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Career Technical Education, Academic Achievement, and Behavioral Engagement

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by

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Abstract

Career technical education (CTE) in the 21st century has been a highly visible component of the American public educational framework, with the majority of graduates estimated to have taken at least one CTE course during their time in school. Yet as CTE continues to benefit from atypically broad levels of support in both legislative circles as well as the general public, its association as an educational model with positive results for students remains equivocal in scholarly research. A quantitative research methodology was used to guide the purpose of this study, which was to investigate the relationship between students' exposure to CTE programs and positive academic and behavioral outcomes over the course of four successive graduate cohorts. The research questions were: (a) Do statistically significant differences exist in on-time graduation status between groups of graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses? (b) Do statistically significant differences exist in Composite ACT scores between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses? (c) Do statistically significant differences exist in number of days attended between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses? (d) Do statistically significant differences exist in total incidents of exclusionary discipline between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses? (e) Do statistically significant

differences exist in academic and behavioral variables between groups of high graduates who take varying levels of CTE, while controlling for gender, race, and special population designation? Results from this study revealed that exposure to CTE does associate at a level of statistical significance with positive academic and behavioral outcomes. While the strengths of associations were determined to be relatively low, results were consistent for all four years of data as analyzed. Students who took two or more years of one or more CTE programs (concentrators) were found to have had a significantly higher likelihood of graduating on time, while students who took only the first year of one or more programs (participants) were more likely to demonstrate improved behavioral engagement and achieve a higher composite score on the ACT assessment. The results suggested that CTE programming in a broad context has the potential to serve as an integral part of a comprehensive educational system, being consistently associated with an increased likelihood of positive academic and behavioral outcomes for students. It is recommended that educational practitioners consider how CTE programs can meet the unique academic and behavioral needs of their respective educational systems, relative to the methods and findings surfaced in this study. Furthermore, it is recommended that researchers in this space focus next on how student outcomes relate to CTE exposure at a more granular level, considering program type and quality of implementation. Ultimately, this study serves to shed light on the relationship of CTE exposure to positive student outcomes, highlighting the complexity of measurement while providing a foundation for further inquiry aimed at enhancing educational systems through evidence-based CTE programming.

Dedication

I dedicate this journey to my amazing wife Catherine and my children Sofia, Alex, and Anne-Marie. You have always been my rock and foundation. Without your unending love, patience, and grace this would have never been possible, and without you this would have never been worth it. You are my greatest blessing and I love you all very much.

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CHAPTER ONE: INTRODUCTION

Career and technical education (CTE) can serve as a vital component of any comprehensive educational system, providing high school students in particular with skills and experiences that prepare them for a wide range of high-wage, high-skill, and in-demand career paths. As an educational model, CTE has the power to deliver transformative change on several fronts, not least of all the fulfillment of education's fundamental promise to inspire, empower, and prepare students for their respective futures. But as with any curricular program, having a clear understanding of CTE's observable impacts to students beyond the face of its promise is crucial for those charged with its oversight and implementation. Such knowledge ensures not only a strong assessment of what CTE can offer in return on investment but can also allow for advocacy of this model to be more deeply rooted in a basis of empirical fact. Clarity in this regard can be difficult to achieve, for unlike most other curricula and programs, CTE is both one model and yet many potential subjects, where complexity and variability in programming is par for the course. However, given the extraordinary potential of CTE, as well as its rising profile in both educational and policymaking circles, a closer look into how it precisely relates to positive outcomes for students is warranted, and at depths not previously explored in prevailing research.

The Benefits of CTE

In the United State (U.S.) the benefits of CTE have been widely observed throughout its long iterative history, traced back to the humble roots of apprenticeships that powered the local and regional economies of colonial America. In that era marked by the 17th and 18th centuries, the apprenticeship system served a variety of both economic

and societal purposes. As one historian noted, it was not only a system by which important practical information was passed from one generation to the next, but also a mechanism for the socialization and moralization of youth, as well as a means of social control aimed mainly at the disruptive tendencies of male adolescents (Rorabaugh, 1988). By the mid to late 1800s, this system would fade and largely be replaced by the establishment of various trade and technical schools, benefiting students with both the new or evolving skills needed to engage in an industrializing economy, and an unprecedented level of access for women, minorities, and those who were impoverished (Ogren, 2003). With the onset of *vocational education* in the 20th century and its progression to *career technical education* at the dawn of the 21st, benefits to students would again be marked by skill enhancement and job preparation, as well as the more novel notion that it can positively impact students' broader academic achievement, particularly toward on-time high school graduation. To what degree these benefits contribute to outcomes, however, and who they extend to is an ongoing question where complexity abounds in the prevailing body of research.

The Mixed Findings of CTE Research

As CTE has expanded in scope and profile, so too has the regulatory framework behind it. To be sure, defining and thus clarifying the essential framework behind CTE has been ongoing for over a century, rooted in the originating precepts of the Smith-Hughes Act of 1917. This seminal piece of legislation, also appropriately known as the National Vocational Education Act, the U.S. federal government not only made unprecedented strides to fund the curricular forebears of modern CTE, but it also established a framework to standardize its structure and implementation (Steffes, 2020).

From this point forward the government would continue in the 20th century to double down on its level of investment, while at the same time adding various regulatory features to the system, culminating with passage of the Carl D. Perkins Act of 1984. Currently in its fifth authorization, the Perkins Act was initially established to both promote economic growth as well as specifically improve the access of "special needs populations" and promote gender equity in vocational education (Friedel, 2011). From the start, Perkins was designed to directly measure for positive student outcomes, to the point that as of this writing, states are required to report and demonstrate progress in meeting over a half dozen core indicators of performance measuring CTE students' technical skill, academic achievement, and transition into work or continuing education after high school.

However, despite seemingly progressive moves toward standardization and systems of accountability, scholarly research on CTE's overall effectiveness remains mixed. To illustrate, scholars have noted the "troubled history" of CTE as marked by local control and have remarked that the complexities of implementation have "enabled huge variations in the quality of programs at the high school and community college level (Symonds et al., 2011, p. 28). Additionally, while several studies have found positive associations between CTE and areas such as improved graduation rate (Dougherty, 2016; Bonilla, 2020) and postsecondary transitions (Dougherty et al., 2019; Dougherty, 2023), there are yet other researchers who have found otherwise. For instance, scholars in other studies have expressed concern as to the variable quality of CTE programs, as well as a need for greater nuance in research and policy discussions that frequently reference CTE as monolithic (Symonds et al., 2008; Ecton & Dougherty, 2022). Current scholarship has

also asserted that despite the body of research established to date, there yet remains general disagreement as to the relative merits and drawbacks of CTE at scale (LaForest, 2023). Such lack of consensus is concerning and suggests that, even though CTE may offer intrinsic value as a learning approach, any claim as to its empirical benefits requires continuous assessment at the local level.

The Continued Need for Research

In fiscal year 2023, the U.S. Congress appropriated an estimated $1.4 billion of federal investment into secondary and postsecondary CTE programs, with hundreds of millions more matched by state level contributions (U.S. Department of Education [ED], 2023). As the resourcing of CTE continues to expand, with large swaths of high school students enrolled in courses and programs of study (Luaces et al., 2018; ED, 2019), it is important to continually ground conversations about the associated effects of CTE programs in scholarly research. Such work not only facilitates a more prudent allocation of resources, but can also foster more substantive conversations with the various stakeholders CTE is meant to serve.

Statement of the Problem

Previous research on CTE at the secondary level has focused on outcomes as they relate to student achievement and/or postsecondary transitions. Variables have included on-time graduation rate, standardized assessment performance, and entry into a postsecondary educational program or the labor market (Dortch, 2014; Gray, 2004; Dougherty et al., 2019; Bonilla, 2020, Plank et al., 2005). However, there have been no studies to consider CTE's relationship with positive outcomes for those students who only take a single year of programming, as they typically focus on *concentrator* students

who enroll in two or more years of coursework (Bozick & Dalton, 2013; Dougherty et al., 2019). This brings to question whether CTE associates with improved outcomes for those who only explore CTE in a single year of coursework, rather than through an entire educational experience.

Furthermore, it is to the best of our knowledge that there have been no studies to date examining CTE's association with variables that one may consider as a measurement of student *engagement*, vis a vis attendance and negative behavioral incidents. This too is essential to explore as a statistically significant relationship with these outcomes could indicate CTE's association not only with a higher level of academic performance but also with a tendency to remain in school longer and with fewer major disciplinary issues. The focus on such variables in relation to students who take multiple years of CTE, as well as only one year, constitutes a novel approach and expands the field of study to a much more comprehensive level beyond students who have opted to specialize in CTE programming.

Lastly, the research on CTE's positive influence on outcomes for students has yielded mixed results that are understood to likely be due to numerous factors, including lack of fidelity to programming delivery across the country. Be that as it may, it also underlies a simple need for more research in this regard, especially on educational systems of sufficient scale where *n*-sizes examined could yield more powerful quantitative inferences.

Purpose of the Study

The primary purpose of this study is to explore CTE's association with positive outcomes for high school students as categorized by achievement and behavioral

engagement, at a district-wide level in one of the most populous K-12 systems in the nation. With respect to achievement, the study seeks to determine if there is a statistically significant relationship between exposure to CTE coursework and on-time high school graduation status as well as standardized test performance. This study also seeks to determine if CTE holds a positive association with student behavioral engagement, as defined by rates of attendance and incidents of disciplinary exclusion (e.g., out-of-school suspension). Considering students who take two or more years of coursework (concentrators), as well as those only taking the first year of any given program (participants), the study explores whether access to CTE is related to positive outcomes for either group in comparison to those who took no classes in CTE. Lastly, the study determines if CTE held benefit for students who graduated. This analysis encompasses students from senior cohorts that graduated in four consecutive years (2019, 2020, 2021, and 2022), providing a window into student outcomes both before and during the height of the COVID-19 pandemic.

Methodology

A quantitative research methodology guides the focus and analysis of this study. Specifically, this study relies upon logistic regression, analysis of variance (ANOVA), and multivariate analysis of variance (MANOVA) to examine the relationships among CTE exposure by academic achievement and behavioral engagement as outcome variables. Analysis of variance has historically been used in educational research, along with having been previously applied to explorations of CTE (Rojewski et al., 2012). Rojewski et al.'s (2012) five-year study found that up to one-quarter of all CTE research employed a *t*-test or ANOVA, there are other researchers who have cautioned against an

overuse of these methods where more sophisticated analyses, such as multiple regression, would be better suited (Cohen et al., 2003; Fritz et al., 2012). However, as the independent variable in this case is categorically grouped by students' exposure to CTE coursework, the aimed analyses are deemed appropriate to answer the study's research questions, which are:

1. Do statistically significant differences exist in on-time graduation status between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses?
2. Do statistically significant differences exist in Composite ACT scores between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses?
3. Do statistically significant differences exist in number of days attended between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses?
4. Do statistically significant differences exist in total incidents of exclusionary discipline between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses?

5. Do statistically significant differences exist in academic and behavioral variables between groups of high school graduates who take varying levels of CTE, while controlling for gender, race, and special population designation?

Significance of the Study

This study contributes to the literature in several ways. Firstly, given the variable mix of findings in the research as to CTE's relationship with student achievement, there is inherent value in continuing to explore this avenue of inquiry. Although scholarship on CTE outcomes has been explored, this study focused on one of the most populous school districts in the nation and encompassed the years immediately before, during, and after the COVID-19 pandemic, providing generalizable outcomes for consideration in research and practice. Given the sheer size of the datasets and the analysis of multiple years of data, this study provides a better understanding of how or if CTE at a relatively large scale relates to positive outcomes in student achievement.

In addition, the study focused on CTE's association with student outcomes that serve as a proxy for indicators of behavioral engagement. As educational leaders, policymakers, and classroom teachers continually search for ways to retain students and engage them in prosocial behaviors, the significant findings in this area provide an opportunity for CTE to be seen not only as an educational program but also as a potential lever for intervention to improve high school completion outcomes.

Lastly, this study opens a relatively unexplored line of investigation by not only examining outcomes as they related to students who took multiple years of CTE programs but also to those who took only the first year. This is an important area to consider, as many students in CTE often take only one year of coursework in a given

subject area. Thus, the study provides unique insight into CTE's association with outcomes at both high and low dosages, with implications for practice where significant associations were uncovered especially at the lower end of exposure.

Delimitations

This study was confined to the population of a large public school district located in the western United States, comprised of just over 61,000 students. The sample drawn from this population was delimited to only those secondary students who attended one of the district's 11 comprehensive high schools, excluding its sole career technical academy. Research has demonstrated a marked difference in the achievement and program implementation characteristics of career academy schools (Fletcher et al., 2020; Fletcher & Tan, 2022). Thus, for the purposes of this study, analysis focused on the bulk of CTE programming in a school district as delivered in comprehensive, traditionally structured high schools. All career technical education programs of study as examined were those specifically defined by the local state department of education, with a timeframe of analysis limited to graduate cohorts for the years 2019, 2020, 2021, and 2022. Datasets for statistical analysis were comprised of those released by the school district's Office of Continuous Improvement, with all personally identifiable information redacted prior to attainment.

Limitations

Within the context of this study, there were several limitations to be considered. Firstly, as the quantitative analysis focused on a sampling of student cohorts within the context of a single state and school district, the generalizability of findings to other school systems or the relative merit of career technical education in general is inherently

limited. In terms of timing, though the study focused on several years' worth of cohort data, findings provided more of a snapshot view than a comprehensive longitudinal study. As to the district's context, the state in which it operates has been identified as home to one of the lowest performing educational systems in the United States, with other uniquely endemic risk factors indicating lower rates of access to health care and mental health services, and conversely higher rates of households living in poverty (Annie E. Casey Foundation, 2023). Thus, the relatively limited scope of the study's timing coupled with a compendium of unique communal elements characterized by various challenges may reflect additional factors not captured in the results of this study.

There are further limitations in that, unlike other programs such as special education and English language acquisition, career and technical education is by its nature highly diffuse. In the district that comprised this study's setting, there were approximately 30 different programs under the CTE umbrella taught by almost 100 instructors, ranging from graphic design and computer science to welding technology and culinary arts, each of them underpinned by different learning and performance standards. With such variation, a quantitative study of this scale may be more likely to reveal demographic trends than any associated with actual programming. The study sought to avoid this tendency by controlling for confounding variables, limiting the scope to only programs that were embedded within traditionally structured high schools, and assessing both higher and lower levels of exposure to CTE. However, the quality of instruction across different programs, the type of CTE program, and the overall variation in culture and climate among schools present additional limitations to the results of this study.

Definition of Terms

Behavioral Engagement

For the purposes of this study, behavioral engagement is fundamentally defined as the tendency of a student to attend school and avoid exclusionary discipline measures.

