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The Relationships Between College and Career Readiness Assessments

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THE RELATIONSHIPS BETWEEN COLLEGE AND CAREER READINESS ASSESSMENTS

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ABSTRACT

This study explored the effects of taking Advanced Placement (AP) courses on college and career readiness in a rural school district in the southeastern United States. I examined student performance data using American College Test (ACT) scores, Ready to Work (R2W) examination scores, and AP examination scores. The results of the study show that taking a single AP course leads to significant improvement on the ACT exam over a student who has not taken an AP courses and the optimal number of courses a student should take. The results of the study also show that taking an AP course leads to similar improvements on the R2W exam.

The findings from this study will help educators and education policy makers by providing information about the efficacy of AP programs in schools and determining whether enrolling in AP courses adequately prepares students for college-level work or the workforce after high school or if school resources would be better utilized in other ways to prepare students for post-secondary life instead of investing heavily in expanding AP curriculum.

DEDICATION

I dedicate this study to my family—especially my four grandparents, who always emphasized the importance of education and set the example for us to follow.

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and believed in me. Liam and Joe, you certainly were on the sidelines cheering for me to make it to the finish line. I love you all so much. None of this was possible without you.

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CHAPTER ONE

INTRODUCTION

Background of the Study

Improving student performance has been a driving force in school improvement research and policy since the publication of *A Nation at Risk* in 1983 (U.S. Department of Education, 1983). This report revealed that American students were falling behind other countries, causing concern that Americans would soon be unable to compete in the global economy. Educators and policy makers began looking for ways to improve school quality and began offering Advanced Placement (AP) courses to motivated students, providing these students a curriculum of increased rigor. According to Kolluri (2018), "early designers of AP sought to serve the nation's elite" (p. 685). Over several decades, the AP program continued to grow, as its popularity among policy makers reflected the belief that a traditional high school curriculum failed to provide the rigor needed to succeed beyond high school and that the AP program could promote equity, close the achievement gap, and provide improved college and career readiness for minority and low-income students (National Center for Educational Achievement, 2010b).

Increased pressure on schools due to national policies like *No Child Left Behind* and *Race to the Top* led to the continued expansion of the AP program as a means to raise the educational proficiency of low-achieving students and allow schools to reach their adequate yearly progress goals. According to the National Center for Educational Achievement (2010a) some policy makers have sought to expand the AP program in schools serving primarily minoritized students and low-income students, believing that

access to AP courses will promote educational equity and greater readiness for either college or a career among these marginalized groups. Even though the number of Black students and Latinx students taking an AP course has increased, they are still underrepresented. As reported by Jeffries and Silvernail (2017), "An observer of a gifted, honors, or Advanced Placement class almost anywhere in the United States is likely to see the same phenomenon: a class made up of primarily white, middle-and-upper class students" (p. 57). According to the AP Cohort Data provided by the College Board (2020), "8.3% of AP exam takers were Black, while 26.6% were Latino/a" (p. 20). Despite an increase in participation, they still underperform on AP exams, showing that "disparities in access and performance on AP exams by race/ethnicity are unfortunately not new" (Roegman et al., 2019, p. 29).

The Every Student Succeeds Act (2015) prompted schools to begin using career and college readiness as a measure of success. According to Fletcher et al. (2018), "One indicator of readiness is enrollment in rigorous academic coursework" (p. 78). As a result, the AP program has continued to expand, currently offering 38 courses (College Board, 2020), believing that participation in AP connects students to college success and provides opportunity for all students. However, preparing high school students to be college and/or career ready is not an easy task.

The National Center for Public Policy and Higher Education (2010) stated that earning a high school diploma does not mean that graduates are ready for college, and that 60% of high school graduates need to take some kind of remedial course. In 2015, the South Carolina Department of Education adopted the Profile of the South Carolina

Graduate (included as Appendix A), with the goal of producing graduates possessing critical skills identified by employers and business leaders as necessary to compete in the global economy. According to Morgan et al. (2018), "to keep the American workforce competitive, it is the charge of the education system to ensure that students are prepared for the skills needed" (p. 1). The Profile of the South Carolina Graduate identifies three broad sets of attributes—world class knowledge, world class skills, and life and career characteristics. According to the Profile, students will gain world class knowledge through rigorous standards for career and college readiness; they will gain world class skills such as creativity, critical thinking, and problem solving; and they will gain career characteristics such as self-direction, perseverance, and work ethic. These are all skills that proponents of the AP program believe students acquire through enrolling in AP coursework. According to The College Board (2014), AP students learn essential time management and study skills needed for college and career success. They dig deeper into subjects that interest them and learn to tap their creativity and problem-solving skills, and to challenge themselves with rigorous coursework.

To keep the American workforce competitive, students need to acquire essential skills. Robles (2012) listed essential soft skills such as communication, courtesy, responsibility, social skills, positive attitude, professionalism, flexibility, teamwork, and work ethic, which are critical to adequately prepare students for post-secondary success. School leaders, teachers, counselors, and parents should work together to ensure that appropriate courses are taken in a student's high school career based on the student's goals after graduation. According to Paolini (2019), "one of the most important aspects

involves assisting students in appropriate course selection, whether that includes AP classes or not, as these choices impact their overall preparedness and readiness for post-secondary success" (p. 4).

In a global economy, additional education beyond a high school diploma is believed to be advantageous to one's career and an indicator of increased employability (Paolini, 2019). According to Chapa et al. (2014), "There is a national necessity for students to be prepared for college" (p. 2). More and more students are seeking post-secondary degrees, so adequate preparation for the demands of college-level work is a necessity. According to the National Center for Education Statistics (NCES) (2019), "the overall college enrollment rate for young adults increased from 35% in 2000 to 40% in 2017" (para. 1). Despite the focus on career and college readiness, there is disagreement between researchers as to whether high school graduates are ready for the demands of college work. Some agree that rigorous coursework such as AP or Dual Enrollment adequately prepares students for college (Fletcher et al., 2018; Morgan et al., 2018) while others disagree and believe high school graduates are unprepared for the demands of college (Digby, 2016; Kolluri, 2018; Kolluri & Tierney, 2020; Oxtoby, 2007). College readiness and success is necessary to meet the requirements of a knowledge-based, world-wide economy. Being prepared for college means a student is more likely to graduate with a degree and be economically stable and able to become a self-actualized, productive citizen.

One measure students, parents, administrators, and college admissions officers look to as a measure of success is the American College Test (ACT) exam. The ACT is a

standardized test used by colleges and universities to determine if a student is college ready. According to Haynes (2016), the ACT was first given in 1959 to 75,406 high school students, when education was seen as a means of staying competitive in a growing economy. The ACT program has grown with the addition of ACT Aspire. Beginning in third grade and finishing with the actual ACT taken in 11th or 12th grade, the ACT Aspire program offers data on a student's progress in meeting benchmark scores that will help parents and teachers make decisions regarding academic courses a student should take throughout his or her high school career. According to the ACT (2020), the majority of post-secondary institutions determine college readiness by ACT scores. The ACT has developed College Readiness Benchmark scores for those students taking the ACT exam in 11th or 12th grade. These scores represent minimum scores required for students to have a high probability of success during their first year of college. The Benchmark score for English is 18 (corresponding college course is English Composition); the Benchmark score for Math is 22 (corresponding college course is College Algebra); the Benchmark score for Reading is 22 (corresponding college course is Social Sciences); the Benchmark score for Science is 23 (corresponding college course is Biology). Earning a high ACT score is important for the college admissions process, as it is believed to show a student's preparedness for college and the rigors associated with college coursework.

In order to help students meet the criteria for the Profile of the South Carolina Graduate, the state of South Carolina provides all high school students with the opportunity to take the ACT free of charge during their junior year. Although they are no longer required to take the ACT, it provides information to guide their coursework in

their final year of high school. In addition to offering the ACT free of charge to students, all 11th-grade students are required to take the Ready to Work (R2W) exam, which is a career-readiness assessment. The R2W exam covers three foundational areas: Applied Mathematics, Locating Information, and Reading for Information. In the Applied Mathematics section, questions cover mathematical reasoning and problem-solving skills; in the Locating Information section, students are shown workplace graphics and asked to comprehend and apply their knowledge of these graphics; and in the Reading for Information section, students are tested on reading comprehension and reasoning skills. In addition, R2W also assesses essential soft skills, such as cooperation, negotiation, positive attitude, and critical thinking. By focusing on workplace skills deemed most important by industry leaders across the state, students will be career-ready upon graduating from high school, "all students graduating from public high schools in this State should have the knowledge, skills, and opportunity to be college ready, career ready, and life ready for success in the global, digital, and knowledge-based world of the twenty-first century" (Education Accountability Act, 2008).

By examining the number of AP courses a student has taken in his or her high school career and comparing the results to received scores on the ACT (leading indicator of college and career readiness), school educators and leaders can learn more about the best path to college readiness for students. By examining R2W scores (leading indicator of career readiness), the same can be done to determine if AP courses help students become career ready.

Keeping the American workforce competitive in a global economy means adequately preparing students for life after high school. For some, that means earning college degrees, while for others it means finding gainful employment. Over time, policies have been implemented in U.S. schools in an attempt to give American students an edge, such as the creation of the AP program in the 1950s and its eventual expansion—Dual Enrollment—in 1955, or the International Baccalaureate program for students moving across international lines in 1968. The state of South Carolina created the Profile of the South Carolina Graduate, which emphasizes the attainment of essential skills. South Carolina educational leaders believe students meeting this profile will adequately be prepared for either college or the workforce. The College Board believes that the rigor provided by AP coursework is on par with material a student would learn in a college-level course. Despite the creation of these programs, there is still a large number of students who enroll in college but never finish a degree. Determining whether enrolling in rigorous coursework prepares one better for college or for the workforce is of benefit to high school students. This knowledge will help them make better decisions regarding coursework in their final year of high school.

Statement of the Problem

Students enroll in AP courses because they believe it will help them be prepared for college. Students want to demonstrate that they have the capacity to succeed in college preparatory courses, have improved their problem-solving skills, and have developed the habits of study necessary for college (Morgan et al., 2018). However, marginalized groups such as Black and Latinx students do not have the same

opportunities to take AP courses, for a variety of reasons, including deficit thinking or gatekeeping. According to Anderson (2020), “Marginalization and views about potential and access by educators, family, and peers have an effect on student concept and performance” (p. 93). According to Majors (2019), “college readiness initiatives maintain the dominance of the white and wealthy” (p. 183).

The College Board (2020) has created programs such as the Pre-AP program in an effort to increase the number of students who choose to take AP courses during their high school career. This Pre-AP program offers nine courses (English 1, English 2, Algebra I, Algebra II, Geometry with Statistics, Biology, Chemistry, World History and Geography, and Arts—dance, music, theatre, visual arts), and a requirement when offering these courses is open enrollment, so that all students will be successful. However, these programs do not appear to be making much of an impact on overall participation or success for marginalized students. According to Morgan et al. (2018), “college and career readiness is prevalent in national and local policy, the reality is that the equity gap is persistent among minoritized and economically disadvantaged students” (p. 6).

Definition of Terms

The following terms are used throughout this study. Their definitions are provided below.

ACT

The ACT (American College Test) is a standardized test consisting of 215 multiple-choice questions. The test is divded into four subsections that cover math,

English, reading, and science. The test has a composite score ranging from 0 to 36, and each subsection is scored within the same range.

Advanced Placement Program

The Advanced Placement (AP) Program consists of 38 college-level courses and exams designed by committees made up of college faculty and experienced AP teachers who ensure that the course and exam reflect college-level expectations. High schools can choose to offer these courses and their corresponding exams that are administered once a year (College Board, 2020).

College and Career Readiness

College and Career Readiness is defined as being qualified for and succeeding in entry-level, credit-bearing college courses leading to a baccalaureate or career pathway-oriented training without remedial or developmental coursework (Conley, 2012).

Dual Enrollment

Dual Enrollment is defined as a program that allows students to take college courses and earn college credits while in high school (An, 2013).

IBM®SPSS

IBM®SPSS is a software package that is widely used as a statistical analytic tool.

International Baccalaureate Diploma Programme

The International Baccalaureate (IB) Diploma Programme is defined as a comprehensive, 2-year curriculum for students aged 16 to 19. Students study six domains (language A, language B, individuals and societies, experimental sciences, mathematics, and an elective) that build on the core. The core curriculum consists of three elements:

theory of knowledge; creativity, action, and service activities; and extended essay (Nugent & Karnes, 2002).

Ready to Work Assessment

Ready to Work (R2W) is a career readiness assessment administered to all 11th-grade students to determine student achievement in three key subjects: Applied Mathematics, Locating Information, and Reading for Information. R2W also includes the Essential Soft Skills (ESS) assessment, which focuses on skills such as problem solving, goal setting, decision-making, and self-direction.

Purpose of the Study

The purpose of the study was to determine whether the number of AP courses a student takes has an impact on his or her ACT scores (a leading indicator of college readiness) and R2W scores (a leading indicator of career readiness). It would also determine if there is a difference in scores between Black and Latinx students and white students who have taken the same number of AP classes. This study will provide information to help schools determine the best course of study for their students.

Research Questions

Initially, there were three research questions guiding this study. Given that students of color are not given equal access to AP programs, part of the intent of this study was to determine whether a difference in ACT and R2W scores existed between Black and Latinx students and white students who took the same number of AP courses. However, the data presented did not allow for this question to be examined, for several reasons. First, when filtering to those with an ACT score (n = 367), only 27 were

classified as Black or African American, with another 10 classified as mixed-race Black. Additionally, only 21 of those 27 students took an AP exam, leaving only six to account for between one and four or more courses taken. This was not a suitable distribution, even with an independent-samples t-test as a consideration. A third, and most important reason, was that ethnicity was not classified in the data set received, and it was not a feasible follow-up request to add. As such, the proportion of white students with an ACT score accounted for 87% of the total base (n = 320 of 367). While it would have been feasible—all things considered—to test White vs. all other, the lack of classification of ethnicity would counter the goal of a portion of this work. As is best practice in demographic classification from the U.S. Census Bureau, ethnicity allows for the distinction of Hispanic/Latino, or Spanish descent. It was assumed and confirmed by a source close to the data sourcing that Latinx students were classified within White students, and there was no identifier for Hispanic/Latino. Due to these reasons, part of this research was not feasible, and an additional research question, stemming from the discoveries of Research Question 1, is analyzed and discussed in Chapter Five.

This new question stemmed from seeing how relationships fared in the data. Despite not being able to address the research question regarding white student scores and Black and Latinx scores, the data did present some interesting information. An examination of the data showed that a linear relationship existed between AP courses and ACT scores. This showed that participation in an AP course is beneficial to an ACT score, but these data led to another question: How many AP courses does a student need

to take to have an impact on their ACT score? Is there an optimal level of courses a student should take?

Therefore, the following research questions guide this study:

1. Is there a positive relationship between the number of AP courses that a student takes and their score on the ACT?
2. Is there a positive relationship between the number of AP courses that a student takes and their score on R2W?
3. How many AP courses does a student need to take to have an impact on their ACT score?
4. Is there an optimal level of AP courses a student should take?

Delimitations

This quantitative study was conducted in a rural school district in the southeastern United States. A comparison of scores between students who took AP courses and those who did not, and a comparison of scores between students who took AP courses and R2W examination scores, were conducted using *IBM®SPSS*.

This district was chosen because there was strong diversity among the students from the four attendance areas within the district. One attendance area had a rapidly growing Latinx population. Two of the attendance areas had Title I feeder schools . One of the attendance areas was considered to be of high socioeconomic status (SES). The number of students tested in each attendance area varied. Approximately 1,145 students attended one of the four high schools in the district: attendance area 1 tested approximately 270 students; attendance area 2 tested approximately 400 students;

attendance area 3 tested approximately 175 students; and attendance area 4 tested approximately 300 students.

