills from a prerequisite course to a postrequisite course.

Q5. Conley (2008) described the college and career readiness framework as emphasizing that a student must possess core study skills to be in a position to succeed in early collegiate coursework. Some core study skills include time management, exam preparation strategies, utilizing effective resources, and class notetaking. In contrast to cognitive strategies, study skills are not discipline specific, as these are integral skills that all students, regardless of major, need to foster a positive high school-to-college transition. Conley (2014) noted that study skills strongly influence GPA because it is a quantitative measure of all coursework, regardless of academic discipline. Accordingly, Q5 was constructed to assess whether the dual-enrollment College Algebra modality had a potential influence on the application of study skills in the first semester of college, as measured by first-semester freshman GPA.

Students who completed dual-enrollment College Algebra online earned the highest first-semester GPA (M = 3.13), students who completed dual-enrollment College Algebra at college earned the second highest first-semester GPA (M = 3.12), and students who completed dual-enrollment College Algebra at the high school earned the lowest first-semester GPA (M = 3.02). The results of the Welch's one-way ANOVA indicated that there were statistically significant differences in first-semester GPAs among students who completed dual enrollment within the three modalities.

As with Q1 - Q4, given that I investigated one independent variable in Q5, the dual-enrollment College Algebra modality, these results must be interpreted with caution because other factors may have also influenced first-semester GPA performance. This analysis produced evidence to support that a potential cause-and-effect relationship may exist between the dual-enrollment College Algebra modality and first-semester GPA performance. Therefore, this finding suggests that the dual-enrolment College Algebra modality may impact the first-semester freshman GPA. As such, it is possible that the dual-enrollment College Algebra modality may influence the application of study skills in the first semester of college.

Post hoc testing revealed that there were two significant differences in first-semester GPAs. First, students who completed dual-enrollment College Algebra at the college earned significantly higher first-semester GPAs than students who completed dual-enrollment College Algebra at the high school. This finding supports an observation by Karp (2012), who concluded that the college modality provided a more effective outlet than the high school modality for students to engage in role-related learning and to develop the requisite study skills and habits that are necessary for collegiate success. Second, the students who completed dual-enrollment College Algebra online earned significantly higher first-semester GPAs than students who completed dual-enrollment College Algebra at the high school. Accordingly, this result suggests that the students who completed dual-enrollment College Algebra online may have exhibited a higher level of first-semester study skills than students who completed dual-enrollment College Algebra at the high school.

Lastly, I did not observe statistically significant differences in first-semester GPAs between students who completed dual-enrollment College Algebra at the college campus and online. As such, this result challenges the assertion made by Stimpson (2016), who expressed

that online dual-enrollment students may be at a disadvantage because they are often unable to utilize on-campus resources. Given the outcome, it is possible that the more common use of digital tutoring services, electronic library resources, and internet academic advising services in recent years may have alleviated the resource gap that online dual-enrollment modality students previously experienced.

The no significant differences finding in first-semester GPAs between students who completed dual enrollment at the college campus and online also contradicts a finding made by Bettinger and Loeb (2017). Bettinger and Loeb's research is the only study identified in this dissertation's literature review that examined the impact of a modality on subsequent semester GPAs. Bettinger and Loeb identified significant differences in GPAs in the semester after completing a course between students who completed an online course and those who completed a college campus course. However, it is important to point out that the student population examined by Bettinger and Loeb consisted of the general DeVry University student population, without an exclusive focus on students who participated in dual enrollment. Another important factor to consider is that nearly 77% of DeVry University's student population was at least 25 years old, which is higher than the national average (DeVry Education Group, 2016). Given that Q5 analyzed students who completed dual enrollment and subsequently earned collegiate credit in the fall semester after high school graduation, these populations are likely to have differed significantly in age. As such, while the outcomes that were revealed by virtue of investigating Q5 differ from Bettinger and Loeb's, the results should be interpreted with the recognition that the populations examined within each study were likely incompatible.

Recommendations

Recommendations for future practice. The OSS institutions should take note of the outcomes that I found in this study. First, these results suggest that the prerequisite dual-enrollment College Algebra modality may not impact freshman College Algebra postrequisite math and science performance. While I did not observe statistically significant differences, a sizable gap was present between the number of students who participated in the dual-enrollment College Algebra at the college campus modality and the number of students who participated in the dual-enrollment College Algebra through the online and high school modalities. This was present in the College Algebra postrequisite math dataset, as dual-enrollment College Algebra college campus students (n = 1,449) outnumbered the dual-enrollment College Algebra high school campus students (n = 318) and online students (n = 403), and in the College Algebra postrequisite science dataset, as the dual-enrollment College Algebra college campus students (n = 1,505) exceeded the number of dual-enrollment College Algebra high school campus students (n = 353) and online students (n = 383).