Carl D. Perkins Act

Otherwise referred to as the "Perkins Framework," "Perkins V," or simply "Perkins," the Carl D. Perkins Acts comprise five authorizations of federal legislation underpinning all CTE programming at both the secondary and postsecondary levels in the United States. First passed in the year 1984, the Carl D. Perkins Act was last amended and reauthorized in 2018 as the "Strengthening Career and Technical Education for the 21st Century Act."

Career Technical Academy

Otherwise known as an "area career and technical education school," a career technical academy (CTA) is a "specialized public secondary school used exclusively or principally for the provision of career and technical education to individuals who are available for study in preparation for entering the labor market" (Strengthening Career and Technical Education for the 21st Century Act, 2018).

Career and Technical Education (CTE)

"Organized educational activities that offer a sequence of courses that provides individuals with rigorous academic content and relevant technical knowledge and skills needed to prepare for further education and careers in current or emerging professions, which may include high-skill, high-wage, or in-demand industry sectors or occupations, which shall be, at the secondary level, aligned with the challenging State academic

standards adopted by a State…" (Strengthening Career and Technical Education for the 21st Century Act, 2018).

CTE Concentrator

As defined by the U.S. federal government, "at the secondary level, a student served by an eligible recipient [of federal funding] who has completed at least 2 courses in a single career and technical education program of study" (Strengthening Career and Technical Education for the 21st Century Act, 2018). For the purposes of this study, a concentrator is further defined as a student who only has attempted at least 2 courses of one or more CTE programs, irrespective of outcomes in passing or failing the classes.

CTE Participant

"An individual who completes not less than one course in a career and technical education program or program of study" (Strengthening Career and Technical Education for the 21st Century Act, 2018). For the purposes of this study, a participant is further defined as a student who only has attempted the first year of one or more CTE programs, irrespective of outcomes in passing or failing the class.

Organization of the Study

This study encompasses five chapters. Chapter One introduces the concept of Career and Technical Education (CTE) as an educational model and its place in a comprehensive school system. It provides a brief description of the problem and sets the purpose of the study to explore CTE's association with positive student outcomes using quantitative analysis. Chapter Two presents a review of related literature, focusing on CTE's historical roots, gaps and opportunities in the research, and implications for current educational systems. Chapter Three provides the methodology, detailing the

statistical methods employed and their rationale. Chapter Four outlines the results of the quantitative analyses conducted in relation to the research questions, while Chapter Five focuses on a discussion of the findings, implications for practice, recommendations for further research, and overall conclusions.

CHAPTER TWO: LITERATURE REVIEW

The purpose of this study is to explore CTE's association with positive outcomes for high school students as categorized by achievement and behavioral engagement, at a district-wide level in one of the most populous K-12 systems in the nation. To this end, the literature review in this chapter begins by providing the foundational context of career and technical education in the United States as rooted in its colonial origins and a continual progression of federal investment and regulation. Next, the chapter moves into a discussion of CTE's current iteration and placement within a comprehensive educational model, as well as its potential to serve as a driver of academic and economic empowerment rooted in its legislative aims. Lastly, these aims are examined via CTE's association with positive outcomes for students as verified in research, with gaps and opportunities for further study highlighted.

The Emergence and Evolution of Career and Technical Education in the U.S.

The development of Career and Technical Education (CTE) in the United States can be traced through a series of legislative policies and investments that have evolved significantly over time. From the early roots of "vocational education" in the late 19th and early 20th centuries, to its current iteration, which was clarified in the 1990s and early 2000s, the story of CTE can be marked by several key eras, the first of which reaches back to the nation's roots in the 17th and 18th centuries. Each of these eras is reflective not only of the nation's economic and social development, but also the U.S.'s geopolitical standing, the expanding role of the federal government in public education, and the industrialization of the Western world. And while the level of investment in CTE and its political and academic profile have varied throughout the last several decades, the overall

narrative is one of growing recognition of the field's importance in preparing students in America for a technologically advancing workforce, while meeting the demands of a globalizing economy where accelerated change is the norm.

Apprenticeships and the Colonial Era

The beginnings of vocational education as CTE's most direct precursor are largely marked by the mid- and late 1800s, when the United States and much of the West was marching headlong into the Industrial Revolution. However, a truer reckoning of CTE's origins can be said to predate this time, reaching all the way back to America's colonial beginnings. During this time, the primary focus of higher education for those who could afford it in the colonies was on religious instruction and a broadly-based classical education. However, the apprenticeship system, imported from England, formed the crux of education in most matters practical and technical for a largely agrarian based society. As one author asserted, "not only was apprenticeship of fundamental social and economic importance, as in England, but it was the most fundamental educational institution of the period" (Seybolt, 1917, p. 22). Particularly common in the New England region, most colonial parents apprenticed their children between the ages of seven and fourteen, wherein they would be placed under the supervision and oftentimes the home of a master craftsman to learn a trade and receive at least a basic education (Ogden, 1990). These arrangements were typically marked by contractual agreements negotiated between a child's parent and the apprenticeship master (Dolgin, 1997).

In the latter colonial era, these apprenticeships focused on preparing workers in industries such as textiles, food processing, metalworking, construction, and agriculture (Snyder, 2007). By the nature of the times, there was no large-scale governmental

investment or oversight in what were essentially work arrangements, with one researcher noting "the character of apprenticeship frameworks, in contrast to schools, was both distinct and informal: few were differentiated by age or ability level and there was little emphasis on formal certification and credential conferral" (Benavot, 1983, p. 64). This would all begin to change, however, with American independence and nationhood in the late 18th century, as "the education that apprentices received became more centralized under the growing influence of schools" (Snyder, 2007, p. 71). Investments in these schools and apprenticeships were, however, limited to those of local governments.

Industrialization and Federal Investment

While apprenticeships comprise the fundamental roots of vocational and later career technical education, it is in the 19th century that one can observe a firm entrenchment of industry-and trades-focused academics within schools, not only in the United States but around the world. With the full onset of the Industrial Revolution, "the apprenticeship system that had trained centuries of workers for skilled trades jobs proved no longer viable" (Floyd, 2005, p. 44). For the first time in human history, workers would now be needed to operate complex machines in entirely new work environments known as factories, the establishment of which led to the growth of urban centers both in the United States and Europe. As a result, *manual training schools* were established to meet the demands of longstanding industries beginning to modernize such as textiles and iron processing, as well as emergent industries producing manufactured goods and machinery (Dougherty & Lombardi, 2016; Floyd, 2005).

In this era, investments in education were being led by a new class of industrialists who supported the establishment of trade and technical schools to provide

students with skills both practical and essentially good for business (Floyd, 2005). Prominent examples of these investments included the Hampton Normal and Agricultural Institute (Hampton University, n.d.), the Tuskegee Normal and Industrial Institute (Britannica, 2023), and the Drexel Institute of Art, Science and Industry (Drexel University, 2023). All founded in the latter half of the 19th century, these schools stood apart from the more traditional, liberal arts focus of other contemporary institutions, and signified a broader move in education to more directly addressing economic development needs. At the same time, the U.S. federal government was taking its first major strides into funding a more practical, skill-based education with the establishment of the Morill Act, also known as the Land-Grant College Act of 1862.

Introduced by its namesake Representative Justin Smith Morrill of Vermont and signed into law by none other than Abraham Lincoln, the act committed the federal government to granting each state in the Union 30,000 acres of public land to be used in establishment of colleges “to benefit the agricultural and mechanical arts” (U.S. Senate, n.d.). Thusly known as *land grant institutions*, the schools established from these investments would serve as the first publicly funded providers of vocational education on a comparatively massive scale, with notable products of the legislation including Kansas State (Kansas State University, 2023), Purdue (Purdue University, 2023), and of course the University of Nevada, Reno (University of Nevada, 2023). Both the original act and the second Morill Act of 1890 resulted in the designation of over 100 land-grant institutions, marking a seminal moment in CTE’s history and that of American higher education.

While the Morill Act typically represents a watershed moment in federal involvement in education, the inherent nature of the law also affected how states uniquely exercised their power to invest in technical training and education in general. For example, as states in the southern region of the U.S. at the time were primarily focused on Reconstruction in the wake of the civil war, investments in education were slower to accrue, while other states leveraged the Morrill Act to support existing institutions such as the College of California (later redesignated as the University of California, Berkely), and the Farmers' High School of Pennsylvania (later named Pennsylvania State University). Nonetheless, all states in the Union would eventually exercise the power and prerogative granted by the Morill Act, with the law standing as an illustrative blend of federal and state investment in the precursive iterations of CTE.

It is important to recall, however, that these developments as outlined pertained primarily to adult education. Curricula in secondary schools for most of the 1800s was still largely rooted in the liberal arts, with one author lamenting "the program of the typical American secondary school was until well after the turn of the [20th] century narrowly bookish and academic" (Espy, 1939, p. 276). It was not until the late 1800s that the landscape of secondary education would shift to incorporate more of the skill-based subjects taking root in postsecondary schools, most notably with the founding of the Manual Training School of Washington University in 1879. As an extension of the university, the school was opened as the first "manual-training high school" founded on the conviction at the time that "the interests of St. Louis demand for young men a system of education which shall fit them for the actual duties of life in a more direct and positive manner than is done in the ordinary American school" (Bennett, 1937, p. 348). This first

experiment at the high school level, coupling manual training with academic studies rather than replacing them outright, would become the template from which vocational education would emerge in the 1900s (Dye, 1974; Floyd, 2005; Coates, 1923).

Vocational Education and the Move to CTE

As the most direct forebear of CTE, vocational education in the United States is widely marked as beginning with the Smith-Hughes Act of 1917, however there were several developments around the turn of the century leading up to passage of the landmark bill. For one, prominent voices in industry and organized labor began to more openly critique an American public schooling system that was increasingly seen as entrenched in academic subjects and preparation for college to the exclusion or outright derision of other more practical fields of study (Krug, 1964). At the same time, American society in general was undergoing several related transitions marked by a large influx of students into urban schools (Provasnik, 1999), coupled with major reductions in employed youth who had been replaced by new technologies rendering their unskilled labor obsolete (Troen, 1976). It is in this context, and the years ensuing the 1906 publication of a seminal report from the *Douglas Commission* calling for a publicly funded vocational school system, that the Smith-Hughes Act would be passed and implemented (Wirth, 1972).

So known for its co-sponsoring lawmakers Senator Hoke Smith and Representative Dudley Hughes both of Georgia, the Smith-Hughes Act is also appropriately known as the National Vocational Education Act and stands as the most direct origin of modern career technical education and federal investment for several reasons. Firstly, the law provided a substantial level of federal funding to be used in

direct support of vocational education at the secondary or precollegiate level (Steffes, 2020). Secondly, the Act established a new Federal Board of Vocational Education tasked with setting clear policy and criteria for the approval and distribution of funds, while at the same time clearly defining a vocational education program (Steffes, 2020). Thirdly, the newly created Board served as an official promotional and advisory arm of the federal government, both marketing the positive potential of vocational education as well as providing counsel on policy changes to foster continuous improvement in this field of education (Steffes, 2020).

From this point, the scope of vocational education and funding support would progress incrementally with passage of the George Acts from 1929 through 1946, and the National Defense Education Act (NDEA) of 1958 (Friedel, 2011). The former set of laws would progressively increase both funding as well as the number of subjects that could qualify as *vocational* (Barrett, 1948; Friedel, 2011), with the latter act providing the first federally backed, low-cost student loans as a means of mobilizing American education to maintain technological parity with the Soviet Union (U.S. House of Representatives, n.d.). Though this move was primarily aimed at colleges and universities, the NDEA is a significant waypoint in CTE's evolutionary history as it represented federal endorsement of highly technical, career-focused educational pathways in maintaining national security (Urban, 2010).

In the 1960s, the federal government essentially doubled down on prior investments with passage of the Vocational Education Act of 1963. At its core, the law dramatically increased the level of federal funding available to state-based vocational programs, an approximate threefold increase compared to the George-Barden legislation

of the 1940s (Dugger, 1965). In addition, the Act again broadened the scope of what educational programs could qualify as vocational and in turn receive funding, programs such as those related to business, health sciences, and home economics. More importantly, and in line with broader civil rights reforms of the era, the law was the first move to shift legislative focus "from maintaining strong vocational programs to programs that served different groups of students" (Scott & Sarkees-Wircenski, 2004, p. 73). In its first passage and several amended follow-ons, the act significantly expanded access to vocational education by charging states with "the responsibility of providing special programs for persons who have academic, socio-economic, or other handicaps that prevent them from succeeding in the regular vocational education programs" (Faulkner, 1968, p. 57). This new and enduring focus on access to programs, in addition to regulating their quality, would continue into the next phase of CTE's history and remain a cornerstone of its framework in the 21st century.

Marking the outset of the federal government's current era of investment and expansion, the Carl D. Perkins Vocational and Technical Education Act was signed into law in 1984, named after the social reforming congressman from Kentucky (Carl D. Perkins Act, 1984). As an iterative extension of the Vocational Education Act, "the Perkins Act was intended to address the needs of both the economy and to improve the access of special needs populations to vocational education" (Friedel, 2011, p. 42). Moreover, its purposes were to "expand, improve, modernize, and develop quality vocational education programs in order to meet the needs of the nation's existing and future workforce for marketable skills, and to improve productivity and promote economic growth" (Scott & Sarkees-Wircenski, 2004, p. 444). To achieve this, Perkins

continued to require matched funding from states while providing them with greater flexibility in deploying resources to better meet the needs of local and regional economies. Over the last few decades, the law has received several reauthorizations, most notable among them the passage of Perkins IV in 2006 wherein "vocational education" was officially retired and replaced by the modern moniker of "career and technical education" (Friedel, 2011).

In summary, one can observe how the history of federal and state investments in CTE has continually progressed over time, and in several ways parallels the emergence of the American public education system. From rudimentary origins in the 18th century as apprenticeships, to the manual training schools of the late 1800s, the nascent beginnings of vocational education were marked by a combination of philanthropic investments and allocations of land by the U.S. government. By the early 20th century, the Industrial Revolution had fully given way to the modern era, during which various technological and economic advancements necessitated an American work force with the skills and knowledge necessary to transition from an agrarian-based society to one built on commerce and consumerism. To meet this need, the federal government enacted the Smith-Hughes Act of 1917, the first major foray into both funding and defining vocational education, while at the same time binding all the states into this expansion by way of requiring matched investments. From this point forward, subsequent laws such as the George Acts, the Vocational Education Act of 1963, and the seminal Perkins Acts would only further the federal government's support and regulatory footprint, to the point that career and technical education in its current iteration comprises a pivotal component of the national educational system, receiving over $1.5 billion in federal funds annually.