Significance of the Study

This study is significant because it contributes to the discussion surrounding the best course of study for students in South Carolina to be adequately prepared for college or a career. This study will help schools determine which of the 38 AP courses to offer to their student body in order to help students achieve the 21st-century skills needed for the workplace and/or college.

With the adoption of the Profile of the South Carolina Graduate, emphasis on students not only being college ready but career ready affects the course selection process. Educational resources are being channeled into expanding AP programs without knowing if there is a difference in college readiness between students who enroll in advanced coursework and those who do not. Educational institutions are funneling money into Pre-AP and AP programs in the hope that expanding access will lead to higher achievement and college/career readiness, to the detriment of other programs that could do just as much to prepare a student for life beyond graduation. Determining whether AP courses have an impact on college and/or career readiness will help policy makers determine the best path to success for all students: "[S]chools need a clear and shared understanding of readiness to align their efforts to meet the needs of students regarding college, career, and future readiness" (Fletcher et al., 2018, p. 79).

Students graduating from high school must be ready to enter the global marketplace equipped with the skills potential employers want. Students who choose to

further their education must possess the skills necessary to meet the rigorous demands of college level work. School districts will have additional information to examine other pathways to success for students such as the implementation of more technical job preparation instead of giving money to AP courses, to help those students who are choosing career over college. If there are disparities between racial groups, this is critical information for school leaders. Information is knowledge and school leaders can use that knowledge to address disparities and make the best decisions for all students.

Assumptions and Limitations

A limitation to the study is that it only involves one school district in South Carolina. This school district does not include any schools located within an urban area.

Organization of the Study

This dissertation is divided into five chapters. Chapter One is the Introduction to the study, describing the background of the study. Chapter Two is the Literature Review of the AP program, a brief history of the ACT and college readiness, and the theoretical framework. Chapter Three describes the methodology of the research conducted for the study. Chapter Four includes the data collected during the study, an analysis of the data, and an examination of the research questions. Chapter Five concludes the paper with a summary of findings and implications for future research.

CHAPTER TWO

LITERATURE REVIEW

In this literature review I explore the history of the AP program, the growth factors affecting the AP program, how the AP program has shifted for some to become a means for closing the achievement gap but instead has become an unintentional barrier to success for many students, and how school administrators are obligated to thoroughly examine their own schools to determine if the AP program is the best option to meet the needs of all their students.

With high schools under greater scrutiny to increase student achievement and being held to greater accountability for student success in measures such as increasing graduation rates, providing a rigorous curriculum, and preparing students to be college and career ready, high school leaders are looking for ways to provide more opportunities for students that meet these requirements. One of the school programs touted to help students engage in a rigorous curriculum and to find success in high school and beyond is the AP program (Dougherty et al., 2005). A great deal of literature has been written about AP courses in schools and the impact of these courses on students, from those who live in rural or urban areas, to minoritized students, to those with exceptional abilities.

School administrators look to the AP program to deliver a curriculum that will challenge students, improve the academic reputation of their schools, and meet parental expectations for a quality education. These are among the reasons the AP program has continued to expand, experiencing explosive growth in recent years (College Board, 2017). Despite the expansion of the AP program, its mission to expand college access,

and its dedication to excellence and equity in education, it fails to meet its goals for all students it serves. According to the College Board (2014), "only 9.2% of AP exam takers were African/American and 18.8% of AP exam takers were Hispanic/Latino in 2013" (pp. 34–35), resulting in a wide gap between the number of white exam takers and minoritized students. Black and Latinx students do not have the same opportunities to take AP courses.

Advanced Placement Program

History and Early Growth Factors

In response to the Cold War and fears that the Soviet Union would best America, educators around the country believed that American education was falling behind other countries, especially in mathematics and science. If America wanted to remain the most powerful country in the world, something needed to be done. Educators were concerned that secondary and post-secondary curricula were too similar, and that valuable instructional time was wasted (Rothschild, 1999; Schneider, 2009). The Ford Foundation established a fund for the Advancement of Education, whose resources would target scientific, educational, and charitable purposes. The fund provided resources to send "talented" high school sophomores to targeted universities to earn 2 years of college credit before graduating from high school. The success of this program led the fund to bring together a committee composed of administrators, professors, and teachers from Harvard, Princeton, Yale, and distinguished private schools to devise a better way to help gifted students. The fund also supported the work of an additional committee founded by the president of Kenyon College, the School and College Study of Admission with

Advanced Standing (SACSAAS), exploring the same idea (Nugent & Karnes, 2002). Shortly after, 12 colleges joined SACSAAS, with the determination that

> admission to college with advanced standing at the normal college-entering age after high school is more desirable…. colleges can and should give a vote of confidence and encouragement to secondary schools that try to establish and maintain high standards of academic achievement. (Rothschild, 1999, p. 178)

Thus, the AP program began. The SACSAAS committee enlisted the help of education leaders to develop course descriptions for secondary programs and assessments that would satisfy college requirements. Once this was completed, seven schools piloted the program. The first AP exams were administered through the Educational Testing Service in 1954. At its final meeting in 1955, the SACSAAS committee turned control over to The College Board and named it the College Board Advanced Placement Program (College Board, 2003).

The College Board, founded in 1900, is a non-profit organization to help students access higher education (College Board, 2017). The original intent of the College Board was to resolve the chaos of admission procedures caused by the increased number of high school graduates who intended to go to college (McCandless, 1967; Stewart & Johanek, 1996). Throughout its history, the College Board has dealt with changes to entrance examinations. The first entrance examinations were written essays geared toward students at elite schools. Later, the College Board developed the Scholastic Aptitude Test (SAT), which helped colleges identify a greater number of qualified students (Stewart &

Johanek, 1996). Following that, the College Board took control of the AP program to resolve testing issues created by the first administration of the exam. The College Board undertook initiatives to streamline the examination scores, decide that exams should be graded holistically, determine reading sites for graders, organize conferences to sell the program to colleges, and create an Advanced Placement Committee (Rothschild, 1999).

The political climate of the 1960s was not conducive to the AP program. It was considered elitist and dominated by suburban white students (Klopfenstein, 2004a; Rothschild, 1999), but some growth occurred as additional courses were added. During the 1970s, many exams changed with the addition of the document-based question. Additionally, schools began offering courses to underclassmen, which increased the number of exams taken (Rothschild, 1999).

A Nation at Risk (U.S. Department of Education, 1983) reported that America's dominance was in danger. Educational leaders determined that society would be improved if school quality was improved, which led to growth of the AP program. Another national report, *High School*, promoted the use of AP to improve education (Boyer, 1983). Other factors led to growth during the 1980s, such as additional courses, promotional advertising by the College Board, school board policy mandates, and state legislature support (Rothschild, 1999).

Support critical to its continued success occurred in the 1990s as teacher fellowships were granted, additional AP courses were added to the program, and more minority participation occurred (Rothschild, 1999). According to Schneider (2009), "Advanced Placement spread rapidly as a result of the competitive nature of US

education" (p. 828). State legislatures began promoting AP programs by requiring high schools to offer AP programs and colleges and universities to accept AP scores for college credit (Rothschild, 1999).

Additional Growth Factors

In recent years, growth in the AP program has been explosive. One reason is that it earned a reputation of academic prestige (Schneider, 2009) as an indicator of a top academic program, and as a feature of the "best" high schools (Gallagher, 2009; Hallett & Venegas, 2011; Morse, 2013). The AP program is described in such a way that students, parents, teachers, and school administrators look on it favorably. Students believe that if they successfully pass an AP test, they will have success in college (Chajewski et al., 2011; Judson & Hobson, 2015; Warne et al., 2015). Additionally, high expectations in the classroom are seen as a hallmark of rigor and high course standards, while hard work and persistence with coursework are viewed as a key to success (Camara et al., 2000; Santoli, 2002; Schneider, 2009; Scott et al., 2010), and rigorous high school courses better prepare students for college work (Santoli, 2002). Also, parents and students often view the AP program as a cost-saving measure by getting ahead in college coursework (Hallett & Venegas, 2011; Judson & Hobson, 2015). Additionally, it is viewed as a method to allow students to get an idea of what is expected of them in college (Willingham & Morris, 1986) and as a way to stand out on college applications (Moller et al., 2013; Wolniak et al., 2016). School administrators tend to look at AP as a benefit to their schools when choosing whether to implement AP courses, but additional factors influencing the decision also play a part in whether courses are added to a

school's curriculum. School leaders should examine student achievement to determine whether students possess the advanced levels of achievement to justify the addition of courses and allocation of important resources (Iatarola et al., 2011). The likelihood of school leaders adding AP courses is high since school quality is judged on the number of AP classes offered in high school rankings by publications such as *Newsweek* and *US News and World Report* (Gallagher, 2009; Sadler, 2010) and administrators look on it favorably.

Benefits of AP

Researchers believe that AP enriches curriculum and motivates students (Curry et al., 1999; Sadler, 2010). Students want to achieve high class rank and grade point average (GPA) scores to bolster their chances of getting into their preferred college program. Students from larger schools who have greater access to AP courses must take a higher number of AP courses to remain competitive in class rank (Klopfenstein & Thomas, 2009). Gifted students seek out AP opportunities for several reasons. Nugent and Karnes (2002) found that the depth and breadth of AP courses appeal to gifted students who need more rigor and challenge. Hertberg-Davis and Callahan (2008) discovered that gifted students enroll because they believe AP courses to be superior to other high school courses. Dougherty et al. (2005) found that gifted students choose AP in order to be with students who are like them, motivated and focused on learning. Shaunessy-Dedrick et al. (2014) discovered that despite the rigorous coursework, gifted students in AP courses form strong bonds of friendship and feel a sense of belonging.

The Achievement Gap and the Potential Benefits of AP

The original goal of the AP program was to target gifted students who showed promise in science and mathematics (Casement, 2003), partly in response to fears that America was falling behind the progress of the Soviet Union during the Cold War in the 1950s. In recent years, the federal government and state legislatures, along with school districts and administrators, have turned their attention to the achievement gap between students who are Black and white and those who are Latinx. According to Ladson-Billings (2006), "one of the most common phrases in today's education literature is 'the achievement gap'" (p. 3), which indicates it is of great concern to educators. The federal government determined that one of the best strategies to close the achievement gap was to offer incentives and to entice a greater number of minority students to enroll in AP (Klopfenstein, 2004b; Klopfenstein & Thomas, 2009; Jeong, 2009; Kyburg et al., 2007; Schneider, 2009). In particular, the federal government began offering incentives to urban and rural schools where AP exam scores for minority students were grim (Judson & Hobson, 2015; Sadler, 2010), with the belief that an AP course would benefit these students, since researchers have found students, in general, benefit from enrolling in an AP course. According to Camara et al. (2000), "increased access to AP exposes students to college level course material, encourages teachers to expand their knowledge domains, lifts curriculum vigor, and allows students to experience academic challenges" (p. 1). Professional development grants from the federal government provided to teachers to improve their teaching and find ways to break down barriers to learning enrich the AP experience for students (Klopfenstein, 2004a). Cook (2013) found that exposure to a

rigorous curriculum in high school is the most important factor in preparing students for college.

Researchers have found that enrolling in AP courses benefits Black and Latinx students in several ways. Klopfenstein (2004b) found the retention rate of low-SES students is improved. In addition, she found that minority students are exposed to a culture of learning. A culture of learning is an expectation of working hard in school, understanding the value of education, and expecting to attend college, or, as Sagy et al. (2018) found, the beliefs, values, and behaviors a person has about learning. Camara et al. (2000) found that minority students are challenged academically in new ways. Klopfenstein (2004b) also found that the additional benefit of mentoring occurs. Camara et al. (2000) discovered that the diversity of students within an AP course adds to the complexity. A more complex environment creates a more robust educational environment.

Barriers Caused by AP

Diversity can strengthen society by allowing for different viewpoints and perspectives, enhancing discussions and broadening horizons. According to Smith and Schonfeld (2000), "increased critical thinking and creativity" occur in a diverse environment (p. 16), but the access and equity policy claims by the College Board do not mirror the experiences of Black and Hispanic student groups (McBride-Davis et al., 2015). Klopfenstein's (2004b) study of Black and Hispanic high school students enrolled in AP courses determined that AP growth is most rapid in predominantly white, non-rural schools and that the AP program is dominated by white, middle-class students living in

suburban areas. Klopfenstein's findings align with Henfield et al. (2008) and Chapman et al. (2014), who found that in majority white suburban schools, the curriculum maintains the social status quo because minority students have unequal access to advanced courses. Hispanic and Black students are underrepresented in the AP program (Clark et al., 2012; Klopfenstein, 2004b; Loveless, 2016; Walker & Pearsall, 2012), and VanSciver (2006) found that AP grouping is practically homogeneous. Witenko et al. (2017) found that Latinx students are underrepresented in AP courses because their schools offer fewer AP classes. However, researchers have found that the lack of minoritized students in AP courses occurs for other reasons as well. Klopfenstein (2004b) found that "urbanicity" affects enrollment in AP courses because a poor attitude toward the value of an education exists. Some students simply choose not to enroll because they are apathetic towards education.

AP and Minoritized Students

The original goal of the AP program was to target math and science achievement, yet when low-SES Black students and Latinx students enroll in AP courses, they tend to avoid math and science (College Board, 2014; Klopfenstein, 2004b). Corra et al. (2011) found that Black students fail to enroll in AP courses due to low teacher expectations, race hostility, deficit thinking, stereotype threat, or lack of motivation to do the work. Other researchers found that the lack of students of color in upper-level courses causes many students to limit their participation in class or they may remove themselves from upper-level programs altogether because they feel a lack of belonging (Carter, 2007;

Henfield et al., 2008). O'Connor et al. (2011) found that gifted Black students disengage and deny their giftedness to gain acceptance from their peers.

Although participation in AP courses is up for Black and Latinx students on the whole, they lag behind white, Asian, and middle-class students (Theokas & Saaris, 2013). Chapman et al. (2014) discovered that Latinx students feel isolated from other peer groups as well. This is congruent with the findings of Walker and Pearsall (2012), who found that a fear of failure and of not fitting in with their peers inhibits Latinx enrollment in AP courses. Walker and Pearsall (2012) also found that Latinx students do not want to give up their home culture and language and want to avoid what is considered disrespectful behavior by outperforming family members. Vela et al. (2013) found that a perceived lack of support from guidance counselors also influenced whether Latinx students enrolled in an AP course. School counselors play a critical role in whether Black and Latinx enroll in advanced coursework (Davis et al., 2013).

In addition to these reasons, tracking programs or bias toward these students prevent them from enrolling in advanced coursework. Multi-cultural student access is often affected by early ability-tracking practices and an overemphasis on standardized achievement (Darity et al., 2001; Walker & Pearsall, 2012). Tracking continues to disproportionately place white students in gifted programs and most who start in one level remain at that level throughout high school (Archibald et al., 2009; Witenko et al., 2017).

There is also concern about AP courses and gender. Stumpf and Stanley (1996) found that a significant gap exists between the number of males and females taking AP

Computer Science and that the percentage of male and female students taking examinations are unbalanced for several subjects. Despite an increase in the overall number of females taking AP exams, according to the College Board (2017), males still heavily outnumber female exam takers in Computer Science, Calculus AB, Calculus BC, and all Physics exams, while females continue to outnumber males in language AP exams, English Language, English Literature, and all Art AP exams.

State and federal mandates enacted to expand the AP program have not been beneficial to minoritized students, who continue to struggle in these courses (Hallett & Venegas, 2011). Students are not prepared for the kind of work expected of them in these advanced courses. Warne et al. (2015) found that many students are not well prepared for the rigor and challenges of AP.