Given the outcomes of the analyses, coupled with the imbalanced participation numbers within the three modalities, it is possible that the online and high school modalities may have been underutilized. Increasing the number of course offerings within these modalities could be advantageous, as such modalities have shown to expand dual-enrollment opportunities for students from rural and low-socioeconomic backgrounds (Catron, 2001; Edwards et al., 2011; Harris & Stovall, 2013; Khazem & Khazem, 2012). While Q1 – Q4 indicated that the dual-enrollment College Algebra modalities produced comparable results, given that only one independent variable was investigated, questions remain about whether other factors may have influenced the results. Therefore, further analysis is needed to determine whether OSS

institutions should expand the dual-enrollment College Algebra high school and online modalities in the future.

The OSS institutions should also recognize the findings that were observed to address Q5. First, it should be noted that no significant differences were observed in first-semester GPAs between students who completed dual-enrollment College Algebra at the college campus and those who completed College Algebra online. While more research is needed to assess the effectiveness of the online modality, this finding provides further support for the argument that the online dual-enrollment College Algebra modality may have been underutilized. Second, the outcomes also revealed that students who completed dual-enrollment College Algebra online and at the college earned significantly higher first-semester GPAs than students who completed dual-enrollment College Algebra at the high school. This is a noteworthy finding because higher GPAs have been linked to higher levels of study skills (Noble, Davenport, Schiel, & Pommerich, 1999; Robbins et al., 2004). As such, this outcome provides evidence to suggest that the dual-enrollment college campus and online modalities may be more effective in building the study skills necessary to foster a positive high-school-to-college transition. Given this disparity, it may be advantageous to implement an alternative strategy to strengthen the study skills that students build within the dual-enrollment College Algebra high school modality.

One such alternative strategy is using a study skills course to enhance students' study skills, as researchers have linked participation in this course with higher academic performance. For example, students who have completed a study skills course have earned higher first-semester freshman GPAs (Forster, Swallow, & Fodor, 1999), as well as higher GPAs in subsequent semesters (Jamelske, 2009; Tuckman & Kennedy, 2011), as compared to students who have not completed such courses. Because of this finding, OSS institutions should consider

requiring that students enroll in study skills courses in conjunction with the dual-enrollment College Algebra courses at the high school, which could provide a potential avenue to instill the foundational study skills and habits that are needed to cultivate early collegiate success.

Recommendations for future research. More research is needed to understand the impact of the dual-enrollment modality on subsequent academic performance. First, as previously noted, other factors that extend beyond the modality might have influenced the transfer of the math skills from the dual-enrollment College Algebra prerequisite course to the freshman College Algebra postrequisite math and science courses. For example, cognitive ability is one factor that has been shown to influence the transfer of knowledge from one environment to a subsequent environment (Baldwin & Ford, 1988; Burke & Hutchins, 2007; Colquitt et al., 2000). Thus, I recommend that future research employs an ACT or SAT math subject score as a covariate to control for the effect of math cognitive ability. In addition to cognitive ability, motivation has also been noted as a factor that impacts knowledge transfer (Axtell et al., 1997; Belenky & Nokes-Malach, 2012; Chiaburu & Marinova, 2005). As such, I recommend that future research utilize a survey instrument that measures motivation to determine if this element, coupled with the dual-enrollment College Algebra modality, influences freshman collegiate performance.

Second, based on the fact that this research focused on the impact of the modality on first-year collegiate performance, there are a number of other performance indicators that researchers could examine. For example, graduation rates and first-year-to-second-year retention rates are the most common performance indicators employed to evaluate higher education institutions (Terkla, 2011). Thus, I recommend that future research is conducted to examine if there is a link between the dual-enrollment College Algebra modality and first-year-to-second-

year retention rates and graduation rates. This would provide a means to determine if the modality has an impact on the overarching performance indicators that are utilized to evaluate institutional effectiveness.