The Promise and Importance of Career and Technical Education

CTE can serve as a vital component of any comprehensive educational system, providing high school students with skills and experiences that prepare them for a wide range of high-wage, high-skill, and in-demand career paths. As an educational model, CTE has the power to deliver transformative change on several fronts, not least of all the fulfillment of education's fundamental promise to inspire, engage, and prepare students for their respective futures. As legislative revisions have pushed more of a focus on accessibility and integration with core academic subjects such as mathematics, science, and English language arts, CTE has evolved from a niche of skill training and job preparation to provide more comprehensive educational programming with rigorous accountability measures. From an economic perspective, CTE likewise holds the potential of empowering students with the ability to explore, prepare for, and directly enter various career fields upon completing their respective paths of schooling. Understanding this potential, and the value proposition of CTE from an educational and economic standpoint is vital for practitioners and policymakers alike, as well as researchers attempting to verify if and how it is meeting its essential objectives.

CTE as an Educational Model

In considering its placement as an educational model, it is worth recognizing the ancestral ties of CTE as interwoven with American public education in general dating back to the 18th and 19th centuries. As a counterpoint to the more traditional forms of education as rooted in the liberal arts, technical training in one form or another has been a part of the American educational landscape from the start. While this positioning has provided educational options to students focused more on occupational skills and job

preparation, it has also contributed to a long-held stigma associating CTE and its forbears with lower academic rigor and low-paying jobs (Fletcher, 2012). That vocational education has been historically regarded as alternative to a more traditional and thus superior educational regimen is no secret, nor is recognition of the social stigma that can often relegate CTE to a perception as the *othe*r in education (Fletcher et al., 2014).

However, as one group of researchers note, "CTE has gone through major transformations in the United States, shifting its function from preparing students for the workforce to preparing students for postsecondary and career success" (Xing et al., 2020, p. 53). Such transformations can be readily observed and tracked through successive iterations of the Perkins legislation, notably in the law's fourth authorization passed in 2006. Reflecting broader trends of educational reform rooted in No Child Left Behind (NCLB), "the major themes of Perkins IV reflect the NCLB emphasis on increased rigor and student achievement through standards and assessment; integration of academics and technical education; alignment of high school curriculum with post-secondary programs; and, increased accountability" (Friedel, 2011, p. 49). The fifth and current authorization of the law would extend these themes, while placing the highest emphasis yet on supporting students transitioning to postsecondary education and doubling down on the call to rigor with CTE programs charged to support academic knowledge, higher-order reasoning, and problem-solving skills (Strengthening Career and Technical Education for the 21st Century Act, 2018).

Another key aspect to observe is the focus of CTE on providing equitable access and opportunity for students hailing from historically underserved, underrepresented, and underprivileged populations. That vocational education has provided a historical lifeline

of learning and economic opportunity to those who would have otherwise been marginalized in American society is well-understood and appreciated. However, where this promise was once only implied by the nature of what the field could offer as a counterpoint to educational tracks based more in the liberal arts, various legislative reforms occurred over the 20th century to convert this promise of equitable outcomes into a federally backed mandate, including the first seminal Perkins Act passed in 1984. From that first law's call to ensure "individuals who are inadequately served under vocational education programs are assured access" (Carl D. Perkins Vocational Education Act, 1984, para. xx), to the current act's requirements for states to report on how students from special populations are being served and achieving (Strengthening Career and Technical Education for the 21st Century Act, 2018), there can be little doubt as to CTE's earnest commitment to equity as an educational framework.

CTE as a Lever of Economic Empowerment

To emphasize the importance of preparing students for the highly skilled and often technological demands of the 21st century workplace, the law's 2006 authorization took the pivotal step of transitioning to the nomenclature of "career and technical education" (Friedel, 2011). While this focus on the utility of CTE as a means of job preparation is certainly nothing new, how education in general relates to career readiness is a relatively recent question. Born of the No Child Left Behind reforms of the early 2000s and further embodied in the Every Student Succeeds Act passed in 2015, the *college and career readiness movement* has oriented public education in the U.S. to not only concern itself with students' academic achievement, but also their preparation for careers and occupations (Bartholomew et al., 2015). As Dougherty et al. noted, "the

current focus on college and career readiness (CCR) in education policy emphasizes utilitarian elements of education and the need for learning to relate to the world of work" (2016, pp. 326-327).

As part of a broader college and career readiness framework, CTE in a secondary context can provide several benefits dependent upon the format in which it is implemented. In a career academy model, where career technical programming forms the basis of a school's instructional focus, CTE can support college and career readiness through a high-level integration of technical skills with core academics (Pierce & Hernandez, 2014), industry-based curriculum review (Fletcher et al., 2020), and a systematic focus on work-based learning (Fletcher & Tan, 2022). Though these academies represent a fully comprehensive model of implem1entation, CTE programs can also provide college and career readiness benefits as embedded in a more typical high school setting. Aside from their innate focus on skill development and job preparation, research has also revealed that students who take CTE courses as part of a traditional secondary course of study are more likely to graduate high school, enroll in postsecondary education, and be attain employment at a higher wage level immediately after graduation (Dougherty, 2016; Plank et al., 2005).

Research and Findings on Career and Technical Education

As a subject of research, career and technical education forms a highly compelling study case, with an annual federal budget of over $1 billion (U.S. Department of Education, 2023) and an enrollment of high school concentrators estimated at over 2.8 million students (U.S. Department of Education, n.d.). Yet while several research studies on the value of CTE's vocational education precursor were conducted in the 20th century

(Bowlby & Schriver, 1973; Trost & Lee, 1984; Catterall & Stern, 1986; Hotchkiss, 1993), the bulk of literature on this field and its relation to student outcomes has been produced in the last several decades. There are several reasons for this evaluative expansion, including enhanced accountability measures in Perkins IV and V (Friedel, 2011; Dougherty et al., 2021), broad political interest (Plasman et al., 2017), and the increasingly technical nature of work necessitating specialized educational programming (Rojewski, 2022). In the literature one can find a range of analyses and conclusions as to CTE's general benefit, with notable trends in studied variables, research needs, and implications for further study highlighted below.

Examined Variables

Variables in the literature that tend to be associated with secondary CTE outcomes are primarily quantitative in nature, with CTE coursework generally handled as the independent treatment. As most research in this space is focused on groups of CTE *concentrators* as defined in the Perkins legislation, the commonly examined level of CTE exposure is two years or more of coursework in a program of study (Dougherty et al., 2021). As such, research on CTE outcomes almost exclusively begins with the variable of CTE coursework, constructed as either the number of courses taken (Agodini & Deke, 2004), the ratio of CTE to non-CTE coursework (Bishop & Mane, 2004), attendance at a CTE school (Brunner et al., 2023), or more typically status as a CTE concentrator (Bozick & Dalton, 2013; Dougherty et al., 2019). In addition, many studies leverage variables such as gender, race and ethnicity, and special population designation as control variables and in outlining descriptive statistics to help set the scene for deeper analysis. Owing to ethical constraints and the complexities of educational programming, studies on

CTE are almost exclusively non-experimental, and examine variables for descriptive and inferential analyses to answer research questions typically across several core topics. While these topics often intermix, the overarching theme is to examine the overall effectiveness of CTE programs, namely in bolstering academic achievement at the secondary level as well as positive postsecondary outcomes.

Academic achievement has been analyzed through variables such as graduation rate, dropout rate, credit accumulation, and standardized test performance at state and national levels (Blowe & Price, 2012; Michaels & Barone, 2020; Neild et al., 2015). In a unique case, participation in career and technical coursework was also examined in relation to the variable of simultaneous enrollment in advanced mathematics and science courses (Aliaga et al., 2014). Meanwhile, positive postsecondary outcomes have largely been framed as either entry into a postsecondary educational pathway or the labor market, with studies at times examining one category in isolation or both in tandem. In outcomes pertaining to postsecondary education, variables have included initial postgraduate enrollment in 2- or 4-year institutions, as well as rates of graduation (Deluca et al., 2005; Dougherty, 2023; LaForest, 2023). Whereas regarding labor outcomes, variables have been typically comprised of initial employment status and average quarterly earnings (Dougherty, 2016; Dougherty et al., 2019; LaForest, 2023).

In addition to academic and postsecondary outcomes, equity research on CTE has also focused on accessibility to programs and qualitative experience. For example, in a 2016 study, researchers sought to surface the benefits of CTE for students with disabilities by again analyzing factors related to academic and postsecondary outcomes, in addition to sociodemographic variables that included parental education level,

combined family income, and disability indicators measuring functional cognitive skills (Wagner et al., 2016). In a similarly focused study, one researcher examined educator behaviors utilizing a survey-based assessment to measure CTE teachers' implementation of instructional standards developed by the Center for Research on Education, Diversity, and Excellence (Dyar, 2018). Other variables for analysis included teacher generational influence, years of teaching experience, CTE "program area," and geographic location.

In summary, there is a typical set of variables utilized in the research to evaluate the outcomes of secondary career and technical education programming. Most of these directly parallel with the core performance indicators of the Perkins accountability framework, comprised of on-time graduation, postsecondary enrollment, and postsecondary labor status. As a matter of routine, studies also typically include student characteristics as a descriptive variable, while a few expand to sociodemographic factors, such as family income and education levels. Gaps in the research suggest additional variables would be helpful to consider, namely those associated with outcomes in work-based learning, postsecondary certifications and credentials, and career technical student organizations. In each case, however, keen attention would be necessary due to logistical challenges in the cataloguing and collection of data.

Implications for Further Study

Given the breadth of research on CTE conducted since the year 2000, several prominent themes can be observed with implications for future study of the field. Firstly, it is important to recognize that as an educational model, CTE has progressed over time from a heavy focus on job training and preparation for the trades, to integration of both highly technical and core academic skillsets (Hernandez-Gantes, 2016). Though this shift

was prominently represented in the 2006 passage of Perkins IV and an official pivot away from the vocational education moniker, the change was produced not in a legislative vacuum but rather in line with the premise that rigorous preparation for both careers *and* postsecondary education are essential to success in a globalized American economy (Stipanovic et al., 2012; Symonds et al., 2011). From a research perspective, the implication is that to study CTE in the 21st century is to no longer study a niche field of education, but rather a core component of any educational system's college and career readiness framework, with equitable access and achievement at the forefront.

Secondly, there is a robust base of research to support CTE's association with a variety of positive student outcomes including a reduced likelihood of dropping out, increased odds of on-time graduation, increased earnings after high school, and increased odds of enrollment in postsecondary education (Dortch, 2014; Gray, 2004; Dougherty et al., 2019; Bonilla, 2020, Plank et al., 2005). As one researcher noted, "by all accounts, [CTE] has been recognized as a viable alternative to help youth transition to productive participation in the new economy" (Hernandez-Gantes, 2022). Yet to a confounding degree, for every study to extol the potential and promise of CTE programming, there are others still with findings that are highly mixed.

For example, Dougherty et al. pointed to various design problems in prevailing causal program evaluations of CTE, going so far as to state that because of these problems and the conclusions drawn from them, "relatively little is known about how CTE participation contributes to student in-school achievement and subsequent postsecondary education and labor market outcomes" (2021, p. 39). Similarly, Ross et al. pointed to the same issue in stating that despite "the large number of students

participating in CTE and the substantial resources dedicated to CTE, remarkably little is known about the causal impacts of CTE on students' short- and long-term outcomes" (2021, p. 15). As previously mentioned, LaForest would again echo these concerns in lamenting that "little empirical research has been conducted on the benefits and drawbacks of high school CTE, and there remains general disagreement among researchers about its effects" (2023, p. 40). That a scholarly consensus on CTE's effectiveness remains elusive should perhaps be no surprise, given both the difficulty of assessing elective courses into which students largely self-select and their highly diffuse nature in both content and quality of implementation. As such, there remains much value in tenacious research and evaluation of CTE at the local level, and exploring its association with the more commonly examined outcomes of achievement with incremental expansion into new avenues of study.

One such avenue worth exploring is the outcome of student engagement, as there is a relative dearth in the literature regarding its association with CTE programming. Yet as Sinatra et al. noted, "engagement is one of the hottest research topics in the field of educational psychology…[yet] there is little agreement on a concrete definition and effective measurement of engagement" (2015, p. 1). Given its conceptual breadth, definitions have tended to avoid granular description and instead cut across domains of engagement including the "behavioral," "emotional," "cognitive," and "psychological" (Kahu, 2013; Sinatra et al., 2015; Abla & Fraumeni, 2019). In relation to CTE, student engagement has been variously defined in research as the likelihood of graduating on time, general feelings of positivity toward one's school community, and level of interaction with a "flipped" class structure (Holik, 2019; Diel, 2020; Xing & Gordon,

2021). However, nowhere in the literature has there been a concerted effort to gauge CTE's relationship with more fundamental representations of engagement from a behavioral perspective, namely the likelihood of a student to receive disciplinary measures and the tendency of a student to physically attend school. Both disciplinary consequences (Anderson et al., 2019; Cobb-Clark et al., 2015) and low school attendance (Chang & Romero, 2008; Schoeneberger, 2012) have been found to associate with negative academic outcomes, and the examination of CTE's relationship to both variables would break new ground as a measure of behavioral engagement.

Literature Review Summary

In summary, the career and technical education programming of today inhabits a lineage extending back to the very roots of American nationhood, first represented in apprenticeships as imported by English settlers, and vastly expanded through the 19th and 20th centuries as vocational education to meet the needs of a rapidly industrializing society. Over the last 100 years, sustained federal investment and regulation have had a transformative effect, ever increasing the scope of what qualifies as CTE programs while continually pushing a trend of accessibility, accountability, and rigorous integration of both technical and academic skillsets. Research on CTE and its associated outcomes has substantially increased in the last few decades, though with a persistent lack of consensus amongst scholars as to its truly realized value both in academics and engagement. Given its inherent complexities and those implied in local level implementation, such evaluative variation is to be expected and embraced as a call to further study.

CHAPTER THREE: METHODOLOGY

The purpose of this study was to explore CTE's association with positive outcomes for high school students as categorized by achievement and behavioral engagement, at a district-wide level in one of the most populous K-12 systems in the nation. With respect to achievement, the study sought to determine if there is a statistically significant relationship between CTE coursework and on-time graduation rate and ACT standardized test performance. On the other hand, the study determined whether CTE holds a positive association with student behavioral engagement as defined by rates of attendance and incidents of disciplinary exclusion (e.g., out-of-school suspension). As the study focused on students who concentrated in two or more years of coursework (concentrators) as well as those only taking one year of any given program (non-concentrators) or no courses at all, the study further sought to establish if CTE was related to positive outcomes for both casual course-takers as well as those who opted to engage fully in a program of study. Lastly, the study determined if CTE held benefit for students that graduated both before and during the height of the COVID-19 pandemic, analyzing data from senior cohorts that graduated in years 2019, 2020, 2021, and 2022.