AP and Lack of Rigor

Schools must ensure that students are given a rigorous curriculum so that they are adequately prepared for college. The mere existence of AP programs cannot be assumed to equate to rigor (Hallett & Venegas, 2011; Judson & Hobson, 2015; Santoli, 2002; Solórzano & Ornelas, 2002). Concern exists among researchers that the expansion of AP results in less rigor. According to Thompson and Rust (2007), "if AP courses are diluted, then their impact on college grades may suffer" (p. 420). Lichten (2000) found that while most high school AP teachers are good teachers, they do not have the breadth or depth of knowledge acquired by college faculty or the most relevant and recent content knowledge. These findings concur with Driscoll (2016), who found that many AP teachers are underprepared. Not all AP teachers are suited to teaching advanced courses.

The competence of the AP teacher affects the quality and challenge of the course (Hertberg-Davis & Callahan, 2008). Sadler et al. (as cited in Duco, 2016) state, "the difference in teacher qualifications is significant" (p. 26).

Sadler and Tai (2007) found that other factors were involved, such as SES status, time management, and study skills, and that AP courses in high school might not mean success in college. An increasing number of underprepared students are sitting for AP exams (Judson & Hobson, 2015), but the growth of AP is out of balance with achievement.

Criticisms of AP

The remarkable growth of the AP program is astounding. In 1955, 104 schools participated, with 1,229 students taking 2,199 exams. In 2017, this number grew to 22,169 schools, with 2,741,426 students taking 4,957,931 exams (College Board, 2017). Some argue that a challenging and rigorous education and opportunity to earn a college degree is the right of all students (Klopfenstein, 2004a; Pappano, 2007). Challenging curricula is the factor in lifting each student to reach his or her potential (Adelman, 2006). Educators and school administrators should examine their curricula carefully to ensure that all students are developing the skills and knowledge they need to be successful with rigorous classwork. The achievement gap between whites and Black and Latinx students continues to exist despite efforts to eliminate it, partly through the expansion of the AP program. Despite developing the *AP Equity Policy* (Koch et al., 2013) to encourage increased participation by underrepresented students in AP courses, the College Board (2014) admitted that Blacks and Latinx students do not enroll in AP

even though they exhibit the potential to do well. As Camara et al. (2000) stated, "AP was never meant to be a barrier to access, instead it should serve as an avenue for success" (p. 3).

Despite educational reforms, criticism of the current state of education has continued. Whether it is too much standardized testing or a lack of resources, complaints persist. An achievement gap continues; too many students give up on their education and drop out each year, and there are still too few minority students who are capable of the work enrolled in advanced programs such as IB and AP (Shields, 2011).

Acknowledging power and privilege means understanding that some groups and individuals are given advantages and that power works toward maintaining those privileges, while others are excluded, disadvantaged, and even ostracized (Shields, 2011). Increased student learning and achievement of all students, not just a group of students, should be the concern of educational leaders. According to Capper and Young (2014), educators should make increased student learning and achievement the primary goal of their work. A lack of agreement exists as to whether rigorous coursework provides all students with the skills they need to be college ready. Adelman (2006) found that high school coursework is a predictor of college success. Belfield and Crosta (2012) also found that the total number of honors courses taken is positively related to college GPA. Other researchers have found positive outcomes for students who have taken AP coursework, such as college enrollment (Chajewski et al., 2011), performance in subsequent college coursework (Shaw et al., 2013), and graduation (Dougherty et al., 2005). On the other hand, Geiser and Santelices (2004) found that the number of AP

courses a student took in high school is not significant with GPA or college persistence. Theokas and Saaris (2013) found that the number of students scoring at least a 3 or higher on the AP exam (the minimum score colleges and universities will accept to award college credit) is approximately 20% of exam takers. Duncheon (2018) found that AP writing assignments, especially in AP English, do not align with college expectations for writing. Even students who demonstrate the aptitude to take an AP course fail to enroll (Handwerk et al., 2008). Klopfenstein (2004a) found that the AP incentives in Texas did not significantly close gaps in AP participation by race or SES. Evidence on the effectiveness of AP and honors coursework to adequately prepare students for college is mixed and college readiness is not consistently defined (Woods et al., 2018).

The ACT

The ACT was created to measure instructional college preparatory objectives. The ACT implemented the College Readiness Benchmark scores to provide meaningful feedback to educators and students so that informed decisions could be made regarding course selections to best prepare students for college. As the Benchmark scores are derived from data collected on the first-year performance of college students, they provide a guideline as to whether a high school student has mastered the skills necessary to be successful at a typical college (ACT, 2010). Comparing ACT scores between students who have taken AP courses and those who have not, as well as comparing scores between different ethnic groups, will provide important information to instructional leaders. College and Career Readiness scores are an important part of School Report Card data for South Carolina. Scores on College and Career Readiness assessments (R2W) are

reported, as are the number of students meeting ACT College and Career Readiness Benchmarks. Despite initiatives such as the implementation of the Common Core State Standards and other efforts to adequately prepare students for college success, the lack of readiness is concerning. Public schools need to be prepared to allocate resources to address lack of readiness. AP classes should expose students to content-rich classes, which should equate to greater knowledge and critical thinking skills. This, in turn, should mean higher scores on ACT exams, but students continue to fail to meet the College Readiness Benchmarks. These data will be beneficial to policy makers determining where and how to allocate funds and how to best serve all students.

The ACT Exam

According to Transforming the ACT (n.d.), in the summer of 1959, the American College Testing (ACT) program was founded by Ted McCarrel and E. F. Lindquist, based on the belief that there was a need for a new regional or national test for college-bound high school students that would serve two purposes: first, as a means for admissions, and second, as an indicator of academic preparation. McCarrel and Lindquist believed it should test information that students learned in school. The test also focused on identifying individual student strengths and weaknesses to better assist students in making academic decisions. The test gained popularity and spread across the Midwest. According to the ACT (2020), the majority of post-secondary institutions determine college readiness by using ACT scores. High schools across the nation are looking for ways to improve college readiness among students and believe that preparing students for the ACT through programs like ACT Aspire will help all students be college ready.

However, there is some disagreement about what college readiness means. According to Woods et al. (2018), “there appears to be misalignment between the important skills and knowledge needed in college as compared with high school” (p. 179). Placing so much emphasis on a standardized test score may be detrimental to a student’s perception of his or her capabilities because “individuals who do not get the appropriate score on an exam may be less likely to go to college than those who do” (Foote et al., 2015, p. 40). According to Burris and Murphy (2013), “when a student hears that he or she is not on the road to college readiness, on the basis of a test score, that student—and his or her family—may stop considering college” (p. 65). According to the ACT (2019), 2019 graduates were less ready for college course work than in previous years, and readiness levels in English and math have declined since 2015. Just because a student earns a diploma does not mean he or she is ready for college. Increasing rigor by expanding AP opportunities should prepare students who are ready to face the challenges and mental demands of college level work.

The Ready to Work Exam

The R2W exam is a career readiness assessment administered in order to determine student achievement in three foundational areas: Applied Mathematics, Locating Information, and Reading for Information. In the Applied Mathematics section, questions cover mathematical reasoning and problem-solving skills; in the Locating Information section, students are shown workplace graphics and asked to comprehend and apply their knowledge of these graphics; in the Reading for Information section, students are tested on reading comprehension and reasoning skills. In addition, R2W also

assesses essential soft skills, such as cooperation, negotiation, positive attitude, and critical thinking, which are important to workplace success. These skills are aligned to the Profile of the South Carolina Graduate. The R2W exam provides students with an opportunity to earn an R2W credential, which select employers across the state of South Carolina require for employment. This exam is important for those students who choose to go directly into the workforce rather than pursuing a college degree. Earning a credential demonstrates to potential employers that graduates who choose to enter the workforce instead of higher education are prepared with the most desirable skills for the workforce. This exam is an indication of career readiness and that students graduating with a diploma from South Carolina high schools possess the ability to perform well in the workplace and become productive citizens for the state.

Theoretical Framework

Critical Race Theory is grounded in legal scholarship from the 1970s, which sought to make equal among races all facets of society, especially education. A principle of Critical Race Theory is that racism is a result of unequal institutional dynamics (Savas, 2014) As a result of this inequity, marginalized groups suffer. According to Brayboy (2005), "racism is endemic in society and in education, and racism has become so deeply engrained in society's and schooling's consciousness that it is often invisible" (p. 428). The AP program was created for elite students. In today's schools, educators face ever-increasing demands to raise student achievement. In this age of high-stakes testing, focus on graduation rates, and accountability, the ability to improve classroom instruction and help all learners be college and career ready is at the forefront of education.

The AP program was created for elite students, with little regard for other students. The AP program has continued to expand, creating opportunities for those with resources. Thirty years after the creation of the AP program, only 2,768 Black students took an AP exam (The JBHE Foundation, 2009). In spite of the College Board's attempts to make AP equitable, the program has continued to create barriers to success for Black and Latinx students. Numerous studies have found that white students are more likely to take advanced classes than Black and Latinx students and that minoritized students remain underrepresented in AP classes (Conger et al, 2009; Klopfenstein, 2004b; Lucas & Berends, 2007; Solórzano & Ornelas, 2004; Theokas & Saaris, 2013; Tyson, 2011).

Harris (1995), as cited in Majors (2019), discussed Whiteness as property, a method by which whites use their racial status to enjoy certain privileges, "rights of use and enjoyment, which entitles Whites to actively reap the benefits of unearned privileges linked to their race" (p. 186). This practice persists. There are patterns of injustice in schools (Ryan, 2006). Klugman (2012) found that schools serving privileged groups maintained their advantages by expanding AP participation at greater rates than schools serving different populations. Lucas (2001) found that students of a more privileged background pursue AP classes to maintain inequality. Noguera (2003) found that the social capital of wealthy parents allows them to maintain privilege for their children.

Understanding practices that inhibit educational equity and examining the impact of AP courses on college and career readiness through the Critical Race Theory lens will provide education leaders insight pertaining to issues surrounding inequity. Previous literature has shown that despite rapid growth and expansion and the hope that AP

programs would close the achievement gap, AP programs have not delivered on what they claimed they could do for students, especially minoritized ones. Do the benefits, as claimed by the AP program, such as better college or career preparation, exist for students? Of major concern to all education stakeholders is preparing students for college and/or career. Collecting test score data between white students and non-white minoritized groups and analyzing them to determine whether taking AP courses positively affects student achievement on college and career readiness assessments will assist stakeholders in determining better, more equitable pathways for all students.

CHAPTER THREE

METHODOLOGY

College and university admissions officers use the ACT assessment to measure the readiness of incoming students. Potential employers utilize the R2W assessment to determine career readiness of students planning to enter the workforce. AP coursework is supposed to be the equivalent of taking a college level course; therefore, students who have participated in AP courses should be better prepared for college (that is, college ready), since they have already experienced college level work. In this chapter, I describe the procedures I followed to address the research questions in this quantitative study conducted in a rural school district in South Carolina. This school district was chosen because it represents a typical rural school district in South Carolina. Additionally, this school district offers 21 AP courses to students. AP courses are touted as providing all students with the skills they need to acquire to be ready for college or career. The College Board states that they are "dedicated to promoting excellence and equity in education" (College Board, 2020, para. 1) but a gap remains in the number of AP courses taken between whites and Black and Latinx students. If taking an AP course will better prepare students for college and/or career, then taking AP courses should have an impact on ACT scores or R2W scores.

Purpose of the Study and Research Questions

The purpose of this quantitative study was to examine the composite scores on the ACT test of a rural school district in South Carolina. The ACT scores of the 11th-grade year, 2019–2020, were compared between students who took AP classes and those who

did not. Data were collected to determine how close students came to the College Readiness Benchmark for ACT based on their ACT score and if the number of AP classes affected this score. This study also examined the R2W scores of the 11th-grade year, 2019–2020, and compared them between students who took AP classes and those who did not. Data were collected to determine how close students came to each career readiness level and whether or not taking AP classes affected this score.

The research questions for this quantitative study were created to examine the difference in ACT composite scores in English and math between 11th-grade students participating in AP courses and to examine the difference in R2W scores between 11th-grade students participating in AP courses.

1. Is there a positive relationship between the number of AP courses that a student takes and their score on the ACT?
2. Is there a positive relationship between the number of AP courses that a student takes and their score on R2W?

Instrumentation

The R2W assessment was the instrument used to measure the level of career readiness in the study. The R2W assessment consists of three subject tests and an additional section testing essential soft skills. Students are given all sections of the assessment on the same day. The three subject tests are Applied Mathematics, consisting of mathematical reasoning and problem-solving skills; Locating Information, consisting of comprehension and application of typical workplace graphics; and Reading for Information, which consists of reading comprehension questions and reasoning skills.

The additional section tests soft skills such as setting and achieving goals and negotiation and problem-solving in the workplace. Each student is given 55 minutes to take each section except the soft skills portion of the test, which is 60 minutes long. Each of the three subject tests on the R2W assessment is scored on a scale from 3 to 7. The higher the score, the greater the student's ability to perform complex tasks. There are four certificate levels: Bronze, Silver, Gold, and Platinum. To earn a Bronze certificate, the student must score a minimum of 3 on all three subject tests. For Silver, a minimum score of 4 is required; for Gold, a minimum of 5 is required; and for Platinum, a minimum level of 6 for all subject tests is required. For the essential soft skills, each student will pass or not pass based on the number of total questions answered correctly.

Table 3.1

Ready to Work Assessment: Applied Mathematics Scoring

Level Score	Scale Score
Less than 3	200–219
3	221–229
4	231–237
5	239–249
6	251–263
7	265–270

Table 3.2

Ready to Work Assessment: Locating Information Scoring

Level Score	Scale Score
Less than 3	200–215
3	217–225
4	227–237
5	239
6	240

Table 3.3

Ready to Work Assessment: Reading for Information Scoring

Level Score	Scale Score
Less than 3	200–229
3	231–233
4	235–251
5	253–261
6	263–265
7	267–270

The ACT assessment was the instrument used to measure the level of college readiness in the study. The ACT is divided into four multiple-choice tests: English, mathematics, reading, and science. There is also an optional writing test. The score range for each multiple-choice test is 1–36. The composite score is the average of the four test scores rounded to the nearest number. The ACT has established College Readiness Benchmarks that represent the level of achievement required for students to have a 50% chance of obtaining a B or higher in a corresponding college course.

Table 3.4

ACT Benchmark Score for College Readiness

Subject	ACT Benchmark Score	First Year College Course
English	18	English Composition
Math	22	College Algebra
Reading	22	Social Sciences
Science	23	Biology

Participants

Students classified as 11th-grade students from a rural school district in South Carolina were the test group for this quantitative study. Overall enrollment within the school district was approximately 4,788 students, with the test group of approximately 1,145 11th-grade students.

Table 3.5

Research Questions and Variables

Research Question	Dependent Variable(s)	Independent Variable
Is there a positive relationship between the number of AP courses that a student takes and their score on the ACT?	ACT Composite Score in English ACT Composite Score in Math	AP Class Enrollment
Is there a positive relationship between the number of AP courses that a student takes and their score on R2W?	Ready to Work Score	AP Class Enrollment

Research Procedures and Data Collection

Research Question 1: Is there a positive relationship between the number of AP courses that a student takes and their score on the ACT?

Hypothesis 1: There is a linear relationship between the number of AP courses that a student takes and their score on the ACT.

AP courses are scored on a range of 1–5. Students scoring a 1 or 2 are not deemed qualified. Students scoring a 3 are considered qualified students, earning a C or B in an equivalent college course. Students scoring a 4 are considered very qualified, earning a B or A- in an equivalent college course. Students who score a 5 are considered highly qualified, earning an A or A+ in an equivalent college course. There are 21 AP courses available to students in this school district. In an observational study, a relationship between two or more variables is examined. Using existing quantitative data (AP scores and ACT scores) a relationship between these two variables can be determined. *IBM®SPSS* software statistical tools allowed for a better understanding of the collected data. Descriptive statistics described the data collected (Aldrich & Cunningham, 2016).