Third, this study did not employ a precise measure of the skills and knowledge students possess upon completing a dual-enrollment College Algebra course. Accordingly, I recommend that a future study examine if differences in standard comprehensive final exam grades exist among students who completed dual-enrollment College Algebra within the three modalities. This would provide an opportunity to determine if the modality has a direct effect on applying math knowledge and skills. Additionally, this study did not provide a direct assessment of knowledge transfer between the dual-enrollment and freshman-year experience. Thus, I recommend that a future study employ an algebra pretest/posttest model to measure if algebra knowledge and skills transfer from a dual-enrollment College Algebra course to freshman College Algebra postrequisite math and science courses.

Fourth, given that this study only focused on two prerequisite-postrequisite sequences, the format of this study could be replicated within other prerequisite-postrequisite course pairings. Like this study, investigating other prerequisite-postrequisite sequences would provide a means to determine if the modality of a dual-enrollment prerequisite course influences the application of academic skills in a subsequent freshman postrequisite course. This research could focus on other common general education course sequences, such as English Composition 1 and English Composition 2, or on prerequisite-postrequisite course pairings that fall within career and technical education majors.

Fifth, one significant research area that has historically been tied to math performance is based on investigating gender differences. While the gender gap in math achievement has

narrowed in recent years, there is still a math disparity between male and female students who seek admission to colleges and universities in the United States (ACT, 2017; College Board, 2013; Else-Quest, Hyde, & Linn, 2010; Hyde, Fennema, & Lamon, 1990). Based on this issue, there is abundant room for further research to determine if gender, coupled with the dual-enrollment modality, impacts freshman collegiate performance.

Lastly, given that this study relied solely upon the GPA figure as a measure of study skills, further research is warranted to investigate the impact of the modality on building study skills. A future study should employ an existing valid survey instrument to measure if there are differences in perceived study skills based upon the modality through which a dual-enrollment College Algebra course is delivered. Additionally, it is also recommended that qualitative research be conducted to provide a deeper inquiry into the potential differences in the study skills and habits practiced by college freshmen who participated within the three dual-enrollment College Algebra modalities.

Conclusions

This study contributed new knowledge to the robust body of dual-enrollment literature. The majority of prior quantitative, dual-enrollment research has focused on comparing nondual-enrollment participants to dual-enrollment participants. This study took a different angle by disaggregating the dual-enrollment College Algebra data by modality and subsequently analyzing early college outcomes. The study was designed to determine if the dual-enrollment College Algebra modality impacted STEM course performance and overall early college success. More specifically, this study was conducted to examine if there was a link between dual-enrollment College Algebra modalities and College Algebra postrequisite math and science course grades and DFW rates, as well as first-semester freshman GPAs. Based on the fact that

this research investigated one independent variable, the dual-enrollment College Algebra modality, these results must be treated with caution because other factors may have also influenced the aforementioned freshman performance measures.

Two meaningful findings emerged from this study that pertained to the dual-enrollment College Algebra online modality. First, the online dual-enrollment College Algebra students did not earn significantly different freshman postrequisite College Algebra math and science grades or exhibit significantly different freshman College Algebra postrequisite math and science DFW grade rates than the students in the high school and college campus dual-enrollment College Algebra modalities. Second, the online dual-enrollment College Algebra students did not earn significantly different first-semester GPAs than the dual-enrollment College Algebra students in the college campus modality, but did earn significantly higher first-semester GPAs than the dual-enrollment students in the high school modality. Given these outcomes, the dual-enrollment College Algebra online modality does not appear to have an adverse impact on freshman College Algebra postrequisite math and science grades, freshman College Algebra postrequisite math and science DFW grade rates, or first-semester GPAs.

Similarly, there were also two noteworthy outcomes that surfaced from the analyses that focused on the dual-enrollment College Algebra high school modality. First, the dual-enrollment College Algebra high school modality students did not earn significantly different freshman College Algebra postrequisite math and science grades or exhibit significantly different freshman College Algebra postrequisite math and science DFW grade rates than the students in the online and college campus dual-enrollment College Algebra modalities. Second, the dual-enrollment College Algebra high school modality students earned significantly lower first-semester GPAs than students in the dual-enrollment College Algebra online and college campus modalities.

Based on the above-mentioned outcomes, the dual-enrollment College Algebra high school modality may not impact freshman College Algebra postrequisite math and science grades or freshman College Algebra postrequisite math and science DFW grade rates. Conversely, participating in dual-enrollment College Algebra at the high school may adversely impact the first-semester freshman GPA, which is a measure that is indicative of study skills. As such, it is recommended that OSS institutions consider offering high school dual-enrollment College Algebra courses under a provision that such courses are taken in conjunction with a study skills course. This approach provides a proactive strategy to address the first-semester freshman GPA gap.