Research Questions

1. Do statistically significant differences exist in on-time graduation status between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses?
2. Do statistically significant differences exist in Composite ACT scores between groups of high school graduates who take only the first year of one or more CTE

programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses?

3. Do statistically significant differences exist in number of days attended between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses?
4. Do statistically significant differences exist in total incidents of exclusionary discipline between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses?
5. Do statistically significant differences exist in academic and behavioral variables between groups of high school graduates who take varying levels of CTE, while controlling for gender, race, or special population designation?

Research Design

This study utilized a quantitative methodology to determine differences in academic achievement and behavioral engagement between groups of students based on their broad level of CTE exposure, spanning four different graduate cohorts. The first of these groupings were *CTE concentrators*, or those students who took two or more years of a CTE program. Students in this group may have concentrated in more than one program, and the study did not delineate students who did so. The second student group was comprised of *CTE participants*, or those who only took the first year of any given CTE program. Again, students in this group may have taken one year of multiple CTE programs. The last student group was comprised of *non CTE course-takers*, or students

who took no CTE classes during their time in high school. For the outcome of academic achievement, the study analyzed variables of on-time graduation status and Composite ACT scores between the three groups. For behavioral engagement, the study also analyzed variables of absences and incidents of exclusionary discipline (suspensions) between the same designated student groups.

Quantitative Analyses

Quantitative methods have been applied in multiple studies examining CTE and its relation to student achievement outcomes (Agodini & Deke, 2004; Blowe & Price, 2012; Dougherty et al., 2019; Malamud & Popeleches, 2010) though their use in examining its association with behavioral outcomes is relatively scant (Diel, 2020; Plasman & Passarella, 2022). Of the various quantitative analyses employed, one-way ANOVAs have been a favored method both in CTE research (Rojewski, 1997) and education generally (Erceg-Hurn & Mirosevich, 2008), with MANOVA used less frequently as a more advanced statistical method (Rojewski et al., 2008). According to Ojelnik and Hess, ANOVA's popularity is rooted in several factors including its versatility, Type I error control, established precedent of usage, and ease of use (1997), while according to Sharpe (2015), Chi-square tests have been used for over 100 years as important and useful methods in applied research and analysis of categorical data.

School District Context

This study was confined to the population of a large public school district located in the western United States. With an annual enrollment of just over 60,000 students, the district has placed in the top one percent of the nation's largest school districts for population (Washoe County School District, n.d.), graduating an annual cohort of

approximately 4,000 students. At the secondary level, the district is primarily made up of 11 comprehensive high schools and 1 career technical academy, with several smaller specialized schools and district-sponsored charters. The district offers just under 30 different CTE programs, comprising 13 of the 16 federally defined career clusters as recognized by the Nevada Department of Education (n.d.).

Sample

Populations of interest for the study were comprised of four high school graduate cohorts encompassing all of the district's comprehensive high schools, with the exclusion of its sole career technical academy as well as several charter schools. From each cohort, three groupings of students were defined based on their level of exposure to CTE coursework and programming, with the first group made up of students who took no CTE classes during their time in high school, the second encompassing students who took only the first year of one or more programs (participants), and the third comprised of students who took two years or more of one or more programs (concentrators).

Attainment and Management of Data

Data for all cohorts and variables were collected from the target district's student information system (SIS), which serves as the statewide storehouse for all student-level academic and behavioral records. The necessary datasets were retrieved from the district's Office of Accountability, with formal permissions also obtained from the district and the University of Nevada, Reno's Institutional Review Board. Each dataset encompassed total populations of each graduate cohort as defined, and was safeguarded in compliance with all policies, administrative regulations, and procedures pertaining to the research protocol.

Data Analysis

Data analysis focused primarily on surfacing statistically significant mean differences between the three targeted treatment groups by previously described variables, utilizing the Statistical Package for the Social Sciences (SPSS). Before all testing, the dataset for each year's population was first examined for missing data and outliers, and then cleaned and appropriately coded as per practices for multivariate statistical research outlined by Mertler and Reinhart (2017). Next, descriptive statistics were produced to surface population-wide demographics of each graduate cohort, as well as class-wide summaries of students again based on their level of exposure to CTE programming.

For the outcome of academic achievement, the first of two dependent variables to be examined was on-time graduation status. Because this dependent variable was categorical and binary in nature, while the independent variable was also categorical comprised of three levels, an appropriate test to deploy was logistic regression (Mertler & Reinhart, 2017). Basic assumptions supporting the test's validity included the independence of each datum, no inappropriately high collinearity between predictors, perfect measurement, and a fully represented data matrix (Osborne, 2015). Results from the test were then analyzed for overall model fit of the leveled predictor variable via Chi-square statistics, as well as statistical reliability in distinguishing between graduates and non-graduates via classification tables, regression coefficients, and odds ratios (Mertler & Reinhart, 2017). The other dependent variable tied to academic achievement was standardized test performance reflected in each graduate's ACT composite score. As this dependent variable was continuous, to again be analyzed in relation to the categorical

variable of CTE exposure, the appropriate initial test to conduct was a one-way ANOVA (Mertler & Reinhart, 2017). Assumptions informing test validity in this case were again observational independence, as well as normally distributed populations and homogeneity of variance (Mertler & Reinhart, 2017).

As to the outcome of behavioral engagement, both the examined variables of total days absent and incident of exclusionary discipline were continuous, thus allowing a one-way MANOVA test as the initial statistical instrument (Mertler & Reinhart, 2017, p. 15), as well as MANCOVA where additional control variables were included. Assumptions underlying the first round of testing included random sampling and observational independence, a multivariate normal distribution for all dependent variables, a homogeneity of covariance matrices, and a linear relationship among all pairs of dependent variables for each cell in the data matrix (Mertler & Reinhart, 2017, p. 131).

CHAPTER FOUR: RESULTS

The purpose of this study was to explore CTE's association with positive outcomes for high school students as categorized by achievement and behavioral engagement, at a district-wide level in one of the most populous K-12 systems in the nation. As a repeated cross-sectional study, varying levels of CTE coursework comprised the treatment, with observable academic and behavioral relationships examined for student graduate cohorts over the course of four academic years. Within each treatment group, the interaction effects of gender and racial demography relative to academic and behavioral outcomes were also examined.

Results in this chapter derive from quantitative analyses adhering to standard methodologies of social science research (Mertler & Reinhart, 2017). The chapter includes a reexamination of the posed research questions, a description of the data collection and preparation process, and descriptive overviews of each dataset. Also presented are reliability and validity of the findings, comprehensive answers for all research questions, and a concise chapter summary.

Research Questions

1. Do statistically significant differences exist in on-time graduation status between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses?
2. Do statistically significant differences exist in Composite ACT scores between groups of high school graduates who take only the first year of one or more CTE

programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses?

3. Do statistically significant differences exist in number of days attended between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses?
4. Do statistically significant differences exist in total incidents of exclusionary discipline between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses?
5. Do statistically significant differences exist in academic and behavioral variables between groups of high school graduates who take varying levels of CTE, while controlling for gender, race, or special population designation?

Dataset Preparation

All datasets for the study were provided via an Excel spreadsheet, which was first checked for missing data and subsequently cleaned. In cases where students did not take the ACT exam on designated dates of administration, their composite scores were submitted by the providing agency as blank and were flagged as incomplete for this variable. Where students did not attend a school in the targeted district for one or more academic years from grades 9 through 12, attendance data were also missing, and their cases were further marked as incomplete for this factor. Next, relevant cases were categorized and coded into one of three groups as the primary independent variable, based on students' level of exposure to CTE coursework. The first group was comprised

of students with zero years of CTE coursework, which also served as the reference group in applicable quantitative analyses. The second group was made up of students who had taken one full year of one or more CTE programs, with the third group comprised of students who had taken two or more years of one or more CTE programs. A fourth group of students was also coded, for those cases where less than a full year of one or more CTE programs was taken during high school. These cases were then subsequently removed from each cohort's dataset, leaving only records of students as noted in Table 1.

Table 1

Cases Removed Where Students Took Less Than 1 Full Year of CTE Programming

Graduate Cohort	All Cases	Cases Removed	Remaining Complete Cases
2018-19	4,175	846	3329
2019-20	4,291	788	3503
2020-21	4,417	821	3596
2021-22	4,206	678	3528

Descriptive Statistics

After initial cleaning all datasets were imported into SPSS and subsequently coded for analyses in the program's Variable View feature. A missing value analysis was performed to confirm completeness of all cases. To acquire demographic overviews of each cohort and treatment group, descriptive analyses were then conducted with collected statistics illustrated in Tables 2 through 5.

Table 2

Descriptives by CTE Exposure Group, Graduate Cohort 2018-19

CTE Exposure	Group 1: 0 Years CTE		Group 2: 1 Year of CTE Program(s)		Group 3: 2+ Years of CTE Program(s)	
	n	%	*n*	%	*n*	%
Gender						
Female	774	56.6%	328	38.0%	485	47.7%
Male	594	43.4%	536	62.0%	612	52.3%
Race						
African American	34	2.5%	25	2.9%	20	1.8%
American Indian	9	0.7%	13	1.5%	7	0.6%
Asian	73	5.3%	33	3.8%	56	5.1%
Hispanic	618	45.2%	391	45.3%	359	32.7%
Multiracial	76	5.6%	43	5.0%	53	4.8%
Pac. Islander	16	1.2%	8	0.9%	18	1.6%
White	542	39.6%	351	40.6%	584	53.2%
Special Population						
Special Education	76	5.6%	35	4.1%	18	3.9%
English Learner	179	13.1%	80	9.3%	45	4.1%
Free/Reduced Lunch	446	41.2%	348	45.7%	311	30.2%

Table 3

Descriptives by CTE Exposure Group, Graduate Cohort 2019-20

CTE Exposure	Group 1: 0 Years CTE		Group 2: 1 Year of CTE Program(s)		Group 3: 2+ Years of CTE Program(s)	
	n	%	*n*	%	*n*	%
Gender						
Female	779	56.7%	354	42.7%	532	41.0%
Male	595	43.3%	476	57.3%	767	59.0%
Race						
African American	32	2.3%	32	3.9%	27	2.1%
American Indian	16	1.2%	12	1.4%	23	1.8%
Asian	70	5.1%	32	3.9%	53	4.1%
Hispanic	599	43.6%	407	49.0%	449	34.6%
Multiracial	79	5.7%	37	4.5%	82	6.3%
Pac. Islander	20	1.5%	9	1.1%	10	0.8%
White	558	40.6%	301	36.3%	655	50.4%
Special Population						
Special Education	83	6.0%	41	4.9%	25	1.9%
English Learner	216	15.7%	103	12.4%	81	6.2%
Free/Reduced Lunch	550	40.0%	347	41.8%	405	31.2%

Table 4

Descriptives by CTE Exposure Group, Graduate Cohort 2020-21

CTE Exposure	Group 1: 0 Years CTE		Group 2: 1 Year of CTE Program(s)		Group 3: 2+ Years of CTE Program(s)	
	n	%	*n*	%	*n*	%
Gender						
Female	840	56.9%	279	37.7%	614	44.6%
Male	637	43.1%	462	62.3%	764	55.4%
Race						
African American	45	3.0%	19	2.6%	24	1.7%
American Indian	23	1.6%	9	1.2%	9	0.7%
Asian	73	4.9%	28	3.8%	82	6.0%
Hispanic	657	44.5%	362	48.9%	501	36.4%
Multiracial	84	5.7%	39	5.3%	73	5.3%
Pac. Islander	19	1.3%	11	1.5%	13	0.9%
White	576	39.0%	273	36.8%	676	49.1%
Special Population						
Special Education	168	11.4%	69	9.3%	68	4.9%
English Learner	232	15.7%	78	10.5%	69	5.0%
Free/Reduced Lunch	532	36.0%	269	36.3%	417	30.3%

Table 5

Descriptives by CTE Exposure Group, Graduate Cohort 2021-22

CTE Exposure	Group 1: 0 Years CTE		Group 2: 1 Year of CTE Program(s)		Group 3: 2+ Years of CTE Program(s)	
	n	%	*n*	%	*n*	%
Gender						
Female	766	56.1%	284	40.9%	668	45.5%
Male	598	43.8%	411	59.1%	800	54.5%
Race						
African American	49	3.6%	20	2.9%	22	1.5%
American Indian	18	1.3%	9	1.3%	14	1.0%
Asian	47	3.4%	33	4.7%	79	5.4%
Hispanic	651	47.7%	336	48.3%	520	35.4%
Multiracial	61	4.5%	37	5.3$	81	5.5%
Pac. Islander	28	2.1%	8	1.2%	10	0.7%
White	511	37.4%	252	36.3%	742	50.5%
Special Population						
Special Education	185	13.6%	86	12.4%	111	7.6%
English Learner	220	16.1%	80	11.5%	74	5.0%
Free/Reduced Lunch	543	39.8%	266	38.3%	421	28.7%

For Group 1 of each cohort, gender ratios remained relatively stable, with an average of about 56% of students taking zero CTE courses classified as female. While Groups 2 and 3 were not as consistently bifurcated from year to year, male students did continually outpace their female peers in CTE coursework at both levels of treatment. In terms of racial demographics, the largest subgroup at the highest treatment level of CTE was mostly comprised of White students, followed by Hispanics. For the mid-level of CTE treatment, Hispanic students consistently formed the largest racial demographic,

seconded nearly by White students with much lower percentages in all other categories. Lastly by special population, students enrolled in special education formed a relatively small proportion of each examined treatment group, with more students in this category ranged in the mid-level treatment group of CTE. The same held true for students designated as "English learners," with the highest proportions in this category clustered at the level of taking only the first year of one or more CTE programs. Students who qualified for the federal free or reduced lunch program comprised the largest share of special population subgroups and were, again, mostly concentrated at the mid-level of CTE treatment.

Results and Analysis for Research Question 1

Do statistically significant differences exist in on-time graduation status between groups of students who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses? Results indicate that, yes, statistically significant differences in on-time graduation status do exist, but only for the group of students who concentrated in one or more CTE programs of study. This finding applied to all cohorts examined.

For the analysis, a binary logistic regression was performed with each cohort's dataset using the *Enter* method to determine which CTE exposure groups were predictors of on-time graduation (yes or no). Initial data screening identified cases in each cohort where students transferred out of the target population before the end of their 12th-grade year. This resulted in exclusion from these analyses of 86 cases for graduate cohort 2018-19, 102 cases for 2019-20, 75 cases for 2020-21, and 192 cases for 2021-22. Collinearity diagnostics were then performed for all variables in each cohort, with Tolerance statistics

indicating no multicollinearity issues. As the dependent variable in this examination was binary with limited variance, screening for outliers via Mahalanobis distances resulted in the identification of all cases where graduation status was recorded as *no*. As such, all cases with complete data for the dependent variable were included with no outliers removed. Summaries for each subsequent logistic regression are provided.