Hypothesis 1 (There is a linear relationship between the number of AP courses that a student takes and their score on the ACT) was tested using a One-Way Analysis of Variance (ANOVA). ANOVA assumes that the dependent variable is continuous, while the independent variable is categorical. Given that the dependent variable, *ACT Score*, is continuous, and the independent variable, *AP Course Count*, is categorical, ANOVA was the ideal fit for this analysis.

Research Question 2: Is there a positive relationship between the number of AP courses that a student takes and their score on R2W?

Hypothesis 2: There is a linear relationship between the number of AP courses that a student takes and their score on the R2W assessment.

Hypothesis 2 was tested differently, given the nature of the variables involved. An ANOVA could not be considered because the parameters had changed. We had two variables: *R2W Score* and *AP Course Count*. As previously discussed, *AP Course Count* was a categorical variable. The second variable, *R2W Score*, was also categorical, since the scores were aggregated based on input variables and placed in a bucketed category. Since the analysis involves two categorical variables, I used a Chi-Square test to determine whether the two variables might be related.

There are four assumptions of a statistical model: normality, homogeneity of variances, linearity, and independence. For normality, the assumption is that data have a normal distribution. For homogeneity of variances, the assumption is that all populations from the data have a common variance. For linearity, the assumption is that data have a linear relationship with no outliers. For independence, the assumption is that data are independent. Testing for these four assumptions was performed to show data validity.

Limitations

A limitation of the study was that the entire testing group came from one school district in South Carolina, with an assumption that the sample of students is representative of the general population.

Summary

The general purpose of this study was to further understand factors that inhibit the college and career readiness of students in a rural school district in South Carolina. The study sought to determine if taking AP courses affects college readiness. The degree to which a student was college ready was assessed using ACT scores. The study also sought

to determine if taking AP courses affects career readiness. Career readiness was assessed using R2W scores. Finally, the study also sought to determine if there was a difference in degree of college and career readiness between white students and minoritized students, who may not have had equal access to AP coursework in this particular school district in rural South Carolina. Data gleaned from this study will help reveal disparities that exist among student groups so that school leadership can make informed decisions regarding pathways to success for students in their schools.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

Introduction

This chapter presents the data analyses and interpretation of the quantitative study that sought to determine whether the number of AP courses a student takes has an impact on his or her ACT scores and R2W scores. ACT scores are a leading indicator of college readiness, and R2W scores are a leading indicator of career readiness. The following research questions guided this quantitative study:

1. Is there a positive relationship between the number of AP courses that a student takes and their score on the ACT?
2. Is there a positive relationship between the number of AP courses that a student takes and their score on R2W?

The following hypotheses were formulated based on the research questions:

Hypothesis 1: There is a linear relationship between the number of AP courses that a student takes and their score on the ACT.

Hypothesis 2: There is a linear relationship between the number of AP courses that a student takes and their score on the R2W assessment.

The Data

Eleventh-grade students for the 2019–2020 school year from a rural school district in South Carolina who took AP courses, the ACT, and the R2W exam constituted the test group (population) for this quantitative study.

The AP program consists of 38 college-level courses and exams designed by committees made up of college faculty and experienced AP teachers who ensure that the course and exam reflect college-level expectations. High schools can choose to offer these courses and their corresponding exams that are administered once a year (College Board, 2020). For the purposes of the study, a count of courses taken and whether the student took and sat for the exam was considered.

The ACT is a standardized test consisting of 215 multiple-choice questions. The test is divided into four subsections that cover math, English, reading, and science. The test has a composite score range of 0–36, and each subsection is scored within the same range. The composite score is determined by calculating the average of the four scores. The ACT is administered eight times throughout the school year, including one administration taken during the school day (March 2020 administration).

Ready to Work (R2W) is a career readiness assessment administered to 11th-grade students to determine student achievement in three key subjects: Applied Mathematics, Locating Information, and Reading for Information. The three subject tests on the R2W assessment are scored on a scale from 3 to 7. There are four certificate levels: Bronze, Silver, Gold, and Platinum. To earn a Bronze certificate, the student must score a minimum of 3 on all three subject tests. For Silver, a minimum score of 4 is required; for Gold, a minimum of 5 is required; and for Platinum, a minimum level of 6 for all subject tests is required.

An observation is a record in the data that has certain associated values.

The data arrived anonymized and in such a manner that there was no way to identify individual students. The data comprised a population of interest, which included 909 students. Each student was an observation, a record in the data that had certain associated values, and consisted of the following elements:

- A randomly generated student ID for sorting and organizing purposes
- The student gender
- The student PIP status
- Student race
- The ACT grade level for each year when the test was taken
- Nine possible ACT composite scores (determined by calculating the average of the scores on the four subsections (English, reading, math, and science).
- When the ACT was administered:
    - July 2019
    - September 2019
    - October 2019
    - December 2019
    - February 2020
    - March 2020
    - June 2020
    - July 2020

Any data that did not have a score for each observation were given a code of "0".

- The 2019 R2W score (which only included four scores, so this was not used)

- The 2020 R2W score
- The test scores for 23 potential AP courses:
    - 2-D Art and Design
    - Art History
    - Biology
    - Calculus AB
    - Calculus BC
    - Chemistry
    - Comparative Government and Politics
    - Computer Science Principles
    - Drawing
    - English Language and Composition
    - Environmental Science
    - European History
    - Macroeconomics
    - Music Theory
    - Physics C – Mechanics
    - Physics 1
    - Psychology
    - Seminar
    - Spanish Language and Culture
    - Statistics

- United States Government and Politics
- United States History
- World History: Modern

Any data that did not have a score were given a code of "0".

Data Cleaning and Preparation

The data included 909 students in their 11th-grade year during the 2019–2020 school year from a rural school district in South Carolina.

The first step in the data cleaning and preparation process was to create a variable called "Highest ACT Score," which was the highest potential score of all observations. Any student who did not have a recorded score was left blank. Second, I created a variable called "AP Course Count," which was a count of the number of courses for which an observation had a recorded score, which ranged from 0 to 7. The score on the exam was not considered for the analysis, as this was a study to look at the interval level of courses and that interval's association with performance on the ACT. Third, a coded R2W score was created, which was a count of the number of those with an R2W score, which was simply a means to prepare the code for SPSS. Fourth, following exploratory analysis, which is explained in the following section, several filter codes were created to ensure that the observations with all valid records for each variable of interest were in proper order for running the analysis.

Data Summaries

Table 4.1 is a summary of the count and percentage of the number of ACT scores taken. Note that roughly half (N = 453, or 49.8% of the population of interest) had no

record, which will be considered in the following section. The remainder had one score (N = 404, or 44.4% of the population of interest), two scores (N = 34, or 3.7% of the population of interest), three scores (N = 13, or 1.4% of the population of interest), or four scores (N = 5, or 0.6% of the population of interest). As discussed in the previous section, the highest ACT score was utilized for this analysis, and any observation that did not have a score was given a code of "0". An adjustment to the data will be discussed in a later section.

Table 4.1

Count of ACT Scores

No. of Scores	N	%
None	453	49.8%
One Score	404	44.4%
Two Scores	34	3.7%
Three Scores	13	1.4%
Four Scores	5	0.6%

Table 4.2 is a summary of the count and percentage of the number of R2W scores taken. Note that some (N = 74, or 8.1% of the population of interest) had no score, which will be considered in the following section. The remainder had scores at different levels: Bronze (N = 127, or 14.0% of the population of interest), Silver (N = 463, or 50.9% of the population of interest), Gold (N = 131, or 14.4% of the population of interest), or Platinum (N = 20, or 2.2% of the population of interest). Some scores were missing values (N = 94, or 10.3% of the population of interest). As discussed in the previous

section, any observation that did not have a score was given a code of "0". An adjustment to the data will be discussed in a later section.

Table 4.2

Ready to Work Coded Scores

Certificate Level	N	%
No Score	74	8.1%
Bronze	127	14.0%
Silver	463	50.9%
Gold	131	14.4%
Platinum	20	2.2%
Missing Values	94	10.3%

Table 4.3 is a summary of the count and percentage of the number of AP courses taken. Note that a little over two-thirds (N = 620, or 68.2% of the population of interest) had no courses, which will be considered in the following section. The remainder had one course (N = 129, or 14.2% of the population of interest), two courses (N = 84, or 9.2% of the population of interest), three courses (N = 38, or 4.2% of the population of interest), four courses (N = 19, or 2.1% of the population of interest), five courses (N = 10, or 1.1% of the population of interest), six courses (N = 6, or 0.7% of the population of interest), or seven courses (N = 3, or 0.3% of the population of interest). As discussed in the previous section, the Highest ACT Score was utilized for this analysis, and any observation that did not have a score was given a code of "0". An adjustment to the data will be discussed in a later section.

Table 4.3

Count of AP Courses

No. of Courses	N	%
No Courses	620	68.2%
One Course	129	14.2%
Two Courses	84	9.2%
Three Courses	38	4.2%
Four Courses	19	2.1%
Five Courses	10	1.1%
Six Courses	6	0.7%
Seven Courses	3	0.3%

Table 4.4 contains the 456 observations out of 909 (as seen in Table 4.1) that had an ACT score. The mean ACT score was 20.71 with a standard deviation of 5.89. The minimum score was 10, with a maximum score of 35, for a range of 25.

Table 4.4

Descriptive Statistics

Statistic	N	Range	Minimum	Maximum	Mean	Std. Deviation
Highest ACT	456	25.00	10.00	35.00	20.7171	5.89366
Valid N (listwise)	456					

Figure 4.1 through Figure 4.3 are visual representations of the data of interest.

Figure 4.1

Histogram of the Distribution of ACT Score Counts

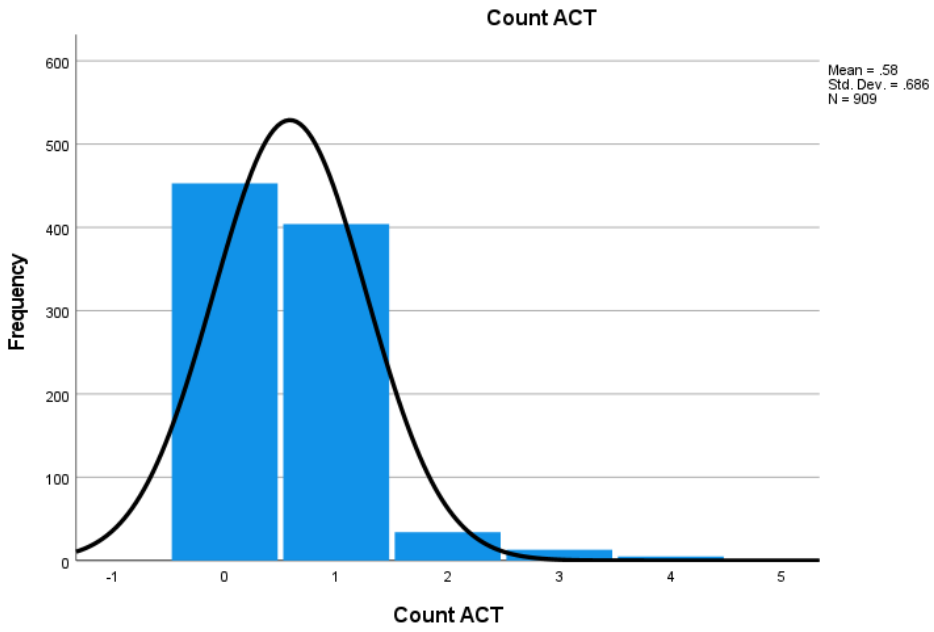


Figure 4.2

Histogram of the Distribution of Ready to Work Coded Scores

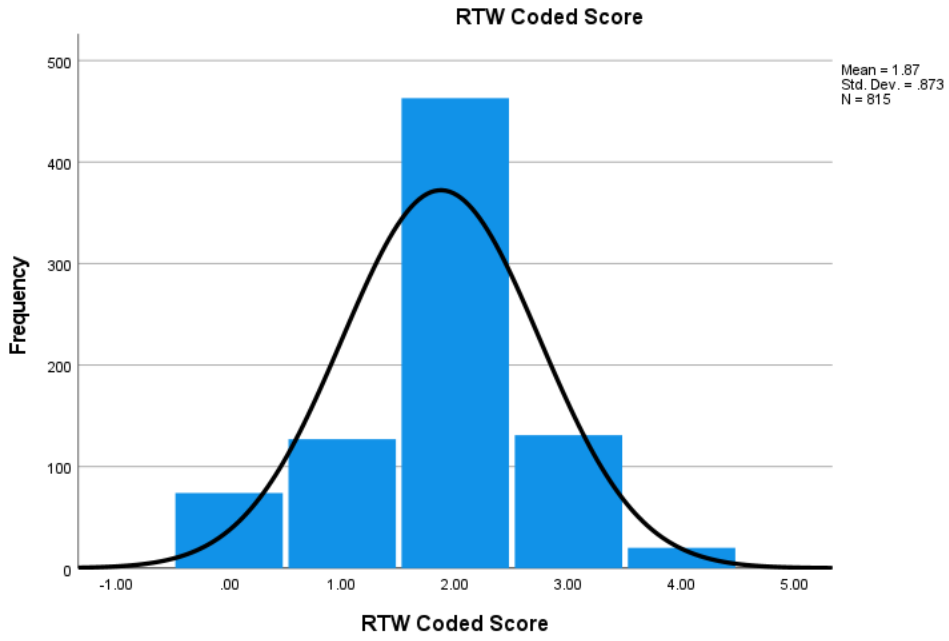
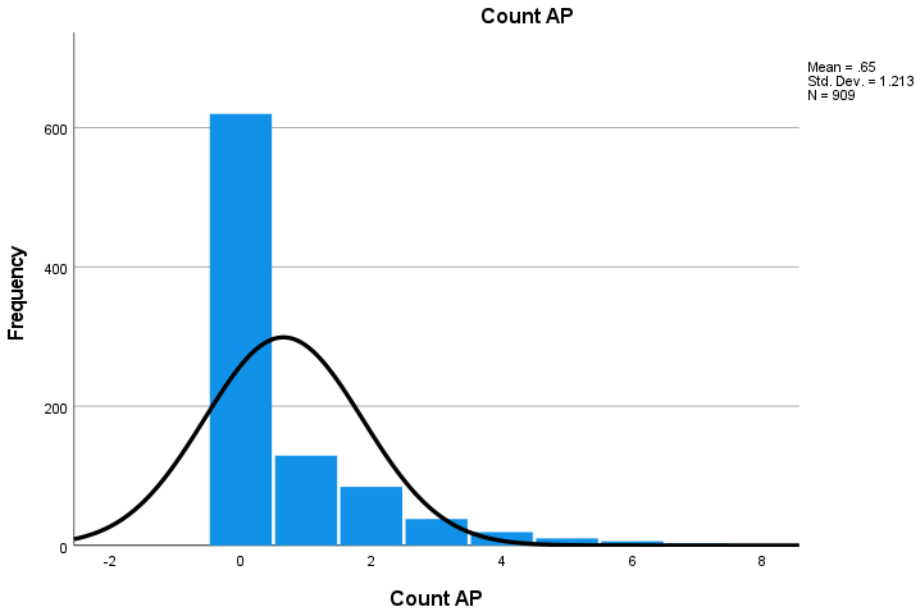


Figure 4.3

Histogram of the Distribution of AP Course Counts



Adjustments to Parameters

Adjustments to the data used are necessary based on the observations that qualify. Table 4.5 is a summary of the count and percentage of the number of ACT scores taken. Note that roughly half (N = 453, or 49.8% of the population of interest) had no record. The remainder had one score (N = 456, or 50.2% of the population of interest).