Previous researchers have expressed concerns that the high school and online dual-enrollment modalities might be less effective than the college modality in preparing students for collegiate success (Burns & Lewis, 2000; Tobolowsky & Allen, 2016). However, this dissertation study provided evidence that challenges these concerns. In this study, most of the results for high school and online dual-enrollment College Algebra students were not significantly different than the results produced by students who completed dual-enrollment College Algebra at the college campus. While this study showed that the dual-enrollment College Algebra online and high school students produced comparable results in most instances, further research is needed to assess the effectiveness of the three dual-enrollment College Algebra modalities.

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Appendix A: IRB Approval Letter

ABILENE CHRISTIAN UNIVERSITY
Educating Students for Christian Service and Leadership Throughout the World

Office of Research and Sponsored Programs
320 Hardin Administration Building, ACU Box 29103, Abilene, Texas 79699-9103
325-674-2885

August 3, 2018

Daniel Archer

Department of Educational Leadership

Abilene Christian University

Dear Daniel,

On behalf of the Institutional Review Board, I am pleased to inform you that your project titled
"Does the Dual Enrollment Modality Impact Subsequent Collegiate Performance?"

(IRB# 18-052)is exempt from review under Federal Policy for the Protection of Human Subjects as:
Non-research, and
Non-human research
Based on:
The research does not involve interaction or intervention with living individuals, and the information to be collected will not be individually identifiable.

If at any time the details of this project change, please resubmit to the IRB so the committee can determine whether or not the exempt status is still applicable.

I wish you well with your work.

Sincerely,

Megan Roth

Megan Roth, Ph.D.
Director of Research and Sponsored Programs

Appendix B: Oklahoma State Regents for Higher Education Data Request Form

Oklahoma State Regents for Higher Education

Data Request Form

Release of data is subject to approval. For consideration please provide the following information

Contact information

Name: Daniel Archer
Title: Abilene Christian University (ACU) Doctoral Student
Organization ACU
Department: School of Educational Leadership
Phone number:
E-mail address:

How will the data be used? What is the purpose of the request?

This data will be analyzed and assessed for a doctoral dissertation.

Please make sure that all identifiable information is removed from the dataset (name, ID, and social security number)

What data are needed?

1). Find students who completed a Course Equivalency Project (CEP) listed dual enrollment (which is also referred to as concurrent enrollment) college algebra course during the 12-13, 13-14, or 14-15 year and subsequently completed a CEP listed elementary calculus or trigonometry course as a freshmen during the 13-14, 14-15, 15-16, or 16-17 year. Disaggregate student data by dual enrollment delivery modality and provide grades earned in the elementary calculus and trigonometry.

2). Find students who completed a CEP listed dual enrollment college algebra course during the 12-13, 13-14, or 14-15 year and subsequently completed a CEP listed general chemistry course as a freshmen during the 13-14, 14-15, 15-16, or 16-17 year. Disaggregate student data by dual enrollment delivery modality and provide grades earned in the general chemistry courses.

3). Find students who completed a CEP listed dual enrollment college algebra course during the 12-13, 13-14, or 14-15 year and subsequently earned credit in the Fall semester after high school graduation during the 13-14, 14-15, 15-16, or 16-17 year. Disaggregate student data by dual enrollment delivery modality and provide fall semester after high school GPAs.

Date needed Upon ACU IRB approval.

Identify preferred mode of output (ASCII, Excel, hardcopy)

Excel

Statement of Understanding

The information obtained through the unitary data system is, by Federal law and State Regents policy, confidential, and may not be used except as officially authorized. The Family Educational Rights and Privacy Act of 1974 (FERPA) protects the privacy of the student records. The requester agrees to maintain the confidentiality of the data provided, use the data exclusively for the intended purpose, store the data in a secure area, and dispose of the data in an approved manner (i.e., shredding). Requesters may be held liable for the information divulged to unauthorized parties as a result of negligent maintenance or use of reports by requesters or their agents.

By my signature, I verify the information requested and confirm I have read, understand, and will comply with the above statement of understanding.

Daryl Archer — 7-16-18

Signature — Date

Approval Level _____

Authorizing Signature G.L. Northrop PhD Director Student Performance Data