Graduate Cohort 2018-19

For the 2018-19 cohort, regression results indicated that the overall model fit of CTE exposure as the predictor was questionable (-2 Log likelihood = 1814.790, Nagelkerke R^2 = .054) but statistically reliable in distinguishing between graduates and non-graduates [$\chi^2(2) = 77.817$, $p < .001$]. The model correctly classified 91.5% of the cases, though the dependent variable was heavily skewed to *yes* in the data, a trend also observed in all successive cohorts. This resulted in 100% of the *yes* category as correctly classified, and 0% of the *no* category. Regression coefficients are presented in Table 6. *Wald* statistics and p-values indicated the highest level of CTE exposure significantly predicts on-time graduation, with a high odds ratio of 4.500. In other words, without controlling for other confounding variables, the model predicted students who concentrate in CTE were 4.5 times more likely to graduate on time when compared to the reference group.

Table 6

Regression Coefficients, Graduate Cohort 2018-19

	B	*Wald*	*df*	*p*	Odds Ratio
1 Year of CTE Program(s) vs. No CTE	.199	1.973	1	.160	1.220
2+ Years of CTE Program(s) vs. No CTE	1.504	57.481	1	<.001	4.500
Constant	1.984	550.088	1	<.001	7.270

Graduate Cohort 2019-20

For the 2019-20 cohort, regression results indicated that the overall model fit of CTE exposure as the predictor was questionable (-2 Log likelihood = 2064.393, Nagelkerke R^2 = .047) but statistically reliable in distinguishing between graduates and non-graduates [$\chi^2(2) = 75.212$, $p < .001$]. The model correctly classified 90.5% of the cases, with 100% of the *yes* category and 0% of the *no* category. Regression coefficients are presented in Table 7. *Wald* statistics and p-values indicated that the highest level of CTE exposure significantly predicts on-time graduation, again with a relatively high odds ratio of 3.377. This translates to the model predicting CTE concentrators are 3.4 times more likely than the reference group to graduate on time.

Table 7
Regression Coefficients, Graduate Cohort 2019-20

	B	*Wald*	*df*	*p*	Odds Ratio
1 Year of CTE Program(s) vs. No CTE	.048	.128	1	.721	1.049
2+ Years of CTE Program(s) vs. No CTE	1.217	56.690	1	<.001	3.377
Constant	1.906	534.643	1	<.001	6.728

Graduate Cohort 2020-21

For the 2020-21 cohort, regression results indicated that the overall model fit of CTE exposure as the predictor was again questionable (-2 Log likelihood = 2657.936, Nagelkerke R^2 = .039) though statistically reliable in distinguishing between graduates and non-graduates [$\chi^2(2) = 75.405$, $p < .001$]. The model correctly classified 86.9% of the cases, with 100% of the *yes* category and 0% of the *no* category. Regression coefficients are presented in Table 8. *Wald* statistics and p-values again indicated that the highest level of CTE exposure significantly predicts on-time graduation with an odds ratio of 2.727. In this cohort, students concentrating in CTE exhibited the lowest odds ratio compared to other graduating classes. Nonetheless, the model still predicted CTE

concentrators were 2.7 times more likely to graduate on time than their peers in the reference group.

Table 8
Regression Coefficients, Graduate Cohort 2020-21

	B	*Wald*	*df*	*p*	Odds Ratio
1 Year of CTE Program(s) vs. No CTE	.098	.628	1	.428	1.103
2+ Years of CTE Program(s) vs. No CTE	1.003	63.055	1	<.001	2.727
Constant	1.564	503.850	1	<.001	4.779

Graduate Cohort 2021-22

For the 2021-22 cohort, regression results indicated that the overall model fit of CTE exposure as the predictor was questionable (-2 Log likelihood = 2211.158, Nagelkerke R^2 = .064) but statistically reliable in distinguishing between graduates and non-graduates [$\chi^2(2) = 109.310$, $p < .001$]. The model correctly classified 88.9% of the cases, with 100% of the *yes* category and 0% of the *no* category. Regression coefficients are presented in Table 9. *Wald* statistics and p-values indicated that the highest level of CTE exposure significantly predicts on-time graduation with an odds ratio of 3.863. Relative to other cohorts, the model for this graduating class indicated the second highest odds ratio for CTE concentrators, predicting students in this group are 3.9 times more likely to graduate than students who take no CTE courses.

Table 9
Regression Coefficients, Graduate Cohort 2021-22

	B	*Wald*	*df*	*p*	Odds Ratio
1 Year of CTE Program(s) vs. No CTE	.122	.826	1	.363	1.130
2+ Years of CTE Program(s) vs. No CTE	1.351	85.986	1	<.001	3.863
Constant	1.639	463.460	1	<.001	5.150

Results and Analysis for Research Question 2

Do statistically significant differences exist in Composite ACT scores between groups of high school graduates who take only the first year of one or more CTE

programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses? Results indicate that, yes, statistically significant differences in Composite ACT scores do exist between groups of students based on CTE exposure. This finding applied to all cohorts examined.

For the analysis, a one-way analysis of variance (ANOVA) was conducted with each graduate cohort, comparing ACT composite scores to CTE exposure grouping as the independent variable. Initial data screening identified cases in each cohort where ACT composite data were missing, resulting in subsequent exclusion from analyses of 166 cases for graduate cohort 2018-19, 190 cases for 2019-20, 206 cases for 2020-21, and 269 cases for 2021-22. The next phase of screening entailed examining the dependent variable to identify outlier cases via generated stem-and-leaf plots. This resulted in further exclusion of 39 outlier cases for graduate cohort 2018-19, 40 cases for 2019-20, 52 cases for 2020-21, and 61 cases for 2021-22.

Before each ANOVA test, normality plots were produced in Explore, indicating cleaned dependent variable data for each cohort were normal though with a slight lefthand skew. Levene's Tests for Equality of Variances were also performed to check for homogeneity of variances, which indicated a violation of this assumption for each graduate cohort. As such, Games-Howell tests were selected for post hoc analyses to determine differences between CTE exposure groups in relation to ACT composite scores (Mertler & Vanatta, 2017). The results of each cohort's ANOVA and post hoc analysis are in the following sections.

Graduate Cohort 2018-19

For the 2018-19 cohort, outliers were identified via stem-and-leaf plotting, resulting in removal of 39 extreme cases with ACT composite score values of 0 and greater than or equal to 32. A summary of univariate ANOVA results is presented in Table 10. Main effect results revealed that ACT composite scores were significantly different among students with differing levels of CTE exposure, $F(2, 3121) = 57.06$, $p < .001$, partial $\eta^2 = .035$. The estimate of effect size revealed a low strength in associations. A Games-Howell post hoc test was conducted, with results revealing that ACT composite scores were significantly different among all CTE exposure groups. Those students who took one year of one or more CTE programs were likely to score 2.26 points higher than those who were concentrators, and 1.52 points higher than those with 0 years of coursework (Appendix, Post hoc A). Conversely, those students who concentrated in CTE were likely to score lower than both other groups.

Table 10

One-Way ANOVA Summary Table for ACT Composite Score, Graduate Cohort 2018-19

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between Treatments	2409.48	2	1204.74	57.06		
CTE Exposure	2409.48	2	1204.74	57.06	<.001	.035
Within Treatments	65894.11	3121	21.113			
Total	1040420.0	3124				

Graduate Cohort 2019-20

For the 2019-20 cohort, 40 extreme cases were identified and removed with an ACT composite score value greater than or equal to 32. A summary of univariate ANOVA results is presented in Table 11. Main effect results revealed that ACT composite scores were significantly different among students with differing levels of CTE exposure, $F(2, 3270) = 55.06$, $p < .001$, partial $\eta^2 = .033$. The estimate of effect size revealed a low strength in associations. A Games-Howell post hoc test was conducted,

with results revealing that ACT composite are significantly different among all CTE exposure groups. Again, those students who took one year of one or more CTE programs were likely to score 2.21 points higher than those who were concentrators, and 1.22 points higher than those with 0 years of coursework (Appendix, Post hoc B). Conversely, those students who concentrated in CTE were likely to score lower than both other groups.

Table 11

One-Way ANOVA Summary Table for ACT Composite Score, Graduate Cohort 2019-20

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between Treatments	2370.26	2	1185.13	55.06		
CTE Exposure	2370.26	2	1185.13	55.06	<.001	.033
Within Treatments	70391.48	3270	21.53			
Total	1079375.0	3273				

Graduate Cohort 2020-21

For the 2020-21 cohort, 52 extreme cases were identified and removed with an ACT composite score value of less than or equal to 3 and greater than or equal to 32. A summary of univariate ANOVA results is presented in Table 12. Main effect results revealed that ACT composite scores were significantly different among students with differing levels of CTE exposure, $F(2, 3335) = 48.71$, $p < .001$, partial $\eta^2 = .028$. The estimate of effect size revealed a low strength in associations. A Games-Howell post hoc test was conducted, with results revealing that ACT composite scores are significantly different among all CTE exposure groups. Once more, those students who took only one year of one or more CTE programs were likely to score 2.14 points higher than those who were concentrators, and 1.36 points higher than those with 0 years of coursework (Appendix, Post hoc C). Conversely, those students who concentrated in CTE were likely to score lower than both other groups.

Table 12

One-Way ANOVA Summary Table for ACT Composite Score, Graduate Cohort 2020-21

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between Treatments	2115.93	2	1057.97	48.71		
CTE Exposure	2115.93	2	1057.97	48.71	<.001	.028
Within Treatments	72439.47	3335	21.72			
Total	1110443.0	3338				

Graduate Cohort 2021-22

For the 2021-22 cohort, 63 extreme cases were identified and removed with an ACT composite score value of greater than or equal to 31. A summary of univariate ANOVA results is presented in Table 13. Main effect results revealed that ACT composite scores were significantly different among students with differing levels of CTE exposure, $F(2, 3193) = 56.26$, $p < .001$, partial $\eta^2 = .034$. The estimate of effect size revealed a low strength in associations. A Games-Howell post hoc test was conducted, with results revealing that ACT composite are significantly different among all CTE exposure groups. Those students who took only one year of one or more CTE programs were again found as likely to score 2.23 points higher than those who were concentrators, and 1.14 points higher than those with 0 years of coursework. Conversely, those students who concentrated in CTE were likely to score lower than both other groups (Appendix, Post hoc D).

Table 13

One-Way ANOVA Summary Table for ACT Composite Score, Graduate Cohort 2021-22

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between Treatments	2291.68	2	1145.84	56.26		
CTE Exposure	2291.68	2	1145.84	56.26	<.001	.034
Within Treatments	65032.22	3193	20.37			
Total	967724.0	3196				

Results and Analysis for Research Question 3

Do statistically significant differences exist in number of days attended between groups of high school students who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses? Results indicate that yes, statistically significant differences in days attended do exist between groups of students based on CTE exposure, though with very small effect sizes. This finding applied to all cohorts examined.

For this analysis, one-way analyses of variance (ANOVAs) were conducted for each graduate cohort, comparing CTE exposure groups to the number of total days attended over four consecutive years of high school. Initial data screening identified cases in each cohort where attendance data for one or more years were missing, resulting in subsequent exclusion from analyses of 342 cases for graduate cohort 2018-19, 526 cases for 2019-20, 420 cases for 2020-21, and 358 cases for 2021-22. Initial data screening led to the transformation of the dependent variable (days attended) by removal of all values identified as outliers via stem-and-leaf plots generated via the Explore function. This resulted in the elimination of an additional 340 outlier cases for graduate cohort 2018-19, 225 cases for 2019-20, 129 cases for 2020-21, and 157 cases for 2021-22. Next, normality plots were generated via the Explore feature, indicating dependent variables across all cohorts were normally distributed, though with a pronounced righthand skew. Homogeneities of variance were checked via Levene's Test statistic, which indicated violation assumption for all cohorts examined. Therefore, Games-Howell tests were selected for post hoc analyses to determine differences between CTE exposure groups in

relation to number of days attended. The results of each cohort's ANOVA and post hoc analysis are detailed below.

Graduate Cohort 2018-19

For the 2018-19 cohort, 340 extreme cases were identified and removed with number of days attended as less than or equal to 580. A summary of univariate ANOVA results is presented in Table 14. Main effect results revealed that number of days attended were significantly different among students with differing levels of CTE exposure, $F(2, 2644) = 19.84$, $p < .001$, partial $\eta^2 = .015$. The estimate of effect size revealed a low strength in associations. A Games-Howell post hoc test was conducted, with results revealing significant differences in number of days attended between all levels of CTE exposure. Those students who took only one year of one or more CTE programs were significantly likely to attend on average 8.92 days more than CTE concentrators, and 4.99 more days than those with 0 years of coursework. Conversely, those students who concentrated in CTE were likely to attend less days on average than both other groups (Appendix, Post hoc E).

Table 14

One-Way ANOVA Summary Table for Days Attended, Graduate Cohort 2018-19

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between Treatments	31879.45	2	15939.73	19.84		
CTE Exposure	31879.45	2	15939.73	19.84	<.001	.015
Within Treatments	2124567.49	2644	803.54			
Total	12158976779.0	2647				

Graduate Cohort 2019-20

For the 2019-20 cohort, 225 extreme cases were identified and removed with number of days attended as less than or equal to 554. A summary of univariate ANOVA results is presented in Table 15. Main effect results revealed that number of days attended

were significantly different among students with differing levels of CTE exposure, $F(2, 2749) = 27.11$, $p < .001$, partial $\eta^2 = .019$. The estimate of effect size revealed a low strength in associations. A Games-Howell post hoc test was conducted, with results revealing significant differences in number of days attended between all levels of CTE exposure. Those students who took only one year of one or more CTE programs were significantly likely to attend on average 8.51 days more than CTE concentrators, and 3.77 more days than those with 0 years of coursework. Conversely, those students who concentrated in CTE were likely to attend less days on average than both other groups (Appendix, Post hoc F).

Table 15

One-Way ANOVA Summary Table for Days Attended, Graduate Cohort 2019-20

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between Treatments	31695.36	2	15847.68	27.11		
CTE Exposure	31695.36	2	15847.68	27.11	<.001	.019
Within Treatments	1607233.62	2749	584.66			
Total	1101298750.0	2752				

Graduate Cohort 2020-21

For the 2020-21 cohort, 129 extreme cases were identified and removed with number of days attended as less than or equal to 424. A summary of univariate ANOVA results is presented in Table 16. Main effect results revealed that number of days attended were significantly different among students with differing levels of CTE exposure, $F(2, 3044) = 38.38$, $p < .001$, partial $\eta^2 = .025$. The estimate of effect size revealed a low strength in associations. A Games-Howell post hoc test was conducted, with results revealing significant differences in number of days attended between all levels of CTE exposure. Those students who took only one year of one or more CTE programs were significantly likely to attend on average 23.62 days more than CTE concentrators, and

11.13 more days than those with 0 years of coursework. Conversely, those students who concentrated in CTE were likely to attend less days on average than both other groups (Appendix, Post hoc G).