Table 4.5

Has ACT Score

ACT Score Provided	N	%
No	453	49.8%
Yes	456	50.2%

Table 4.6 is a summary of the count and percentage of the number of R2W scores taken. Note that almost one-fourth (N = 168, or 18.5% of the population of interest) had no record. The remainder had a score (N = 741, or 81.5% of the population of interest).

Table 4.6

Has Ready to Work Score

R2W Score Provided	N	%
No	168	18.5%
Yes	741	81.5%

Table 4.7 is a summary of the count and percentage of the number of AP scores taken. Note that slightly over two-thirds (N = 620, or 68.2% of the population of interest) had no record. The remainder had a score (N = 289, or 31.8% of the population of interest).

Table 4.7

Has AP Score

AP Score Provided	N	%
No	620	68.2%
Yes	289	31.8%

Table 4.1 was used for the first hypothesis test, as it provides an idea of the number of observations. Table 4.8, the crosstabulation, which displays a count of each category for each variable in correspondence, shows that, of the 909 observations, only 197 observations had both an ACT score and an AP score. Therefore, a filter variable was

created so that in the analysis to test Hypothesis 1, only observations that qualified were used, and the data were not skewed due to missing values. The filter variable was called "Filter-all qualifiable AP x ACT." This filter was generated by accounting for all observations where there was both a recorded ACT score and a recorded R2W score.

Table 4.8

Crosstabulation of Counts of Having an AP Score x Having an ACT Score

		Has_ACT_Score		
		No	Yes	Total
Has_AP_Score	No	361	259	620
	Yes	92	197	289
	Total	453	456	909

Table 4.9, a crosstabulation that displays a count of each category for each variable in correspondence, shows that, of the 909 observations, only 245 observations had both an ACT score (which was utilized as a count rather than the score itself) and an R2W score. Therefore, a filter variable was created so that in the analysis to test Hypothesis 2, only observations that qualified were used, and the data were not skewed due to missing values.

Table 4.9

Crosstabulation of Counts of Having a Ready to Work Score x Having an AP Score

		Has_AP_Score		
		No	Yes	Total
Has_R2W_Score	No	124	44	168
	Yes	496	245	741
	Total	620	289	909

There was a low count of observations of ACT counts beyond four courses (only 29 observations had four or more of a qualifiable). It is recommended in many statistical books that a minimum of 20 observations should be used per group to be statistically robust enough for a valid and reliable output (Aldrich & Cunningham, 2016; Casella & Berger, 2002; Field, 2017). In the Statistical Analysis section later in this chapter, I will demonstrate why these were necessary.

Statistical Methods Applied

Table 4.10 and Table 4.11 are discussed under both Hypothesis 1 and Hypothesis 2 in the following subsections.

Table 4.10 is a summary of the count of AP courses taken and mean of the highest ACT scores taken. With no AP courses taken, the highest ACT mean was 18; with one AP course taken, the highest ACT mean was 22; with two AP courses taken, the highest ACT mean was 25; with three AP courses taken, the highest ACT mean was 27; with four AP courses taken, the highest ACT mean was 28; with five AP courses taken, the highest ACT mean was 31; with six AP courses taken, the highest ACT mean was 31; and with seven AP courses taken, the highest ACT mean was 34. Note that it is obvious

that there is a marginal increase at each interval of Count AP (count of AP courses taken).

Table 4.10

Crosstabulation Mean of AP Courses Taken and Highest ACT Scores Taken

	Count AP (Count of AP Courses Taken)							
	No Courses	One Course	Two Courses	Three Courses	Four Courses	Five Courses	Six Courses	Seven Courses
Highest ACT Mean	18	22	25	27	28	31	31	34

Table 4.11 is a summary of the R2W score and mean of the highest ACT scores taken. With a Bronze score, the highest ACT mean is 16; with a Silver score, the highest ACT mean is 23; with a Gold score, the highest ACT mean is 27; and with a Platinum score, the highest ACT mean is 31.

Table 4.11

Crosstabulation Mean of Ready to Work Score and Highest ACT Scores Taken

	R2W Certificate Level			
	Bronze	Silver	Gold	Platinum
Highest ACT Mean	16	23	27	31

For Hypothesis 1

Although it is obvious that there is a marginal increase at each interval of Count AP and R2W, I could not conclude it was statistically significant without performing a formal hypothesis test. We had two variables: *ACT Score* and *AP Course Count*. *AP Course Count* was the independent variable, which was categorical according to the category count of courses taken. Given the need to bin the count, it was safe to assume the count to be categorical rather than continuous.

The key considerations for selecting the method were the number of inputs, the number of outcomes, and the nature of the input and outcome variables. First, on the input, there was one variable, and there were two or more levels. As discussed, the input variable *AP Course Count* was considered categorical, and it had two or more levels. As a result of these considerations, an Analysis of Variance (ANOVA), a statistical test that analyzes the levels of variance within groups of data, was selected.

For Hypothesis 1, as there was a linear relationship between the number of AP courses a student takes and their score on the ACT, an ANOVA (specifically, a One-Way ANOVA) was selected. A One-Way ANOVA compares the effects of an independent variable on dependent variables. A detailed discussion of the One-Way ANOVA, as well as the Tukey HSD post-hoc test, is provided in the Statistical Analysis section.

For Hypothesis 2

Given the nature of Hypothesis 2, an ANOVA could not be conducted because the parameters had changed. We had two variables: *Ready to Work Score* and *AP Course Count*. As previously discussed, *AP Course Count* was categorical. The second variable,

Ready to Work Score, was also categorical, since the scores were aggregated based on input variables and placed in a bucketed category. Since we had a categorical variable and a second categorical variable, a Chi-Square test generated from crosstabulation of the categories was utilized. A Chi-Square test is used to determine whether two variables might be related. A detailed discussion of Chi-Square, as well as the supporting method of the independent z-test, is provided in the Statistical Analysis section.

Statistical Analysis

Hypothesis 1

In order to answer Research Question 1 in empirical fashion, it was necessary to convert the question into a hypothesis and then convert the hypothesis into working hypotheses applied to the method applied.

Hypothesis 1: There is a linear relationship between the number of AP courses that a student takes and their score on the ACT.

To convert the hypothesis into a form that matches the statistical method applied, we first applied the relevant statistical notation. The hypothesis has a null hypothesis and an alternative hypothesis. The null hypothesis loosely suggests that there is nothing going on in the data. The alternative, then, is that there is some phenomenon occurring outside the realm of random chance.

As noted in the Statistical Methods Applied section, Hypothesis 1 was tested using a One-Way ANOVA. ANOVA assumes that the dependent variable is continuous, while the independent variable is categorical. Given that our dependent variable, *ACT*

Score, was continuous, and our independent variable, *AP Course Count*, was categorical, ANOVA was the ideal fit.

The statistical notation of a null and alternative hypothesis works as follows:

- H_0: $\mu 0 = \mu 1 = \mu 2 = \mu 3 = \mu 4 = \mu 5 = \mu 6 = \mu 7$, where μ is the mean score at each level of AP Course Count
- H_a: at least one mean is different

Or, more loosely interpreted:

- Null hypothesis: All means are equal
- Alternative hypothesis: Not all means are equal
- Significance level: $\alpha = 0.05$

ANOVA Test 1. Three One-Way ANOVA models were conducted utilizing IBM's SPSS Software version 27 (IBM Corp., Released 2020). For the first model, the *Highest ACT Score* was tested against the count of AP courses, ranging from 0 to 7, for a total of eight categories. As noted previously in the Data Cleaning and Preparation section, all missing values for ACT scores were filtered out, and only those with a logged ACT test were included.

SPSS runs One-Way ANOVA as a Univariate Analysis of Variance ("univariate" implying "one"); it is a single-variable test. Table 4.12 shows a tabulated count of the count of AP courses. The code on the far left is the numerical code SPSS needs, while the value label is the category corresponding to each code. The N value is the count of observations at each count of AP courses across the population.

Table 4.12

Tabulation of AP Course Counts Taken across Feasible Population

Count AP SPSS Code	Value Label	N
0	No Courses	194
1	One Course	63
2	Two Courses	57
3	Three Courses	24
4	Four Courses	14
5	Five Courses	7
6	Six Courses	5
7	Seven Courses	3

We see that 194 observations had no AP courses; 63 had one course on record, 57 had two courses, and so on. We also see that the last three categories—five courses, six courses, and seven courses—had low base sizes of 7, 5, and 3, respectively.

Table 4.13 displays the Levene's Test of Equality of Variances. The Levene's Test, as noted by IBM, "[t]ests the null hypothesis that the error variance of the dependent variable is equal across groups" (IBM Corp., 2020), utilizing the dependent variable as Highest ACT Score against the Count of AP courses + the Intercept.

Table 4.13

Levene's Test of Equality of Variances for ANOVA Test 1

Highest ACT	Levene's Statistic	df1	df2	Sig.
Based on mean	1.850	7	359	0.077
Based on median	1.750	7	359	0.096
Based on median and with adjusted df	1.750	7	341.512	0.097
Based on trimmed mean	1.839	7	359	0.079

Notes: Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Dependent variable: Highest ACT

b. Design: Intercept + CountAP

Levene's Test is a test for homogeneity of variances and is only relevant when having groups, which we do here. In order to pass the Levene's Test, albeit counterintuitive, we want to fail to reject the null hypothesis. Our Levene's Statistic, based on the mean—the value we used to test—was 1.85. This presented a p-value of 0.077, which was higher than the test value at 95% confidence of 0.05; therefore, we failed to reject the null hypothesis. The conclusion was that we do not violate the assumption of homogeneity, and we can conclude we have equality of variances across groups.

Table 4.14 displays the test of Between-Subject Effects. The One-Way ANOVA utilizes the F-statistic, which explores whether the group statistics, specifically the group means, are significantly differently overall. The key word is overall, which simply tests the null hypothesis that there is no differences across all groups. If there are any differences within the model, the F-statistic, and its corresponding p-value ("Sig." in the table), will reject the null hypothesis.

Table 4.14

Test of Between-Subject Effects for ANOVA Test 1

Dependent Variable					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6588.587[a]	7	941.227	53.696	0.000
Intercept	56540.128	1	56540.128	3225.569	0.000
Count AP	6588.587	7	941.227	53.696	0.000
Error	6292.814	359	17.529		
Total	177597.000	367			
Corrected Total	12881.401	366			

Note: R Squared (R^2) = .511 (Adjusted R Squared = .502).

In Table 4.14, the F-statistic for ANOVA Test 1 is 53.67, which generates a p-value of 0.000. This p-value passes all values of statistical confidence, including our test value statistical level of $\alpha = 0.05$. Given that the p-value of 0.000 is lower than the $\alpha = 0.05$, we can reject the null hypothesis. The conclusion suggests that there are some differences in the model. What the Test of Between-Subjects does not tell us is where these differences are. Therefore, we employed a post-hoc test. Post-hoc, Latin for "after this," is a follow-up test to get deeper into the data.

It is also worth noting that the R^2 value of 0.511 is a measure of how much variance in the data is explained by the model. Translated, an R^2 value of 0.511 means that roughly 51% of all variance about ACT Scores is explained by the model that includes AP Score Count plus its error.

The post-hoc test utilized was the Tukey HSD test, introduced by John Tukey in 1977 (Tukey, 1977). Tukey's HSD is a test of multiple comparisons (Tukey, 1977). In a

multiple comparisons test, we can see where specific mean differences from one category exist, and whether those differences are statistically significant.

Table 4.15 shows the Multiple Comparisons Test utilizing Tukey's HSD. This looks at the Mean Difference (I-J) from one level (I) from another level (J). For example, the mean difference from *No AP Courses* taken to *One Course* taken is -4.49 ACT test points. It is negative because it takes the mean value of *No AP Courses* (I) in the table and subtracts the mean value from *One Course* taken (J), and the mean value of *One Course* taken is larger than those with *No Courses* taken by a value of 4.49 ACT score points. Also reported are the standard error of the mean, the p-value, and the 95% confidence level. Any means difference with an asterisk (*) is marked as statistically significant, meaning the difference in the means of those two values are different at the 95% confidence level.

Working down the ladder in courses, we see that the mean difference of *No Courses* is negative from all other course categories, and each interval value of courses taken is a notch higher. All values are statistically significant, meaning the mean value of *No Courses* is statistically lower than all other values of courses taken. The mean difference of zero courses to one course of 4.5 shows the substantial value difference in those who take AP courses. That difference jumps to 7.5 ACT points at two courses from zero, 9.4 ACT points at three courses from zero and so on.

At one course, we see statistically significant differences across the board as well. A 3-point difference from one to two, a roughly 5-point ACT score difference from one to three, and so on.

Where this pattern changes slightly is at two courses, where there is a statistical difference between no courses as well as one course, but we do not see a statistical difference from two versus three or two versus four. We do not see a difference again until the five-course level from two, where the mean score difference is 5.8 ACT score points. At four courses, a similar pattern occurs, where there are statistical differences at no courses and at one course, but no statistical differences at any other level. At five courses, six courses, and seven courses, we see a statistical difference from two courses, but at no other level.

Table 4.15

Tukey's HSD Test of Multiple Comparisons for ANOVA Test 1

(I) Count AP		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
No Courses	One Course	-4.49*	0.607	0.000	-6.34	-2.64
	Two Courses	-7.54*	0.631	0.000	-9.47	-5.62
	Three Courses	-9.43*	0.906	0.000	-12.20	-6.67
	Four Courses	-10.56*	1.159	0.000	-14.10	-7.03
	Five Courses	-13.35*	1.611	0.000	-18.26	-8.44
	Six Courses	-13.75*	1.896	0.000	-19.53	-7.97
	Seven Courses	-16.02*	2.436	0.000	-23.44	-8.59
One Course	No Courses	4.49*	0.607	0.000	2.64	6.34
	Two Courses	-3.05*	0.765	0.002	-5.38	-0.72
	Three Courses	-4.94*	1.004	0.000	-8.00	-1.88
	Four Courses	-6.07*	1.237	0.000	-9.84	-2.30
	Five Courses	-8.86*	1.668	0.000	-13.94	-3.77
	Six Courses	-9.26*	1.945	0.000	-15.19	-3.33
	Seven Courses	-11.52*	2.474	0.000	-19.07	-3.98
Two Courses	No Courses	7.54*	0.631	0.000	5.62	9.47
	One Course	3.05*	0.765	0.002	0.72	5.38
	Three Courses	-1.89	1.019	0.582	-5.00	1.22
	Four Courses	-3.02	1.249	0.235	-6.83	0.79
	Five Courses	-5.81*	1.677	0.014	-10.92	-0.69
	Six Courses	-6.21*	1.953	0.034	-12.16	-0.25
	Seven Courses	-8.47*	2.480	0.016	-16.03	-0.91

(I) Count AP		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Three Courses	No Courses	9.43*	0.906	0.000	6.67	12.20
	One Course	4.94*	1.004	0.000	1.88	8.00
	Two Courses	1.89	1.019	0.582	-1.22	5.00
	Four Courses	-1.13	1.408	0.993	-5.42	3.16
	Five Courses	-3.92	1.798	0.368	-9.40	1.57
	Six Courses	-4.32	2.058	0.419	-10.59	1.96
	Seven Courses	-6.58	2.564	0.171	-14.40	1.23
Four Courses	No Courses	10.56*	1.159	0.000	7.03	14.10
	One Course	6.07*	1.237	0.000	2.30	9.84
	Two Courses	3.02	1.249	0.235	-0.79	6.83
	Three Courses	1.13	1.408	0.993	-3.16	5.42
	Five Courses	-2.79	1.938	0.839	-8.69	3.12
	Six Courses	-3.19	2.181	0.828	-9.84	3.46
	Seven Courses	-5.45	2.664	0.452	-13.57	2.67
Five Courses	No Courses	13.35*	1.611	0.000	8.44	18.26
	One Course	8.86*	1.668	0.000	3.77	13.94
	Two Courses	5.81*	1.677	0.014	0.69	10.92
	Three Courses	3.92	1.798	0.368	-1.57	9.40
	Four Courses	2.79	1.938	0.839	-3.12	8.69
	Six Courses	-0.40	2.451	1.000	-7.87	7.07
	Seven Courses	-2.67	2.889	0.984	-11.48	6.14
Six Courses	No Courses	13.75*	1.896	0.000	7.97	19.53
	One Course	9.26*	1.945	0.000	3.33	15.19
	Two Courses	6.21*	1.953	0.034	0.25	12.16
	Three Courses	4.32	2.058	0.419	-1.96	10.59

(I) Count AP		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
	Four Courses	3.19	2.181	0.828	-3.46	9.84
	Five Courses	0.40	2.451	1.000	-7.07	7.87
	Seven Courses	-2.27	3.058	0.996	-11.59	7.06
Seven Courses	No Courses	16.02*	2.436	0.000	8.59	23.44
	One Course	11.52*	2.474	0.000	3.98	19.07
	Two Courses	8.47*	2.480	0.016	0.91	16.03
	Three Courses	6.58	2.564	0.171	-1.23	14.40
	Four Courses	5.45	2.664	0.452	-2.67	13.57
	Five Courses	2.67	2.889	0.984	-6.14	11.48
	Six Courses	2.27	3.058	0.996	-7.06	11.59

Notes: Based on observed means.