Table 16

One-Way ANOVA Summary Table for Days Attended, Graduate Cohort 2020-21

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between Treatments	237668.84	2	118834.42	38.38		
CTE Exposure	237668.84	2	118834.42	38.38	<.001	.025
Within Treatments	9425650.63	3044	3096.47			
Total	1092728944.0	3047				

Graduate Cohort 2021-22

For the 2021-22 cohort, 157 extreme cases were identified and removed with number of days attended as less than or equal to 395. A summary of univariate ANOVA results is presented in Table 17. Main effect results revealed that number of days attended were significantly different among students with differing levels of CTE exposure, $F(2, 3010) = 64.15$, $p < .001$, partial $\eta^2 = .041$. The estimate of effect size revealed a low strength in associations. A Games-Howell post hoc test was conducted, with results revealing significant differences in number of days attended between all levels of CTE exposure. Those students who took only one year of one or more CTE programs were significantly likely to attend on average 32.27 days more than CTE concentrators, and 11.22 more days than those with 0 years of coursework. Conversely, those students who concentrated in CTE were likely to attend less days on average than both other groups (Appendix. Post hoc H).

Table 17

One-Way ANOVA Summary Table for Days Attended, Graduate Cohort 2021-22

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between Treatments	516331.61	2	258165.81	64.15		
CTE Exposure	516331.61	2	258165.81	64.15	<.001	.041
Within Treatments	12113583.55	3010	4024.45			
Total	1071600491.0	3013				

Results and Analysis for Research Question 4

Do statistically significant differences exist in total incidents of exclusionary discipline between groups of high school graduates who take only the first year of one or more CTE programs of study, who concentrate in one or more CTE program of study, and who take no CTE courses? Results indicate that yes, statistically significant differences in incidents of exclusionary discipline do exist between groups of students based on CTE exposure, though with very small effect sizes. This finding applied to all cohorts examined.

For this analysis, one-way analyses of variance (ANOVAs) were conducted for each graduate cohort, comparing CTE exposure groups to the number of times students were suspended out of school over four consecutive years of high school. Because the great majority of cases in each cohort recorded zero exclusionary incidents, initial data screening identified all students with one or more suspensions as an outlier. This amounted to the identification of 546 cases for cohort 2018-19, 575 cases for 2019-20, 538 cases for 2020-21, and 556 cases for 2021-22. As each of these cases represented genuine observations, and because ANOVA is robust against violations of normality, analyses proceeded with no outlier removal. Normality plots for each cohort were generated via the Explore feature, indicating a severe lefthand skew in the data with cases clustered at or near 0. Homogeneity of variance was checked via Levene's Test statistic, which indicated violation assumption for all cohorts examined. Therefore, Games-Howell tests were selected for post hoc analyses to determine differences between CTE exposure

groups in relation to number of times suspended. The results of each cohort's ANOVA and post hoc analysis are detailed below.

Graduate Cohort 2018-19

A summary of univariate ANOVA results for cohort 2018-19 is presented in Table 18. Main effect results revealed that number of suspensions were significantly different among students with differing levels of CTE exposure, $F(2, 3326) = 18.63$, $p < .001$, partial $\eta^2 = .011$, though the estimate of effect size revealed an extremely low strength in associations. A Games-Howell post hoc test was conducted, with results revealing a significant difference between students who concentrated in one or more CTE programs and the other two groups. Those students who concentrated in one or more CTE programs were more likely to be suspended than students in the other two groups, though with a very low mean difference of .16 between students who took no courses in CTE, and .26 between students who took only a year in one or more courses (Appendix, Post hoc I).

Table 18

One-Way ANOVA Summary Table for Incidents of Disciplinary Suspension, Graduate Cohort 2018-19

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between Treatments	33.72	2	16.86	18.63		
CTE Exposure	33.72	2	16.86	18.63	<.001	.011
Within Treatments	3009.85	3326	.91			
Total	3383.0	3329				

Graduate Cohort 2019-20

A summary of univariate ANOVA results for cohort 2019-20 is presented in Table 19. Main effect results revealed that number of suspensions were significantly different among students with differing levels of CTE exposure, $F(2, 3500) = 25.57$, $p < .001$, partial $\eta^2 = .014$, though the estimate of effect size revealed an extremely low

strength in associations. A Games-Howell post hoc test was conducted, with results revealing a significant difference between students in all CTE exposure groups. Those students who concentrated in one or more CTE programs were more likely to be suspended than students in the other two groups, though with a very low mean difference of .18 between students who took no courses in CTE, and .31 between students who took only a year in one or more courses (Appendix, Post hoc J).

Table 19

One-Way ANOVA Summary Table for Incidents of Disciplinary Suspension, Graduate Cohort 2019-20

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between Treatments	50.93	2	25.46	25.57		
CTE Exposure	50.93	2	25.46	25.57	<.001	.014
Within Treatments	3485.62	3500	.10			
Total	3903.0	3503				

Graduate Cohort 2020-21

A summary of univariate ANOVA results for cohort 2020-21 is presented in Table 20. Main effect results revealed that number of suspensions were significantly different among students with differing levels of CTE exposure, $F(2, 3593) = 13.96$, $p < .001$, partial $\eta^2 = .008$, with an estimate of effect size indicating an extremely low strength in associations. A Games-Howell post hoc test was conducted, with results revealing a significant difference between students who concentrated in one or more CTE programs and the other two groups. Those students who concentrated in one or more CTE programs were more likely to be suspended than students in the other two groups, though with a very low mean difference of .18 between students who took no courses in CTE, and .16 between students who took only a year in one or more courses (Appendix, Post hoc K).

Table 20

One-Way ANOVA Summary Table for Incidents of Disciplinary Suspension, Graduate Cohort 2020-21

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between Treatments	25.59	2	12.80	13.96		
CTE Exposure	25.59	2	12.80	13.96	<.001	.008
Within Treatments	3293.60	3593	.92			
Total	3634.0	3596				

Graduate Cohort 2021-22

A summary of univariate ANOVA results for cohort 2021-22 is presented in Table 21. Main effect results revealed that number of suspensions were significantly different among students with differing levels of CTE exposure, $F(2, 3525) = 30.95$, $p < .001$, partial $\eta^2 = .017$, with estimate of effect size indicating extremely low strength in associations. A Games-Howell post hoc test was conducted, with results revealing a significant difference between students who concentrated in one or more CTE programs and the other two groups. Those students who concentrated in one or more CTE programs were more likely to be suspended than students in the other two groups, though with a very low mean difference of .13 between students who took no courses in CTE, and .33 between students who took only a year in one or more courses (Appendix, Post hoc L).

Table 21

One-Way ANOVA Summary Table for Incidents of Disciplinary Suspension, Graduate Cohort 2021-22

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between Treatments	52.50	2	26.25	30.95		
CTE Exposure	52.50	2	26.25	30.95	<.001	.017
Within Treatments	2989.34	3525	.85			
Total	3349.0	3528				

Results and Analysis for Research Question 5

Do statistically significant differences exist in academic and behavioral variables between groups of high school graduates who take varying levels of CTE by gender,

while controlling for gender, race, and special population designation? Results indicate that yes, statistically significant differences do exist by levels of CTE exposure when compared to combined variables for both academic and behavioral outcomes while also controlling for demographics. In addition, several covariables also significantly contributed to group differences relative to the dependent variables.

Due to the different nature of the academic variables, with graduation status being binary and categorical and ACT composite score being continuous, these two variables were not included together in a multivariate analysis. Instead, graduation status was examined via a binary logistic regression using the *Enter* method along with the covariates, while ACT composite score was analyzed via a one-way analysis of covariance (ANCOVA) again controlling for gender, race, and special population. As to the behavioral variables of days attended and incidents of suspension, both continuous variables were compared to CTE exposure while controlling for covariates via multivariate analyses of covariance (MANCOVA), with follow-on ANCOVAs conducted to determine differences within each treatment group. The results of each round of analysis for both sets of variables are described by graduate cohort in the next sections.

Graduate Cohort 2018-19

For the academic dependent variable of graduation status, logistic regression results indicated that the overall model fit of six predictors (enrollment as a CTE concentrator, enrollment in two of three special population groups, gender, and identification as African American or Hispanic) was moderate (-2 Log likelihood = 1429.33, Nagelkerke $R^2 = .301$) but statistically reliable in distinguishing between graduates and non-graduates [$\chi^2(12) = 463.28$, $p < .001$]. The model correctly classified

93.3% of the cases, with 99.2% of the *yes* category and 30.3% of the *no* category. Regression coefficients are presented in Table 22. Five covariates and enrollment as a CTE concentrator were statistically significant for on-time graduation. While *Wald* statistics indicated special education status held the strongest predictive value, the highest odds ratio was observed for CTE concentrators with a value of 3.547.

Table 22

Regression Coefficients, Graduate Cohort 2018-19

	B	*Wald*	*df*	*p*	Odds Ratio
1 Year of CTE Program(s) vs. No CTE	.263	2.545	1	.111	1.300
2+ Years of CTE Program(s) vs. No CTE	1.266	33.574	1	<.001	3.547
IEP (Special Education)	-3.649	223.870	1	<.001	.026
EL (English Learner)	-.721	12.920	1	<.001	.486
FRL (Free & Reduced Lunch)	-.288	3.315	1	.069	.749
African American vs. White Reference Group	-.990	6.318	1	.012	.372
American Indian vs. White Reference Group	-.151	.030	1	.862	.860
Asian vs. White Reference Group	489	1.049	1	.306	1.630
Hispanic vs. White Reference Group	-.511	7.648	1	.006	.600
Multiracial vs. White Reference Group	.470	1.206	1	.272	1.600
Pacific Islander vs. White Reference Group	-.575	.854	1	.355	.562
Male vs. Female Reference Group	-.787	25.894	1	<.001	.455
Constant	3.323	323.391	1	<.001	27.750

For the academic dependent variable of ACT composite score, an ANCOVA was conducted again after removing cases with missing data, and those identified as outliers via generation of stem-and-leaf plots in Explore. Results of that analysis are summarized in Table 23. After significant adjustment by covariates of race (African American, American Indian, Hispanic, Pacific Islander) and special population designation (all three variables), ACT composite scores varied significantly between students who took only the first year of one or more CTE programs and the reference group of those who took none. Comparison of adjusted group means are displayed in Table 24.

Table 23

One-Way ANCOVA Summary Table for ACT Composite Score, Graduate Cohort 2018-19

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between treatments	177769.14	12	1480.76	91.16	<.001	.260
Gender	2.31	1	2.31	.14	.706	.000
Race (African American)	1004.10	1	1004.10	61.81	<.001	.019
Race (American Indian)	178.65	1	178.65	11.00	<.001	.004
Race (Asian)	1.295	1	1.295	.080	.778	.000
Race (Hispanic)	2750.30	1	2750.30	169.31	<.001	.052
Race (Multiracial)	5.85	1	5.85	.36	.548	.000
Race (Pacific Islander)	292.79	1	292.79	18.02	<.001	.006
IEP (Special Education)	730.72	1	730.72	44.99	<.001	.014
EL (English Learner)	2829.58	1	2829.58	174.19	<.001	.053
FRL (Free & Reduced Lunch)	1385.40	1	1385.40	85.29	<.001	.027
1 Year of CTE Program(s)	1106.62	1	1106.62	68.126	<.001	.021
2+ Years of CTE Program(s)	1.870	1	1.870	.115	.734	.000
Error	505334.45	3111	16.24			
Total	10404200.00	3124				

Table 24

Adjusted and Unadjusted Group Means for ACT Composite Scores

	Adjusted *M*	Unadjusted *M*
1 Year of CTE Program(s)	16.54	16.27
2+ Years of CTE Program(s)	18.00	18.53

Note. No statistical difference was found between students who took 2+ Years of CTE and the reference group of students who took no CTE.

Lastly, for the combined behavioral variables of days attended and number of times suspended, a one-way multivariate analysis of covariance (MANCOVA) was performed with CTE exposure groups and covariates included. Only the variable for days attended was transformed with the removal of outliers, with cases removed where values were below 497. As the assumption for homogeneity of variances and covariances was found to have been violated, Pillai's trace was utilized as the statistic to reference for group differences in the initial round of analysis (Mertler & Reinhart, 2017). MANCOVA results revealed significant differences among the CTE exposure groups on the combined dependent variable [Pillai's $V = .015$, $F(4, 5720) = 10.719$, $p < .001$, multivariate $\eta^2 = .007$]. The covariates of gender, race, and special population status also significantly influenced the combined dependent variables as shown in Table 25. Analysis of covariance (ANCOVA) was conducted on each dependent variable as a

follow-up test. CTE exposure category differences were significant for both number of times suspended [$F(2, 2860) = 8.971$, $p < .001$, partial $\eta^2 = .006$] and number of days attended [$F(2, 2860) = 16.726$, $p < .001$, partial $\eta^2 = .012$]. A comparison of adjusted means revealed small differences in the dependent variables by CTE exposure, presented in Table 26.

Table 25

MANCOVA Summary Table for Days Attended and Number of Times Suspended

Source	Pillai's *V*	Hypothesis DF	Error DF	*F*	*p*	η^2
Race	.002	2	2859	3.44	<.001	.002
Gender	.007	2	2859	9.97	<.001	.007
IEP (Special Education)	.024	2	2859	34.40	<.001	.024
EL (English Learner)	.008	2	2859	10.96	<.001	.008
FRL (Free & Reduced Lunch)	.015	2	2859	21.76	<.001	.015
CTE Exposure	.015	4	5720	10.72	<.001	.007

Table 26

Adjusted and Unadjusted Means for Behavioral Outcomes by CTE Exposure Group

	Days Attended		Number of Times Suspended	
	Adjusted *M*	Unadjusted *M*	Adjusted *M*	Unadjusted *M*
0 Years of CTE	666.37	665.35	.24	.24
1 Year of CTE Program(s)	659.30	658.41	.36	.40
2+ Years of CTE Program(s)	671.97	673.69	.20	.17

Graduate Cohort 2019-20

For the academic dependent variable of graduation status, logistic regression results indicated that the overall model fit of five predictors (enrollment as a CTE concentrator, enrollment in each of the three special population groups, and gender) was moderate (-2 Log likelihood = 1625.98, Nagelkerke $R^2 = .300$) but statistically reliable in distinguishing between graduates and non-graduates [$\chi^2(12) = 513.62$, $p < .001$]. The model correctly classified 92.8% of the cases, with 99.3% of the *yes* category and 31.2% of the *no* category. Regression coefficients are presented in Table 27. Four covariates and enrollment as a CTE concentrator were statistically significant for on-time graduation. While *Wald* statistics again indicated special education status as holding the strongest

predictive value, the highest odds ratio was observed for CTE concentrators with a value of 3.074.

Table 27

Regression Coefficients, Graduate Cohort 2019-20

	B	*Wald*	*df*	*p*	Odds Ratio
1 Year of CTE Program(s) vs. No CTE	.057	.134	1	.714	1.059
2+ Years of CTE Program(s) vs. No CTE	1.123	36.878	1	<.001	3.074
IEP (Special Education)	-3.840	229.815	1	<.001	.022
EL (English Learner)	-.516	7.428	1	.006	.597
FRL (Free & Reduced Lunch)	-.486	11.188	1	<.001	.615
African American vs. White Reference Group	-.521	2.093	1	.148	.594
American Indian vs. White Reference Group	-.417	.641	1	.423	.659
Asian vs. White Reference Group	.686	2.204	1	.138	1.985
Hispanic vs. White Reference Group	-.168	.979	1	.322	.846
Multiracial vs. White Reference Group	.569	1.966	1	.161	1.766
Pacific Islander vs. White Reference Group	-.267	.188	1	.665	.766
Male vs. Female Reference Group	-.657	21.222	1	<.001	.518
Constant	3.017	333.693	1	<.001	20.420

For the academic variable of ACT composite scores, ANCOVA results are summarized in Table 28. After significant adjustment by several covariates of race and special population designation (all three variables), ACT composite scores again varied significantly between students who took only the first year of CTE programming and the reference group of those who took no CTE courses. Comparison of adjusted group means are displayed in Table 29.

Table 28

One-Way ANCOVA Summary Table for ACT Composite Score, Graduate Cohort 2019-20

Source	***SS***	***df***	***MS***	***F***	***p***	η^2
Between treatments	20801.43	12	1733..45	108.76	<.001	.286
Gender	242.12	1	242.12	15.19	<.001	.005
Race (African American)	670.23	1	670.23	42.05	<.001	.013
Race (American Indian)	266.11	1	266.11	16.70	<.001	.005
Race (Asian)	34.60	1	34.60	2.17	.141	.001
Race (Hispanic)	3223.81	1	3223.81	202.26	<.001	.058
Race (Multiracial)	40.03	1	40.03	2.51	.113	.001
Race (Pacific Islander)	372.57	1	372.57	23.38	<.001	.007
IEP (Special Education)	827.61	1	827.61	51.93	<.001	.016
EL (English Learner)	3589.55	1	3589.55	225.21	<.001	.065
FRL (Free & Reduced Lunch)	1580.37	1	1580.37	99.15	<.001	.030
1 Year of CTE Program(s)	605.06	1	605.06	37.90	<.001	.011
2+ Years of CTE Program(s)	55.23	1	55.23	3.465	.063	.001
Error	51960.31	3260	15.94			
Total	1079375.0	3273				

Table 29

Adjusted and Unadjusted Group Means for ACT Composite Scores, Cohort 2019-20

	Adjusted *M*	Unadjusted *M*
1 Year of CTE Program(s)	16.56	16.24
2+ Years of CTE Program(s)	18.00	18.44

Note. No statistical difference was found between students who took 2+ Years of CTE and the reference group of students who took no CTE.

Lastly, for the combined behavioral variables of days attended and number of times suspended, a one-way multivariate analysis of covariance (MANCOVA) was performed with CTE exposure groups and covariates included. Only the variable for days attended was transformed with the removal of outliers, with cases removed where values were below 470. MANCOVA results revealed significant differences among the CTE exposure groups on the combined dependent variable [Pillai's $V = .019$, $F(4, 6006) = 14.39$, $p < .001$, multivariate $\eta^2 = .009$]. The covariates of gender, race, and special population status also significantly influenced the combined dependent variables as shown in Table 30. Analysis of covariance (ANCOVA) was conducted on each dependent variable as a follow-up test. CTE exposure category differences were significant for both number of times suspended [$F(2, 3003) = 12.278$, $p < .001$, partial $\eta^2 = .008$] and number of days attended [$F(2, 3003) = 21.794$, $p < .001$, partial $\eta^2 = .014$]. A comparison of adjusted means revealed small differences in the dependent variables by CTE exposure, presented in Table 31.

Table 30

MANCOVA Summary Table for Days Attended and Number of Times Suspended

Source	**Pillai's *V***	**Hypothesis DF**	**Error DF**	***F***	***p***	***η^2***
Race	.003	2	3002	4.88	.008	.003
Gender	.011	2	3002	9.97	<.001	.011
IEP (Special Education)	.031	2	3002	48.16	<.001	.031
EL (English Learner)	.005	2	3002	8.29	<.001	.005
FRL (Free & Reduced Lunch)	.013	2	3002	19.68	<.001	.013
CTE Exposure	.019	4	6006	14.39	<.001	.009

Table 31
Adjusted and Unadjusted Means for Days Attended and Number of Times Suspended by CTE Exposure Group

	Days Attended		Number of Times Suspended	
	Adjusted *M*	**Unadjusted *M***	**Adjusted *M***	**Unadjusted *M***
0 Years of CTE	620.28	619.08	.27	.27
1 Year of CTE Program(s)	614.55	613.88	.37	.40
2+ Years of CTE Program(s)	*627.11*	*628.56*	*.18*	*.16*

Graduate Cohort 2020-21

For the academic dependent variable of graduation status, logistic regression results indicated that the overall model fit of seven predictors (enrollment as a CTE concentrator, enrollment in each of the three special population groups, gender, and identification as Hispanic or Asian) was moderate (-2 Log likelihood = 2398.15, Nagelkerke R^2 = .168) but statistically reliable in distinguishing between graduates and non-graduates [$\chi^2(12) = 335.189$, $p < .001$]. The model correctly classified 87.1% of the cases, with 98.3% of the *yes* category and 13.2% of the *no* category. Regression coefficients are presented in Table 32. While *Wald* statistics again indicated special education status as holding the strongest predictive value, the highest odds ratio was observed for CTE concentrators with a value of 2.339.

Table 32
Regression Coefficients, Graduate Cohort 2020-21

	B	*Wald*	*df*	*p*	Odds Ratio
1 Year of CTE Program(s) vs. No CTE	.092	.485	1	.486	1.097
2+ Years of CTE Program(s) vs. No CTE	.850	40.361	1	<.001	2.339
IEP (Special Education)	-1.467	106.638	1	<.001	.639
EL (English Learner)	-.732	20.377	1	<.001	.879
FRL (Free & Reduced Lunch)	-.741	42.631	1	<.001	.718
African American vs. White Reference Group	-.129	.182	1	.670	4.091
American Indian vs. White Reference Group	-.332	.627	1	.429	1.379
Asian vs. White Reference Group	1.409	12.118	1	<.001	.876
Hispanic vs. White Reference Group	.322	5.719	1	.017	1.380
Multiracial vs. White Reference Group	-.132	.334	1	.563	.231
Pacific Islander vs. White Reference Group	.322	.459	1	.498	.481
Male vs. Female Reference Group	-.448	16.415	1	<.001	.477
Constant	2.296	345.765	1	<.001	9.933

ANCOVA results comparing ACT composite scores to the covariates are summarized in Table 33. After significant adjustment by several covariates of race (African American, Hispanic, Pacific Islander) and special population designation (all three variables), ACT composite scores once more varied significantly between students who took only the first year of one or more CTE programs and the reference group of students who took no CTE courses. Comparison of adjusted group means are displayed in Table 34.

Table 33

One-Way ANCOVA Summary Table for ACT Composite Score, Graduate Cohort 2020-21

Source	***SS***	***df***	***MS***	***F***	***p***	η^2
Between treatments	20186.82	12	1682.24	102.51	<.001	.270
Gender	14.95	1	14.95	.91	.340	.000
Race (African American)	719.04	1	719.04	43.82	<.001	.013
Race (American Indian)	62.58	1	62.58	3.81	.051	.001
Race (Asian)	.273	1	.273	.017	.897	.000
Race (Hispanic)	3006.16	1	3006.16	183.18	<.001	.052
Race (Multiracial)	49.46	1	49.46	3.01	.083	.001
Race (Pacific Islander)	185.59	1	185.59	11.31	<.001	.003
IEP (Special Education)	2292.09	1	2292.09	139.67	<.001	.040
EL (English Learner)	3091.43	1	3091.43	188.38	<.001	.054
FRL (Free & Reduced Lunch)	1418.82	1	1418.82	86.46	<.001	.025
1 Year of CTE Program(s)	876.14	1	876.14	53.39	<.001	.016
2+ Years of CTE Program(s)	.008	1	.008	.001	.982	.000
Error	54582.15	3326	16.41			
Total	1110452.00	3339				

Table 34

Adjusted and Unadjusted Group Means for ACT Composite Score, Cohort 2020-21

	Adjusted *M*	Unadjusted *M*
1 Year of CTE Program(s)	16.51	16.24
2+ Years of CTE Program(s)	17.91	18.38

Note: No statistical difference was found between students who took 2+ Years of CTE and the reference group of students who took no CTE.

Lastly, for the combined behavioral variables of days attended and number of times suspended, a one-way multivariate analysis of covariance (MANCOVA) was performed with CTE exposure groups and covariates included. Only the variable for days attended was transformed with the removal of outliers, with cases removed where values

were below 339. MANCOVA results revealed significant differences among the CTE exposure groups on the combined dependent variable [Pillai's $V = .024$, $F(4, 6502) = 19.43$, $p < .001$, multivariate $\eta^2 = .012$]. The covariates of gender and special population status also significantly influenced the combined dependent variables as shown in Table 35.

Table 35

MANCOVA Summary Table for Behavioral Variables, Cohort 2020-21

Source	Pillai's *V*	Hypothesis DF	Error DF	*F*	*p*	η^2
Race	.000	2	3250	.259	.772	.000
Gender	.005	2	3250	8.42	<.001	.005
IEP (Special Education)	.018	2	3250	29.48	<.001	.018
EL (English Learner)	.010	2	3250	17.15	<.001	.010
FRL (Free & Reduced Lunch)	.023	2	3250	38.29	<.001	.023
CTE Exposure	.024	4	6502	19.43	<.001	.012

Analysis of covariance (ANCOVA) was conducted on each dependent variable as a follow-up test. CTE exposure category differences were significant for both number of times suspended [$F(2, 3251) = 5.610$, $p < .001$, partial $\eta^2 = .003$] and number of days attended [$F(2, 3003) = 37.501$, $p < .001$, partial $\eta^2 = .023$]. A comparison of adjusted means revealed small differences in the dependent variables by CTE exposure, presented in Table 36.

Table 36

Adjusted and Unadjusted Means for Behavioral Variables, Cohort 2020-21

	Days Attended		Number of Times Suspended	
	Adjusted *M*	Unadjusted *M*	Adjusted *M*	Unadjusted *M*
0 Years of CTE	620.28	577.91	.31	.32
1 Year of CTE Program(s)	614.55	570.62	.28	.30
2+ Years of CTE Program(s)	627.11	596.33	.20	.18

Graduate Cohort 2021-22

For the academic dependent variable of graduation status, logistic regression results indicated that the overall model fit of six predictors (enrollment as a CTE concentrator, enrollment in one of three special population groups, gender, and identification as Asian) was moderate (-2 Log likelihood = 1919.47, Nagelkerke R^2 =

.226) but statistically reliable in distinguishing between graduates and non-graduates [$\chi^2(12) = 401.002$, $p < .001$]. The model correctly classified 89.1% of the cases, with 98.1% of the *yes* category and 16.3% of the *no* category. Regression coefficients are presented in Table 37. While *Wald* statistics once more indicated special education status as holding the strongest predictive value for graduation status, the highest odds ratio was observed for students identified as Asian with a value of 12.384.

Table 37
Regression Coefficients, Graduate Cohort 2021-22

	B	*Wald*	*df*	*p*	Odds Ratio
1 Year of CTE Program(s) vs. No CTE	.107	.538	1	.463	1.113
2+ Years of CTE Program(s) vs. No CTE	1.136	53.388	1	<.001	3.113
IEP (Special Education)	-1.662	139.107	1	<.001	.190
EL (English Learner)	-.451	6.681	1	.010	.637
FRL (Free & Reduced Lunch)	-.758	35.182	1	<.001	.469
African American vs. White Reference Group	-.218	.468	1	.494	.804
American Indian vs. White Reference Group	-.502	1.246	1	.264	.605
Asian vs. White Reference Group	2.516	6.186	1	.013	12.384
Hispanic vs. White Reference Group	-.089	.345	1	.557	.915
Multiracial vs. White Reference Group	-.066	.045	1	.832	.936
Pacific Islander vs. White Reference Group	-.713	2.727	1	.099	.490
Male vs. Female Reference Group	-.463	14.246	1	<.001	.4629
Constant	2.719	336.884	1	<.001	15.173

ANCOVA results comparing ACT composite scores to the covariates are summarized in Table 38. After significant adjustment by covariates of race (African American, American Indian, Hispanic, Multiracial, Pacific Islander) and special population designation (all three variables), ACT composite scores again varied significantly between students who took only the first year of a CTE program and those who took no courses in CTE. Comparison of adjusted group means are displayed in Table 39.

Table 38

One-Way ANCOVA Summary Table for ACT Composite Score, Graduate Cohort 2020-21

Source	*SS*	*df*	*MS*	*F*	*p*	η^2
Between treatments	19372.90	12	1614.41	107.17	<.001	.288
Gender	.01	1	.01	.001	.979	.000
Race (African American)	401.87	1	401.87	26.68	<.001	.008
Race (American Indian)	271.70	1	271.70	18.04	<.001	.006
Race (Asian)	.11	1	.11	.01	.931	.000
Race (Hispanic)	4043.33	1	4043.33	268.40	<.001	.078
Race (Multiracial)	100.94	1	100.94	6.70	.010	.002
Race (Pacific Islander)	352.92	1	352.92	23.43	<.001	.007
IEP (Special Education)	2309.96	1	2309.96	153.34	<.001	.046
EL (English Learner)	1639.55	1	1639.55	108.83	<.001	.033
FRL (Free & Reduced Lunch)	1175.84	1	1175.84	78.05	<.001	.024
1 Year of CTE Program(s)	681.15	1	681.15	45.22	<.001	.014
2+ Years of CTE Program(s)	23.27	1	23.27	1.55	.214	.000
Error	47950.99	3183	15.07			
Total	967724.00	3196				

Table 39

Adjusted and Unadjusted Group Means ACT Composite Score, Cohort 2021-22

	Adjusted *M*	Unadjusted *M*
1 Year of CTE Program(s)	15.66	15.40
2+ Years of CTE Program(s)	17.15	17.63

Note. No statistical difference was found between students who took 2+ Years of CTE and the reference group of students who took no CTE.