The error term is Mean Square (Error) = 17.529.

* The mean difference is significant at the .05 level.

These findings seem counterintuitive to what we saw earlier in the mean summary table, Table 4.10, we saw in the Summary Statistics section. We saw earlier that the mean score improves at every marginal level of AP Courses taken, but the base sizes may be influencing the p-values. There is no robustness past three or four courses. Additionally, many texts (Aldrich, 2018; Field, 2017) on statistics note the need for at least 20 observations for a test to be valid; otherwise, a non-parametric method is recommended. Given the remarkably low base sizes for those with five, six, or seven courses being 7, 5, and 3, respectively, it may be best to re-run the model. In doing so, it will likely help to combine those with between four and seven courses, thus making the base for that category equal to 29, a robust enough size within the population of interest to be considered statistically valid.

Additionally, while the model passes the Levene's Test at the alpha = 0.05 level (95% confidence), the p-value would not pass if we were to allow at 90% confidence as a fail-to-reject measure. While we can conclude equality of variances here at 95% confidence, the value is close enough to consider adjusting. It suggests the possibility of more optimized course counts by binning into four-plus courses to make a cleaner model. Therefore, it may be necessary to bin the AP Course count.

It is also worth noting that many scholars of statistics (Fisher, 1992; Pearson, 1900; Tukey, 1977) state that a statistically significant difference does not mean there is an order of magnitude threshold met that makes the difference significant. Instead, it should be interpreted that there is enough evidence that the mean difference is different from zero.

ANOVA Test 2. Three One-Way ANOVA models were conducted utilizing IBM's SPSS Software version 27 (IBM Corp., Released 2020). For the first model, the *Highest ACT Score* was tested against the count of AP courses, ranging from 0 to 7, for a total of eight categories. In the second model, the variable *AP Course Count* was binned from eight categories (count 0 to 7) to five. This variable ranges from zero courses taken to four or more. Like the previous model, all missing values for ACT scores were filtered out, and only those with a logged ACT test were included.

SPSS runs One-Way ANOVA as a Univariate Analysis of Variance ("univariate" implying "one"); it is a single-variable test. Table 4.16 shows a tabulated count of the count of AP courses. The code on the far left is the numerical code SPSS needs, while the value label is the category corresponding to each code. The N value is the count of observations at each count of AP courses across the population. Note that this time around, the counts are different, as four or more courses are binned, meaning they were combined.

Table 4.16

Tabulation of AP Course Counts Taken across Feasible Population, Binned to Five Categories

AP_Binned SPSS Code	Value Label	N
.00	None	194
1.00	One	63
2.00	Two	57
3.00	Three	24
4.00	Four Plus	29

We see again that 194 observations had no AP courses; 63 had one course on record, 57 had two courses, 24 had three courses, and 29 had four or more. We no longer have the base size issues we had in ANOVA Model 1.

Table 4.17 displays the Levene's Test of Equality of Variances for ANOVA Test 2. Our Levene's Statistic, based on the mean—the value we used to test—was 1.236. This presented a p-value of 0.295, which was higher than the test value at 95% confidence of 0.05; therefore, we failed to reject the null hypothesis. The conclusion was that we do not violate the assumption of homogeneity, and we can conclude we have equality of variances across groups. Additionally, as cautioned in the previous model, the p-value would not fail to reject at 90% confidence; therefore, we can feel more comfortable about this model.

Table 4.17

Levene's Test of Equality of Variance for ANOVA Test 2

Highest ACT	Levene's Statistic	df1	df2	Sig.
Based on mean	1.236	4	362	0.295
Based on median	1.027	4	362	0.393
Based on median and with adjusted df	1.027	4	341.075	0.393
Based on trimmed mean	1.201	4	362	0.310

Notes: Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Dependent variable: Highest ACT

b. Design: Intercept + AP_Binned

Table 4.18 displays the test of Between-Subject Effects. Again, the One-Way ANOVA utilizes the F-statistic, which explores whether the group statistics, specifically

the group means, are significantly differently overall. In the model in Table 4.18, we see the same results as the previous model, which is to be expected, given that the differences were observed at categories that were not binned. The F-statistic for ANOVA Test 2 is 53.67, which generates a p-value of 0.000. This p-value passes all values of statistical confidence, including our test value statistical level of $\alpha = 0.05$. Given that the p-value of 0.000 is lower than the $\alpha = 0.05$, we can reject the null hypothesis. The conclusion suggests that there are some differences in the model.

Table 4.18

Test of Between-Subject Effects for ANOVA Test 2

Dependent Variable					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6588.587[a]	7	941.227	53.696	0.000
Intercept	56540.128	1	56540.128	3225.569	0.000
Count AP	6588.587	7	941.227	53.696	0.000
Error	6292.814	359	17.529		
Total	177597.000	367			
Corrected Total	12881.401	366			

Note: [a] R Squared (R^2) = .511 (Adjusted R Squared = .502).

Again, the R^2 value of 0.511 is a measure of how much variance in the data is explained by the model. Translated, an R^2 value of 0.511 means that roughly 51% of all variance about ACT Scores is explained by the model that includes AP Score Count plus its error.

Table 4.19 shows the Multiple Comparisons Test utilizing Tukey's HSD (Tukey, 1977). Again, we have Mean Differences (I-J) from one level (I) to another level (J), as well as the standard error of the mean, the p-value, and the 95% confidence level. Any means difference with an asterisk (*) is marked as statistically significant, meaning the difference in the means of those two values is different at the 95% confidence level. Working back down the ladder, we see the same results for no courses and one course: that there are statistical differences at each level.

Where this pattern changes slightly is at two courses, where there is a statistical difference between no courses as well as one course, but we do not see a statistical difference from two versus three; however, while in the previous model there was no observed difference from two to four, binning to four-plus, we do see differences between two and four-plus courses. And at three, the difference at four-plus is not significant at the 95% confidence level, but is significant at the 90% level. This is still meaningful, given the small group sizes we observe.

Table 4.19

Tukey's HSD Test of Multiple Comparisons for ANOVA Test 2

Dependent Variable						
Tukey HSD						
(I) AP Binned		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
None	One	-4.49*	0.609	0.000	-6.16	-2.82
	Two	-7.54*	0.633	0.000	-9.28	-5.81
	Three	-9.43*	0.909	0.000	-11.93	-6.94
	Four Plus	-12.35*	0.837	0.000	-14.64	-10.06
One	None	4.49*	0.609	0.000	2.82	6.16
	Two	-3.05*	0.768	0.001	-5.16	-0.94
	Three	-4.94*	1.008	0.000	-7.70	-2.18
	Four Plus	-7.86*	0.943	0.000	-10.44	-5.27
Two	None	7.54*	0.633	0.000	5.81	9.28
	One	3.05*	0.768	0.001	0.94	5.16
	Three	-1.89	1.023	0.347	-4.69	0.91
	Four Plus	-4.81*	0.959	0.000	-7.44	-2.18
Three	None	9.43*	0.909	0.000	6.94	11.93
	One	4.94*	1.008	0.000	2.18	7.70
	Two	1.89	1.023	0.347	-0.91	4.69
	Four Plus	-2.92	1.160	0.090	-6.10	0.26
Four Plus	None	12.35*	0.837	0.000	10.06	14.64
	One	7.86*	0.943	0.000	5.27	10.44
	Two	4.81*	0.959	0.000	2.18	7.44
	Three	2.92	1.160	0.090	-0.26	6.10

Notes: Based on observed means.

The error term is Mean Square (Error) = 17.665.

* The mean difference is significant at the .05 level.

We saw earlier that the mean score improves at every marginal level of AP Courses taken, but the base sizes may still be influencing the p-values. There is no

robustness past three or four courses. And it may be improved in the Tukey post-hoc by binning further by rolling up to three-plus courses.

Finally, as a means that bears repeating, many scholars of statistics (Fisher, 1992; Pearson, 1900; Tukey, 1977) state that a statistically significant difference does not mean there is an order of magnitude threshold met that makes the difference significant. Instead, it should be interpreted that there is enough evidence that the mean difference is different from zero.

ANOVA Test 3. As a final reminder, three One-Way ANOVA models were conducted utilizing IBM's SPSS Software version 27 (IBM Corp., Released 2020). For the first model, the *Highest ACT Score* was tested against the count of AP courses, ranging from 0 to 7, for a total of eight categories. In the second model, the variable AP Course Count was binned from eight categories (count 0 to 7) to five. This variable ranges from zero courses taken to four or more. Like the first model, all missing values for ACT scores were filtered out, and only those with a logged ACT test were included. The third and final model, the variable *AP Course Count* was binned from five categories to four, rolling up three-plus courses. Like both of the previous models, all missing values for ACT scores were filtered out, and only those with a logged ACT test were included.

Table 4.20 displays a tabulated count of the count of AP courses. We see again that 194 observations had no AP courses; 63 had one course on record, 57 had two courses, and 53 had three or more. We no longer have the base size issues we had in

ANOVA Model 1, and the base size issues from three to four-plus show improvement in areas as well.

Table 4.20

Tabulation of AP Course Counts Taken across Feasible Population, Binned to Four Categories

AP_Bin_Four_Levels SPSS Code	Value Label	N
.00	None	194
1.00	One	63
2.00	Two	57
3.00	Three	53

Table 4.21 displays the Levene's Test of Equality of Variances for ANOVA Test 3. Our Levene's Statistic, based on the mean—the value we used to test—was 2.42. This presented a p-value of 0.066, which was higher than the test value at 95% confidence of 0.05; therefore, we failed to reject the null hypothesis. The conclusion was that we do not violate the assumption of homogeneity, and we can conclude we have equality of variances across groups. Interestingly, the Levene's Statistic increased when binning to four categories from five, so we may not have a significant improvement. The opposite may be true.

Table 4.21

Levene's Test of Equality of Error Variances for ANOVA Test 3

Highest ACT	Levene's Statistic	df1	df2	Sig.
Based on mean	2.420	3	363	0.066
Based on median	1.485	3	363	0.218
Based on median and with adjusted df	1.485	3	337.945	0.219
Based on trimmed mean	2.192	3	363	0.089

Notes: Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Dependent variable: Highest ACT

b. Design: Intercept + AP_Bin_Four_Levels

Table 4.22 displays the test of Between-Subject Effects. Again, the One-Way ANOVA utilizes the F-statistic, which explores whether the group statistics, specifically the group means, are significantly differently overall. In the model in Table 4.22, we see the same results as the previous model, which is to be expected, given that the differences were observed at categories that were not binned. The F-statistic for ANOVA Test 3 is 118.56, which generates a p-value of 0.000. This p-value passes all values of statistical confidence, including our test value statistical level of $\alpha = 0.05$. Given that the p-value of 0.000 is lower than the $\alpha = 0.05$, we can reject the null hypothesis. The conclusion suggests that there are some differences in the model.

Table 4.22

Test of Between-Subject Effects for ANOVA Test 3

Dependent Variable					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	6375.097[a]	3	2125.032	118.560	0.000
Intercept	########	1	########	8521.436	0.000
AP_Bin_Four_Levels	6375.097	3	2125.032	118.560	0.000
Error	6506.304	363	17.924		
Total	########	367			
Corrected Total	12881.401	366			

Note: [a] R Squared (R^2) = .495 (Adjusted R Squared = .491)

The new R^2 value of 0.495 is a measure of how much variance in the data is explained by the model. Translated, an R^2 value of 0.495 means that roughly 50% of all variance about ACT Scores is explained by the model that includes AP Score Count plus its error.

Table 4.23 is the Multiple Comparisons Test utilizing Tukey's HSD (Tukey, 1977). Again, we have Mean Differences (I-J) from one level (I) to another level (J), as well as the standard error of the mean, the p-value, and the 95% confidence level. Any means difference with an asterisk (*) is marked as statistically significant, meaning the difference in the means of those two values is different at the 95% confidence level.

Working back down the ladder, we see the same results for no courses and one course: that there are statistical differences at each level. And while the previous difference from two to three does not prove significant from the previous model, binning four to seven does show statistical differences.

Table 4.23

Tukey's HSD Test of Multiple Comparisons for ANOVA Test 3

Dependent Variable						
Tukey HSD						
(I) AP_Bin_Four_Levels		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
.00	1.00	-4.49*	0.614	0.000	-6.08	-2.91
	2.00	-7.54*	0.638	0.000	-9.19	-5.90
	3.00	-11.03*	0.656	0.000	-12.72	-9.34
1.00	.00	4.49*	0.614	0.000	2.91	6.08
	2.00	-3.05*	0.774	0.001	-5.05	-1.05
	3.00	-6.54*	0.789	0.000	-8.57	-4.50
2.00	.00	7.54*	0.638	0.000	5.90	9.19
	1.00	3.05*	0.774	0.001	1.05	5.05
	3.00	-3.49*	0.808	0.000	-5.57	-1.40
3.00	.00	11.03*	0.656	0.000	9.34	12.72
	1.00	6.54*	0.789	0.000	4.50	8.57
	2.00	3.49*	0.808	0.000	1.40	5.57

Notes: Based on observed means.

The error term is Mean Square (Error) = 17.924.

* The mean difference is significant at the .05 level.

Finally, as this was somewhat of a thought experiment to the previous test, it was interesting to see if some of the null differences in the previous model look different when binning to four categories instead of five, while still not violating Levene's Test for Equality of Error Variances. While this is a cleaner model in terms of showing statistical differences working up the ladder, it may not be as meaningful when borrowing from the interpretations into practice.

Hypothesis 2

As with Research Question 1, to answer Research Question 2 in empirical fashion, it is necessary to convert the question into a hypothesis and then convert the hypothesis into working hypotheses applied to the method applied.

Hypothesis 2: There is a linear relationship between the number of AP courses that a student takes and their score on the Ready to Work assessment.

To convert the hypothesis into a form that matches the statistical method applied, we first apply the relevant statistical notation. The hypothesis has a null hypothesis and an alternative hypothesis. The null hypothesis loosely suggests that there is nothing going on in the data. The alternative, then, is that there is some phenomenon occurring outside the realm of random chance.

Hypothesis 2 will be tested differently, given the nature of the variables involved. An ANOVA could not be considered because the parameters have changed. We have two variables: *Ready to Work Score* and *AP Course Count*. As discussed previously, *AP Course Count* was categorical. The second variable, *Ready to Work Score*, was also categorial, since the scores were aggregated based on input variables and placed in a bucketed category.

Ready to Work scores come in four categories: Bonze, Silver, Gold, and Platinum. As was stated earlier, these scores are standardized on the backend; thus, their distribution is largely concentrated on Silver.

We tested the hypothesis, in statistical notation, of the following:

- H_0: p0 = p1 = p2 = p3 = p4 = p5, where p is the proportion of Ready to Work scores for each category of AP Course Count
- H_a: H_0 is false

Or, more loosely interpreted:

- Null hypothesis: There is no difference in proportions across all categories of Ready to Work scores for each category of AP Course Count
- Alternative hypothesis: There is some difference present across categories of Ready to Work scores over some category of AP Course Count
- Significance level = $\alpha = 0.05$

Chi-Square and Independent z-tests 1. Since we had a categorical variable and a second categorical variable, a Chi-Square test generated from crosstabulation of the categories was utilized. Table 4.24 is the crosstabulation of Ready to Work score by AP Course Count, first showing the levels of AP courses from 0 to 7.

Table 4.24

Ready to Work x Count AP Crosstabulation at Eight AP Course Levels

R2W Coded Score	Count AP								Total
	No Courses	One Course	Two Courses	Three Courses	Four Courses	Five Courses	Six Courses	Seven Courses	
Bronze	124	2	1	0	0	0	0	0	127
Silver	332	66	43	10	8	1	3	0	463
Gold	38	36	25	16	9	3	2	2	131
Platinum	2	1	7	3	1	4	1	1	20
Total	496	105	76	29	18	8	6	3	741

A total of 741 observations are included in this analysis, a markedly higher count than those used in the previous analysis. The interpretation indicates that, among those with no AP courses (n = 496), 124 received a Bronze R2W score, 332 received Silver, 38 Gold, and 2 Platinum.

A Chi-Square test (Pearson, 1900) is run on the backend of crosstabulation. It utilizes the Pearson Chi-Square value, which is used to convert into p-values, which were utilized in the ANOVA modeling.

Table 4.25

Chi-Square Test of Ready-to-Work by AP Course Count, from Zero to Seven Courses

Measure	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	271.559[a]	21	0.000
Likelihood Ratio	227.465	21	0.000
Linear-by-Linear Association	168.673	1	0.000
N of Valid Cases	741		

Note: [a] 19 cells (59.4%) have an expected count less than 5. The minimum expected count is .08.

Similar to the ANOVA method, the Chi-Square test identifies whether the group statistics are significantly different overall. The difference from ANOVA, which uses means, is that Chi-Square looks at proportional differences. Like ANOVA, Chi-Square simply tests the null hypothesis that there are no differences across all groups. If there are any differences within the model, the Pearson Chi-Square statistic and its corresponding p-value will reject the null hypothesis.

The Chi-Square value here is 271.6, which generates a p-value of 0.000. This p-value passes all values of statistical confidence, including our test value statistical level of $\alpha = 0.05$. Given that the p-value of 0.000 is lower than the $\alpha = 0.05$, we can reject the null hypothesis. The conclusion suggests that there are some differences in the model. Similar to ANOVA, the Chi-Square does not tell us is where these differences are. Therefore, we employed a test within crosstabulation to identify where significant differences exist.

Coming off the backbone of Student's t-test, Salsburg (2002) tells the story of William Gossett, who, at the time he was a consultant for Guinness, published his 1908

Biometrika paper under the pseudonym "Student." This paper (Student, 1908) introduced the Student's t, which later became the z-table under the consideration that the larger the sample size, the closer the t-distribution converged to the z-distribution, as the sample size approaches population.

The independent proportions z-test is utilized as a means of post-hoc testing of proportional differences. Similar to a means test, it determines whether the difference between two proportions are statistically significant at the 95% confidence level. Table 4.26 shows the proportion values, which are simply the count tables from Table 4.24 converted to percentages.

Working from left to right in Table 4.26, we see that 25% of those having no AP courses received a Bronze R2W score. This is significantly higher than those with one course and those with two courses. This value could not be tested against any other values because their corresponding proportions are 0. And among those with no AP courses, 67% received a Silver score, which is significantly different than those who took three, four, and five courses.

Among those taking one course, 69% received a Silver R2W score, which was higher than those who took three or four courses, and 34% received a Gold R2W score, which is statistically different than the 7.7% of those with no AP courses.

Among those taking two courses, 57% received a Silver R2W score, which was statistically different than those taking three courses and those with four, and the 33% value among those with two courses receiving a Gold R2W score is significantly

different than the 7.7% of those with no courses. Finally, 9% were at Platinum level, statistically different than those with zero to one courses, but not those at two.

At three courses, 55% received a Gold R2W score, which was statistically different than those with zero to two courses, and 10% were at Platinum level, statistically different than those with zero to one courses, but not those at two.

As interpretations go down the line, the proportion of Gold by four courses is statistically higher than *only* those with no courses. The same can be said among those at five, six, and seven courses. Yet their proportions at the Gold level are markedly higher than those in lower course categories. This is likely explained by the low base sizes for those from four to seven courses.

The follow-up table, Table 4.27, shows the significant differences. The scripts from A through H are the reference cell. Any inside cell that has a letter means that cell is significantly higher than its corresponding reference cell.

Table 4.26

Crosstabulation of AP Course Count x R2W Score in Proportions

R2W Coded Score	Count AP							
	No Courses	One Course	Two Courses	Three Courses	Four Courses	Five Courses	Six Courses	Seven Courses
	(A)	(B)	I	(I(E)	(F)	(G)	(H)	
No Score	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bronze	25.0%	1.9%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Silver	66.9%	62.9%	56.6%	34.5%	44.4%	12.5%	50.0%	0.0%
Gold	7.7%	34.3%	32.9%	55.2%	50.0%	37.5%	33.3%	66.7%
Platinum	0.4%	1.0%	9.2%	10.3%	5.6%	50.0%	16.7%	33.3%

Table 4.27

Significance Testing of Table 4.26 using Independent z-tests

R2W Coded Score	Count AP							
	No Courses	One Course	Two Courses	Three Courses	Four Courses	Five Courses	Six Courses	Seven Courses
	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
NoScore	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]
Bronze	B C			[a]	[a]	[a]	[a]	[a]
Silver	D E F	D F	D F					[a]
Gold		A	A	A B C	A	A	A	A
Platinum			A B	A B	A	A B C D E	A B	A B

Notes: Results are based on two-sided tests. For each significant pair, the key of the category with the smaller column proportion appears in the category with the larger column proportion.

Significance level for upper case letters (A, B, C): .05

[a] This category is not used in comparisons because its column proportion is equal to 0 or 1.

As previously discussed, a general rule of minimum tests per group is best at 20 observations. Since those at four courses have 18, five courses have 8, six courses have 6, and seven courses have 3, it should be worth running the analysis again, binning the counts to five categories.

Chi-Square and Independent z-tests 2. Again, the Chi-Square test is run, and the same results net. The Chi-Square value of 265 shown in Table 4.28 returns a p-value of 0.000, meaning there are differences in the proportions somewhere. The question becomes, where are the differences?

Table 4.28

Chi-Square Table with AP Course Count Binned to Five Levels

Chi-Square Tests			
Measure	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	265.005[a]	16	0.000
Likelihood Ratio	256.716	16	0.000
Linear-by-Linear Association	169.913	1	0.000
N of Valid Cases	815		

Note: [a] 8 cells (32.0%) have expected counts less than 5. The minimum expected count is .74.

Table 4.29 shows the proportional distributions across the binned categories of AP Course Count by the Ready to Work Score. Their corresponding significance tests are provided in Table 4.30.

Table 4.29

Crosstabulation of R2W Score AP Course Count Binned to Five Levels

R2W Coded Score	AP_Binned				
	None	One	Two	Three	FourPlus
	Column N %	Column N %	Column N %	Column N %	Column N %
Bronze	25.0%	1.9%	1.3%	0.0%	0.0%
Silver	66.9%	62.9%	56.6%	34.5%	34.3%
Gold	7.7%	34.3%	32.9%	55.2%	45.7%
Platinum	0.4%	1.0%	9.2%	10.3%	20.0%

Table 4.30

Significance Testing of Table 4.29 using Independent z-tests

Comparisons of Column Proportions					
R2W Coded Score	AP_Binned				
	None	One	Two	Three	FourPlus
	(A)	(B)	(C)	(D)	(E)
Bronze	B C			[a]	[a]
Silver	D E	D E	D E		
Gold		A	A	A B C	A
Platinum			A B	A B	A B

Notes: Results are based on two-sided tests. For each significant pair, the key of the category with the smaller column proportion appears in the category with the larger column proportion.

Significance level for upper case letters (A, B, C): .05

[a] This category is not used in comparisons because its column proportion is equal to zero or one.

We see some cleaner differences when the AP courses are binned to five categories. First, among those with no AP courses, there is a higher proportion of Bronze than those with one or two courses, and three and four could not be tested because they had no Bronze recipients. This group has a higher proportion of Silver than those with three or four-plus courses. All of these values are statistically significant. It is worth

noting that the proportion of Silver among those with no AP courses shows no significant differences between those with one or two AP courses.

Those with one course have a higher proportion of Silver than those with three or four-plus courses. Also, this group has a higher proportion of Gold than those with no AP courses. These returns are all statistically significant.

Those with two AP courses have a higher proportion of Silver than those with three or four-plus. They have a higher proportion of Gold than those with no AP courses, and a higher proportion of Platinum than those with no or one AP course.

Those with three courses have a significantly higher proportion of Gold than of those with none, one, or two courses, and no significant differences from those with four-plus. They also have a significantly higher proportion of Platinum than those with one or two courses.

Those with four-plus courses have a significantly higher proportion of Gold than those with no AP courses, and a higher proportion of Platinum than those with no AP courses or one AP course. Yet, this proportion is not higher than those with two or three AP courses.

CHAPTER FIVE

FINDINGS AND CONCLUSIONS

The purpose of this quantitative study was to examine the effect of taking AP courses on ACT test scores and the effect of taking AP courses on R2W test scores of a rural school district in South Carolina. Policy makers have sought to expand the AP program in schools, believing that taking an AP course is beneficial, particularly for marginalized groups. They believe enrolling in an AP course will promote educational equity and greater readiness for either college or a career. However, expanding the AP program has failed these groups of students. As Kolluri (2018) stated, "Predominantly White high schools have a long history of inequitable access to classroom rigor for their African American and Latina/o students" (p. 691).

Part of the intent of this study was to determine whether a difference in ACT and R2W scores existed between Black and Latinx students and white students who took the same number of AP courses. The data presented did not allow for this question to be examined; however, the data did provide additional information that led to additional research questions.

The following research questions guided this study:

1. Is there a positive relationship between the number of AP courses that a student takes and their score on the ACT?
2. Is there a positive relationship between the number of AP courses that a student takes and their score on R2W?

3. How many AP courses does a student need to take to have an impact on their ACT score?
4. Is there an optimal level of AP courses a student should take?

This chapter provides a review of what was learned from the statistical analysis and discusses the implications and considerations for practitioners. Additionally, future study ideas are offered, and limitations of the study are discussed.

Hypothesis 1

The first guiding question to this research is, "Is there a positive relationship between the number of AP courses that a student takes and their score on the ACT?"

There is a relationship between the number of AP courses taken and the highest ACT score on record. The mean ACT score at each level of AP courses taken is higher than the previous category. Conducting a One-Way ANOVA test with a Tukey HSD post-hoc test provided the following results by AP Courses Taken category:

- No AP Courses: the mean score is significantly different at every level, with a mean difference higher at each increasing category.
- One AP Course: the mean score is significantly different at every level, with a mean difference higher at each increasing category, and is significantly higher than those taking no AP courses.
- Two AP Courses: the mean score is significantly higher than those taking no AP courses or one AP course; the mean score difference between two and three is *not* statistically significant; the mean score difference between two

courses and four or more courses is significantly different, with a mean score of four plus nearly three points higher than those with two courses.

- Two AP Courses (as shown in Table 5.1): the mean score is significantly different than those taking no AP courses, one course, or two courses; the mean score difference between those taking four courses is only statistically significant at 90% confidence when comparing to those taking three AP courses
- Three AP Courses: the mean score is significantly different than those taking no AP courses or one course; the mean score difference between three courses and two courses is *not* statistically significant; and the mean score difference between those taking three courses is only statistically significant at 90% confidence when comparing to those taking four AP courses.

Table 5.1

Statistical Significance of Mean Differences from Tukey HSD Test

No. of AP Courses	No AP Courses	One AP Course	Two AP Courses	Three AP Courses	Four AP Courses
No AP Courses	-	*	*	*	*
One AP Course	*	-	*	*	*
Two AP Courses	*	*	-	X	*
Three AP Courses	*	*	X	-	**
Four AP Courses	*	*	*	**	-

Notes: * = statistically significant at 95% confidence.

** = Statistically significant at 90% confidence.

X = not statistically significant at 90% confidence or 95% confidence

Even though there are some differences, the trend of the data is linear regarding the increase in count of AP courses. As a result, this discovery offered a third research question—Is there an optimal level of AP courses to take?—because the relationship between AP Course Count and ACT is not perfectly linear, and inflection points change when moving from two courses to three courses, where no significant differences occur. Only 90% confidence differences from three to four or more courses taken are noted. Does this mean that four categories of improvement on the ACT is associated with participation in AP courses?

- Category One: No AP Participation—significantly lower than all categories
- Category Two: One AP Course—significant improvement over no AP (mean difference of 4.5 from No AP), but significantly different from all other values
- Category Three: Two AP Courses—significant improvement over no AP or one AP (mean difference of 7.5 and 3.1 respectively), yet no significant difference until a student gets to four or more courses (mean difference of 4.8), where no difference is observed between two and three courses (mean difference of 1.9)
- Category Four: Four plus Courses—the only definitive way to supplant a score from two courses at a statistically significant level, as three courses does not, yet the difference between three and four or more is only significant at 90% confidence

The data show that taking a single course makes for a significant improvement, but is there an optimal level of AP courses to take? It is clear that *some* participation is

better than none. In simple terms, it seems there are three categories: (1) the participate-nots, (2) the participate-some, and (3) the active participants.

A second question emerges from the data: What is the association between the specific courses and ACT performance? To explore this, one more analysis was performed—taking the top six courses, all having greater than 20 participants, and modeling participation in each course against the highest recorded ACT scores.

Table 5.2 shows the participation overall out of the 367 students with recorded ACT scores, as well as cross-course participation. The base sizes in the table are the number of students participating in each course, and the corresponding numbers are those taking both courses. For example, among the 101 students taking US History, 51 also took English Language and Composition, which is roughly half of all US History students.

Table 5.2

Crosstabulation of ACT Participation by Top Six Courses

	United States History	English Language and Composition	Psychology	Environmental Science	Chemistry	Biology
Base Size:	101	81	52	38	27	25
United States History	-	51	29	15	21	19
English Language and Composition	51	-	17	18	17	20
Psychology	29	17	-	11	10	6
Environmental Science	15	18	11	-	5	9
Chemistry	21	17	10	5	-	11
Biology	19	20	6	9	11	-

Therefore, taking a single AP course makes for a significant improvement. But is there an optimal level of AP courses to take? It is clear that *some* participation is better than none. In simple terms, it seems there are three categories: (1) the participate-nots, (2) the participate-some, and (3) the active participants.

Table 5.3 shows the ACT Score means among those who took each course versus those who did not. All mean differences are statistically significant at the 95% confidence level.

Table 5.3

Mean ACT Scores among Those Participating in the Top Six AP Courses

	United States History		English Language and Composition		Psychology		Environmental Science		Chemistry		Biology	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Highest ACT Mean	19.1	26.7	19.6	26.9	20.4	25.8	20.7	25.1	20.4	30.5	20.6	29.6

Table 5.4 shows the results of a One-Way ANOVA Test, which looks at model differences across the entire data set, as well as whether there are differences in the model explained by the individual course as well as the interaction of courses.

Table 5.4

ANOVA Test of AP Courses Taken x Mean ACT Score

Tests of Between-Subjects Effects					
Dependent Variable: Highest ACT Score					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7419.534[a]	37	200.528	12.079	0.000
Intercept	24423.939	1	24423.939	1471.196	0.000
United States History	115.237	1	115.237	6.941	0.009
English Language and Composition	94.658	1	94.658	5.702	0.018
Psychology	4.596	1	4.596	0.277	0.599
Environmental Science	37.548	1	37.548	2.262	0.134
Chemistry	24.369	1	24.369	1.468	0.227
Biology	53.107	1	53.107	3.199	0.075
United States History * English Language and Composition	13.016	1	13.016	0.784	0.377
United States History * Psychology	1.648	1	1.648	0.099	0.753
United States History * Environmental Science	0.664	1	0.664	0.040	0.842
United States History * Chemistry	2.293	1	2.293	0.138	0.710
United States History * Biology	1.722	1	1.722	0.104	0.748
English Language and Composition * Psychology	20.497	1	20.497	1.235	0.267
English Language and Composition * Environmental Science	10.026	1	10.026	0.604	0.438
English Language and Composition * Chemistry	37.676	1	37.676	2.269	0.133
English Language and Composition * Biology	4.426	1	4.426	0.267	0.606
Psychology * Environmental Science	5.212	1	5.212	0.314	0.576
Psychology * Chemistry	29.523	1	29.523	1.778	0.183
Psychology * Biology	0.207	1	0.207	0.012	0.911
Environmental Science * Chemistry	46.735	1	46.735	2.815	0.094
Environmental Science * Biology	0.075	1	0.075	0.005	0.946
Chemistry * Biology	3.527	1	3.527	0.212	0.645

Note: [a] R-Squared = .576 (Adjusted R-Squared = .528).

As shown by the Corrected Model, we see that the p-value is 0.000, which passes all significance levels, suggesting, as expected, that differences occur between the individual courses and interaction of courses. Yet the only courses that are statistically significant at the 95% confidence level are US History and English Composition. Biology is significant at the 90% confidence level. And, interestingly, the interaction of Environmental Science and Chemistry is also significant at the 90% confidence level.

What this ultimately shows is, while there are differences within the model, they are not best explained by some of the courses, likely because there is not robust enough participation in those courses. The mean difference among those taking AP Chemistry is 10 points, a substantial difference that is statistically significant. However, more is explained in the variance about the data by other courses, where there is more evidence—meaning there is a higher base size and a sizeable mean difference. US History and English Composition are the only courses to pass a 95% confidence check; their mean score differences of 7.6 and 7.4, respectively, reveal a great deal about what is happening overall in AP participation. These two courses have the highest opt-in rate and likely serve as feeders to other courses.

The context of English Language and Composition has a more obvious link to the ACT test. A bulk of the context taught in an English Language and Composition course accounts for two of the four sections on the ACT exam, as well as the optional writing section. Additionally, the English section contains the most questions per time allotted, at one question every 36 seconds, while the Reading section contains one question for every 52.5 seconds. The Math and Science sections allot slightly more time per question.

Therefore, achieving the highest rigor in English courses might best prepare students to perform on such a test.

Why did the AP science courses not have more influence in the model? Likely because of the relationship between the sciences and US History and English Language and Composition. Most students taking Chemistry and Biology courses also participated in US History and English Language and Composition courses.

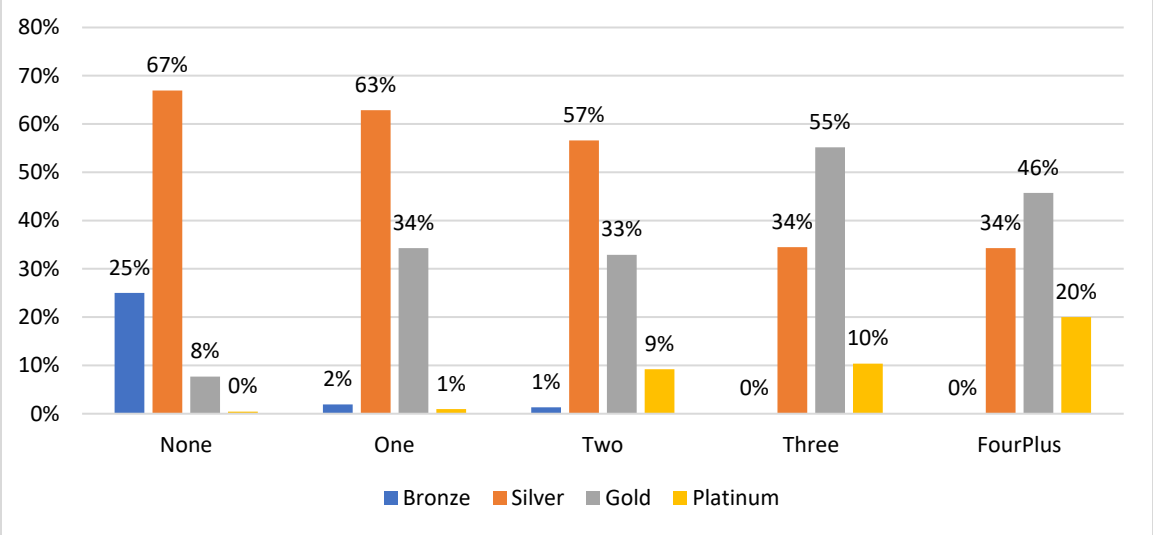
Hypothesis 2

The second question guiding this research is, "Is there a positive relationship between the number of AP courses that a student takes and their score on R2W?" There is clearly a relationship, as the R2W score improves as AP participation moves up the ladder. Is there a similar phenomenon that was observed with ACT scores?

Figure 5.1 is a distribution of R2W scores at each category of AP participation.

Figure 5.1

R2W Score Distribution x AP Participation



The lift from no courses to one course is substantial, because, while the proportion of Silver is the same, the high proportion of Bronze at no courses shifts to a higher proportion of Gold at one course. From one course to two courses, a relatively close distribution exists, but there is a small swing to Platinum, which, while statistically significant, is a mere 8-point swing. So, at no courses to two courses, the proportion of Silver is significantly higher than those at three courses and four plus courses. When students take three courses and four plus courses, their proportion of Gold is significantly higher than taking no courses through two courses. Further, at four courses, there is no movement from three courses. Therefore, here again, essentially three groups exist:

- No Courses—predominantly Silver and Bronze
- One Course and Two Courses—predominantly Silver and Gold
- Three Courses and Four Plus Courses—predominantly Gold, with mix of Silver and Platinum

The same scenario as with ACT exists, in that some participation is better than none, but again, it appears that there are three categories: (1) the participate-nots, (2) the participate-some, and (3) the active participants.

Returning to the same question as posed from Hypothesis 1 relating to course, Table 5.5 is a crosstabulation of each of the top six AP courses in terms of participation and their proportions of scoring at each level of R2W. Highlighted cells denote statistical significance.

Table 5.5

Crosstabulation of AP Courses Participated by R2W Score

R2W Score Level	US History		English Language and Composition		Psychology		Environmental Science		Chemistry		Biology	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Bronze	21%	0%	20%	0%	19%	1%	18%	2%	18%	0%	18%	0%
Silver	66%	49%	66%	40%	63%	62%	63%	47%	64%	39%	64%	24%
Gold	13%	39%	13%	48%	16%	32%	16%	44%	16%	45%	16%	52%
Platinum	0%	12%	1%	13%	2%	5%	2%	7%	2%	15%	2%	24%

It is clear that the greatest improvement comes from four courses: US History, English Language and Composition, Chemistry, and Biology—Biology especially, where 76% of those participating scored Gold or Platinum, while Chemistry and English turned in 60%. This is a favorable return, considering the standardization of the exam scales the test at predominantly Silver at roughly 60%.

Correlation vs. Causation

These results show a correlation. Does this mean there is causation as well? The purpose of this study was to explore the relationship. There is a relationship, and it is clear, but does that imply that AP courses influence ACT scores? This was an observational study, which took data from a population of interest, and observed the behaviors of this cohort of students. The only way to know whether AP courses are a direct influence on an ACT score is an experiment with a test and control group. These groups should be randomly selected and the only observable difference between these students is the dependent variable: the test group participates in AP courses.

To do this would be unethical. Taking a random set of 100 students, and splitting them in half, then giving the advantage to one side would significantly affect the other half. The control group would miss out on the academic rigor brought by AP courses, under the assumption, and supported by literature, that taking AP courses does influence academic growth.

So, what does this leave for options to get closer to causation? This is discussed in the Suggestions for Future Research section.

Implications for Practice

Access to AP courses is inherently important. While it cannot be concluded that AP participation is causing these improvements in ACT scores and R2W scores, it is hard to deny the association between them, notably when considering similar impacts to both tests. These tests are administered differently and have a different set of goals, content, and participants. Yet, the association is relatively close when examining AP course participation.

Much was discussed in Chapter One and Chapter Two about the fact that access to rigorous courses is critical to preparing students for either college or the workplace. While access is critical, there are disparities in who has access. According to findings from this research, participation in AP courses by marginalized students is far from equal. Participation in AP courses by marginalized students was woefully disproportionate. Identifying strategies to increase access to AP coursework to address disparities must be a goal for educators. A good first step toward increasing access may be to eliminate prerequisites. There are many students who are capable of succeeding in AP courses, yet

fail to fulfill their AP potential (Rodriguez & Hernandez-Hamed, 2020) due to not being provided accesss or by choosing not to challenge themselves. Another strategy might be for guidance counselors to encourage students to enroll in an AP course. Discussing the benefits of taking an AP course and giving encouragement and support through the process might be the answer for some marginalized students who may simply lack belief in their ability to do the work.

The AP program fails to meet its mission to provide equity for all students. Educators and school administrators need to examine their curriculum to ensure that the needs of all students are met and that all students can be successful and prepared for the future beyond high school. However, findings from this study show that undertaking an entire AP portfolio might not be needed. Having four AP courses, a "core AP" program with more open access, may be the key. Across a multitude of scholars and scholarly works, from the Bible, to Socrates, and many others alike, moderation may be key. The expenses of building a major AP portfolio may simply serve the highest achievers within a high school. The reality may be that investments into Pre-AP programs to expose students to skills they will need to be successful in future AP courses may prove beneficial to readying students for college or the workplace. Pre-AP programs are designed to build critical thinking skills students will need in AP courses, college, or future careers (College Board, 2022).

Extending this thinking, knowing the high association with *any* participation, beyond simply access, quality should be considered. The quality consideration should be inclusive of a more open audience, as well as having pace. Opening AP course

enrollment to all students and improving access to courses with a challenging curriculum and high expectations ensures that students at all levels are exposed to courses that will help them be successful beyond high school. The goal of any educator should be to provide opportunities for all students. And while this may break the core AP model, having adaptive learning components to courses may prove beneficial. Each student has a unique learning curve; some students may excel, while others may require more slowly paced content.

Suggestions for Further Research

As discussed in an earlier section, this study was an observational study of a single school district in the rural southeastern United States. Simply replicating this study at different school districts within the state may be beneficial to validate the key findings—most notably, that *any* participation is better than none, and that two to three courses may have the greatest lift from the base.

While the data included had AP test scores, there were not enough observations to use to identify how a student takes to the material and its relationship with the ACT and R2W exams. However, if courses were bundled into core areas (e.g., science, mathematics, history, etc.), a score index might be generated to see how scores in those disciplines are associated with the composite score.

Additionally, this research focused on the composite ACT score, for example. The same can be said of the R2W scores. It would be interesting to see how individual courses might be associated with key areas of the ACT or R2W exams. This might be helpful, as many high school students have an idea of their intended major in their

sophomore or junior year. Encouraging these students to take AP courses in an area aligned with their major may prepare them well for their future major. It also may help a student be competitive in college admissions, notably in programs that prioritize specific areas of an exam. For example, a program in nursing may place markedly higher emphasis on the science score on the ACT. Seeing that Biology was a key course associated with success in both exams may prove effective in recommending that students take certain courses.

Finally, one of the key implications of this study concluded that having a deep AP course portfolio might not be the answer when it comes to equity in schools. Conducting this study in schools with a more limited course portfolio versus one with a deep and active portfolio might prove to further validate the idea. The schools should look as similar as possible, perhaps considering locale, school size, and similar distributions in ACT scores and other standardized measures. Such schools might not be easy to find, but again, could prove interesting.

Limitations

There are several limitations of this study. First, there were small base sizes in this population of interest when counting AP courses beyond four. Therefore, there may be biases in the binning of those categories, as I saw mean score differences as the AP Count increased. Additionally, there were also missing values in parts of the data. Some may be due to the difficulty of accurate record keeping over time, system changes, or other data aggregation issues. Additionally, there are lifecycle considerations in play in terms of how students grow in their high school career. Some students take the ACT early in their

high school career, while others may opt to take it later. Those taking it earlier may have achieved a high score prior to enrolling in any AP courses. Others taking the test late may have not achieved their highest score, and still had time to complete another exam.

Second, this is the population of one school district in the southeastern United States. Ideally, this population should be examined as a census, accounting for the entire population of those taking AP courses and recording an ACT score. This, however, might prove timely and has wide sweeping limitations. One such limitation is that many students taking AP courses are not qualified for the ACT due to age.

Third, as noted previously, this is the population of one school district in the southeastern United States. The results of a school district 15 miles away with a similar population in size and participation on both AP courses and the ACT exam may differ. Finding a look-alike school district in another state, in an urban area within the same state, or other considerations may serve to validate some of the findings from this study.

Fourth, online distance education coursework has been available to high school students for a number of years, but the COVID-19 pandemic brought about an increased reliance on virtual learning to deliver instruction to students. Further initiatives to provide AP coursework to students in rural areas to address disparities in access have been implemented (Long et al., 2019), leading to vast differences in how AP coursework content is delivered. Considering that online delivery of AP course content is much different than face-to-face instruction, an impact on AP exam scores and an impact on ACT or R2W exam scores is possible.

Fifth, a popular choice for students looking to earn college credit without having to earn a certain score on an exam is dual enrollment. Community colleges and universities are reaching out to local school districts and offering dual enrollment courses in partnership, believing that it cultivates beneficial relationships between higher education and public K–12 schools (Camp & Walters, 2016). Students taking dual enrollment courses feel they have access to rigorous coursework without the pressure of performing well on a standardized test, which benefits students who may suffer from test anxiety. Increased participation in dual enrollment courses could affect the number of students who take an AP course. Those students who may be capable of enrolling in an AP course may choose to enroll in dual enrollment courses instead. Dual enrollment courses and their potential impact on the ACT exam or R2W exam was not considered as part of this study.

Finally, the population of interest was a single student body within one school district from 2019 through 2020. Of the 409 recorded ACT scores over the eight test dates included in the data, 305 were received from the exam administered on February 8, 2020, more than a month prior to the nationwide lockdown to COVID. It is fair to assume many of the highest recorded scores were achieved prior to COVID. How these findings would look during or post-COVID is worthy of consideration. Recently, the high school class of 2022 recorded the lowest ACT scores in over 30 years (Press, 2022). How this trend fares against AP participation will be necessary to track over time.

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Appendix A

Profile of the South Carolina Graduate

World-Class Knowledge

Rigorous standards in language arts and math for career and college readiness

Multiple languages, science, technology, engineering, mathematics (STEM), arts, and social sciences

World-Class Skills

Creativity and innovation

Critical thinking and problem solving

Collaboration and teamwork

Communication, information, media and technology

Knowing how to learn

Life and Career Characteristics

- Integrity
- Self-Direction
- Global perspective
- Perseverance
- Work ethic
- Interpersonal skills