Lastly, for the combined behavioral variables of days attended and number of times suspended, a one-way multivariate analysis of covariance (MANCOVA) was performed with CTE exposure groups and covariates included. Only the variable for days attended was transformed with the removal of outliers, with cases removed where values were below 290. MANCOVA results revealed significant differences among the CTE exposure groups on the combined dependent variable [Pillai's $V = .043$, $F(4, 6542) = 35.72$, $p < .001$, multivariate $\eta^2 = .021$]. The covariates of gender, race and special population status also significantly influenced the combined dependent variables as shown in Table 40.

Table 40

MANCOVA Summary Table for Behavioral Variables, Cohort 2021-22

Source	Pillai's *V*	Hypothesis DF	Error DF	*F*	*p*	η^2
Race	.002	2	3270	3.46	.031	.002
Gender	.009	2	3270	15.49	<.001	.009
IEP (Special Education)	.007	2	3270	11.77	<.001	.007
EL (English Learner)	.014	2	3270	23.27	<.001	.014
FRL (Free & Reduced Lunch)	.051	2	3270	88.08	<.001	.051
CTE Exposure	.043	4	6542	35.72	<.001	.021

Analysis of covariance (ANCOVA) was conducted on each dependent variable as a follow-up test. CTE exposure category differences were significant for both number of times suspended [$F(2, 3271) = 23.518$, $p < .001$, partial $\eta^2 = .014$] and number of days attended [$F(2, 3271) = 57.761$, $p < .001$, partial $\eta^2 = .034$]. A comparison of adjusted means revealed small differences in the dependent variables by CTE exposure, presented in Table 41.

Table 41

Adjusted and Unadjusted Means for Behavioral Variables, Cohort 2021-22

	Days Attended		Number of Times Suspended	
	Adjusted *M*	Unadjusted *M*	Adjusted *M*	Unadjusted *M*
0 Years of CTE	562.84	559.09	.26	.27
1 Year of CTE Program(s)	559.41	556.38	.47	.50
2+ Years of CTE Program(s)	592.89	597.41	.19	.18

Summary of Results

Employing a combination of logistic regression, analysis of variance (ANOVA), analysis of covariance (ANCOVA), and multivariate analysis of covariance (MANCOVA), all research questions were answered with findings of statistical significance. For Research Question 1, the binary logistic regression analysis across four graduating cohorts consistently revealed that students who concentrated in CTE programs significantly improved their likelihood of on-time graduation compared to their non-CTE counterparts. Odds ratios ranged from 2.727 to 4.500 across the years, suggesting a strong, positive influence of prolonged CTE engagement on timely graduation. Notably,

the model was statistically significant in each cohort, despite the skewed distribution of graduates in the sample, which consistently leaned heavily toward *yes* for graduation.

For Research Question 2, one-way ANOVA tests revealed that students who completed one year of CTE coursework generally outperformed both non-CTE students and those who concentrated in CTE, the latter group scoring the lowest among the three. Following each ANOVA Games-Howell post hoc tests confirmed significant differences across all CTE exposure categories, with one-year CTE students consistently scoring higher than their peers. These findings were consistent across all cohorts, indicating a recurrent pattern of the influence of CTE on ACT performance, though interestingly with the most positive association for students who do not enroll in the highest level of treatment.

ANOVAs conducted for Research Question 3 that attendance did indeed significantly differ among the groups based on their CTE exposure, albeit with small effect sizes. One-year CTE participants were likely to attend more days on average compared to their peers with no CTE experience and those deeply immersed as CTE concentrators—with the latter group attending the fewest days. This pattern remained consistent across all cohorts studied. Notably, due to the violation of homogeneity of variances, Games-Howell post hoc tests were employed, reinforcing the existence of these attendance disparities across varying degrees of CTE involvement.

Research Question 4 investigated whether variations in the number of exclusionary discipline incidents were present among students with different levels of CTE engagement. The analysis concluded that statistically significant differences do indeed exist, though the effect sizes are very small, suggesting a limited practical

significance. This was consistent across all cohorts studied. Despite the majority of students having zero incidents, the analysis proceeded without outlier removal, justified by ANOVA's robustness to such data characteristics. The Games-Howell post hoc test indicated that CTE concentrators were slightly more likely to be suspended than their peers in other categories of CTE exposure. This trend persisted across the cohorts, with CTE concentrators facing a marginally higher likelihood of suspension compared to those with no CTE courses and those who only completed one year of CTE coursework.

Research Question 5 examined whether statistically significant differences in academic and behavioral outcomes exist among high school graduates with varying levels of CTE exposure when controlling for gender, race, and special population designation. The results confirmed that statistically significant differences exist. Logistic regression for graduation status showed moderate model fit but was statistically significant, with special education status, high CTE exposure, and eligibility for free and reduced lunch emerging as significant predictors of on-time graduation. For academic achievement, measured by ACT scores, ANCOVA analyses revealed that students with one year of CTE program exposure scored higher than those with no CTE exposure. In behavioral terms, MANCOVA results indicated significant differences among CTE exposure groups for days attended and suspension incidents, with CTE exposure categories showing significance for both variables in follow-up ANCOVA tests. The adjusted means suggested small yet consistent disparities in academic and behavioral outcomes based on levels of CTE exposure.

CHAPTER FIVE: DISCUSSION

The purpose of this study was to explore CTE's association with positive outcomes for high school students as categorized by achievement and behavioral engagement, at a district-wide level in one of the most populous K-12 systems in the nation. The study was guided by five research questions and subsequent analyses which all yielded significant findings, though for the most part relatively low explanatory power. Relative to the study's objectives, the analyses surfaced several key results and thematic insights that will be explored in this chapter, as well as their implications for practitioners and future research.

The primary objective of this study was to ascertain the extent to which CTE programs provide broadly defined benefit to students via enhanced academic and behavioral outcomes. Research to this point has repeatedly highlighted the complexity of quantifying the success of CTE programs (Symonds et al., 2008; Ecton & Dougherty, 2022), given their variation and uneven implementation across different school environments. A key result of this study is further confirming of the problem of measurement. Despite employing various analytical methods, the study and its findings indicate that CTE programs, when considered in isolation, account for only a small portion of variance when predicting positive academic and behavioral outcomes. While part of this challenge is logically rooted in other confounding variables, an enduring concern is again the widely varying nature of programs qualifying as "CTE." Yet, rather than signaling a research impasse, these findings can prompt a more granular examination of programs, with implications for practice that will be discussed by the end of this chapter.

Another objective of this study was to explore CTE programming at a level of treatment lower than what is commonly considered in the research, vis a vis students taking only the first year of one or more programs. It is in this respect that the study yielded a key result previously unseen in the review of the literature, indicating associations with enhanced outcomes for students in this group across several variables. Compared to their concentrator peers who engaged at the highest level of treatment, the groups of students who took only the first year of one or more CTE programs were likely to score an average of over two points higher on their respective ACT exams, while also being more likely to attend school and slightly less likely to be suspended. Findings from these analyses were, for the most part, consistent across all graduate cohorts and stand in stark contrast to unadjusted means in the dependent variables that tended to show the most positive outcomes for concentrators in CTE. Though perhaps counterintuitive, this observation presents several implications for practice meriting further consideration, along with a compelling argument for extended research into benefits associated with lower intensity exposure to CTE.

Lastly, as a repeated cross-sectional study of successive graduate cohorts, a main goal of this research was to assess any shift in the relationship of CTE exposure to student outcomes over time, especially through the duration of the COVID-19 pandemic. Analyses once more in this respect yielded a key result, indicating that, while the pandemic has disrupted any number of facets in education, the influence of CTE on academic and behavioral gains (though minor when compared to other contributors unexplored in this study) has remained stable. Such constancy suggests the resilient nature of CTE programming in the face of severe conditional changes and challenges and

underscores its position as a steadfast component within a comprehensive educational system operating at scale.

Implications for Practice

As a broad assessment of educational programming, there are several implications to be gleaned from this study for both CTE practitioners as well as those focused on more traditional academic pathways. To begin, results from this study indicate a clear relationship between concentration in a CTE program with an increased likelihood of on-time graduation. This is important to note, as in this context, the study's parameters defined concentrators as only those who attempted a full second year of a program, rather than those who successfully passed the second level course. While this may differ from the more commonly accepted definition which defines concentrators as those who both take *and* pass the second year of a program, the definition employed here provides a more compelling argument for practitioners. For with a more participation-based definition, it can be argued that even the attempt of persisting to a second year of CTE, irrespective of passing the class, has a clear effect on the odds of successfully graduating from high school on time. As such, educational practitioners in their respective districts would do well to evaluate the degree to which their CTE programs serve as strategic interventions for curbing student dropout rates, in addition to their traditional capacities of skill development and career preparation.

While it may be a strategic intervention, increased awareness about the success of those engaged with CTE programming is essential, particularly in understanding the long-standing stigma associated with CTE, including tracking of students, pushing them toward certificate or two-year programs, rather than expanding all forms of

postsecondary options, and the like. With increased student and family engagement, as well as leaders and educator understanding, removing the stigma for CTE by sharing the positive outcomes documented across the four-years of data in this study, may help to mediate existing misconceptions. Furthermore, the increased rigor through high school completion may help stakeholders see additional benefits for all students in CTE programming.

Another implication of practice to emerge from the study, and especially for those operating in a large-scale context, is that to measure and assess the effectiveness of CTE is again a highly complex endeavor. In this study, alone, there were over 30 different CTE programs embedded within the district examined, a diversity matched and then exceeded by the varied course taking patterns of students reflected in the data, ranging from those who concentrated in as many as three different pathways, to those who took only a single year of coursework. Given this scope, it would behoove educators to take into account the lessons of this study, as well as prior research, in avoiding perception of CTE as a monolithic entity, but rather an educational program comprised of disparate parts. In this respect, CTE could be viewed as akin to Advanced Placement courses which have likewise been studied in comparison to variables of academic achievement (Warne et. al, 2015).

In line with the analytical findings of the final research question, it is also worth noting for educators that in addition to CTE programming, demography does make a difference in relation to student outcomes. In several of the tests conducted with control variables, the covariates of race as well as free and reduced lunch eligibility, and especially enrollment in special education significantly increased the explanatory power

of the analytical models produced. While statistically significant group differences persisted students based on their levels of CTE exposure, it was clear that far more can be explained in outcomes when one considers not only which courses students take, but also other confounding variables rooted in their respective backgrounds. As such, the founding directives of the Perkins framework remain true in that educators should endeavor to make CTE programs accessible and effective from a general standpoint, while at the same time continuing to assess their benefit to students by disaggregated subgroups.

Lastly, educators should take note of the study's findings with regards to CTE concentrators and their performance on the ACT exam as well as their rates of attendance. Graduates in this group who were exposed to the highest level of CTE coursework were consistently associated with a likelihood of scoring lower on the ACT, while also being less likely to attend school at the same rate as their peers in the other two groups. From a practitioner perspective, this spurs questions about the potential opportunity costs of intensive study in CTE programming, and invites further examination into whether this trend could be attributed to factors such as reduced time for core academic subjects, misalignment of CTE coursework with core academic standards, and the unique challenges faced by CTE concentrators in attending school more regularly. At a minimum, practitioners in contexts similar to the one studied here would do well to develop means of more fully integrating higher level mathematics and literacy into their CTE curricula, while teachers and administrative staff should be cognizant of potentially lower rates of attendance amongst students who commit to CTE over the long term.

Recommendations for Further Research

Given the current body of literature and the study's confirmatory findings, research in this space can firstly advance by taking a more granular approach to student outcomes and their relation to CTE programming. From a basic standpoint, this would entail comparing outcomes to CTE programs as further stratified by federally defined career cluster, to explore if some categories of programs invariably differ from others in associated benefit. This approach would serve to further reduce the complexity of CTE as an educational model, while providing educators with actionable insight into which programs predict broader positive outcomes as opposed to others where there may be neutral or even negative associations surfaced. Similarly, researchers would do well to examine precisely how exposure to CTE associates with improved outcomes for students from different demographic backgrounds. Such a move would aid in surfacing deeper patterns of correlation, and provide potentially valuable insights into how CTE programs can be implemented to meet the needs of diverse student populations.

Another avenue of inquiry worth pursuing entails if or to what extent taking advanced CTE coursework correlates with lags in other measures of academic achievement. One of the more interesting results to emerge from the study was that students who concentrate in CTE were more likely to score lower on the ACT than their other peer groups. This outcome is worth pursuing via further study, not only because it runs contrary to logical assumption, but also as it contradicts the Perkins-mandated focus of CTE on academic rigor and preparation for a range of postsecondary pathways.

There is also value in further exploring to what extent CTE improves the behavioral engagement of students, particularly those from underserved and

underprivileged backgrounds. Moving beyond the quantitative analyses employed in this study, the addition of qualitative methods as well could provide deeper insight into the various sociocultural and socioeconomic factors that are sure to influence engagement over and above any one curriculum. In addition to expanding the research base, study in this regard would offer a more nuanced understanding of the ways in which CTE programs influence behavioral engagement, while potentially informing strategies to implement them in parallel with other initiatives such as social emotional learning and culturally responsive teaching. As students who engaged in only the first year of one or more CTE programs were consistently associated with a higher likelihood of attending school than both concentrators and non-CTE students alike, there is inherent value in focusing initial efforts on this group using qualitative methods to further explore the nature of their engagement, as well as their motivations to ultimately attend school more often.

Lastly, a broader qualitative study exploring students' decisions to opt into CTE programming, and their lived experiences within such coursework, may help to identify more nuanced explanations with regard to CTE outcomes across diverse populations. Additionally, an ethnographic study or comparative case study of programs may help to explore school factors such as school leadership experience, teacher influence, program length, school culture, and overall climate settings that contribute to student achievement.

Conclusion

In conclusion, it is clear that career and technical education (CTE) continues to play a role in supporting student outcomes well befitting its longstanding place in American public education. This study serves to confirm prior research finding that

measurement of outcomes relative to engagement in CTE is a highly complicated endeavor with confounding factors to consider, while further affirming association with academic benefit in one of the largest school districts in the nation. Moreover, this examination ventures into newer lines of inquiry, assessing how CTE correlates with behavioral outcomes and, more broadly speaking, outcomes for students who participate in a lower level of CTE than is commonly considered. Lastly, the study takes a long view in analysis of CTE programming and related variables over four successive academic years, including those during and immediately after the most impactful global health crisis in recent history. In each of these core efforts, significant findings were revealed answering all research questions, with a clear signal to both researchers and practitioners as to CTE's value, both intrinsically and as a subject of further study.

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Appendix

Post hoc A

Multiple Comparisons

Dependent Variable: ACT Scale Score - Composite
Games-Howell

(I) CTE Group	(J) CTE Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
0 Years CTE	1 Year of CTE Program(s)	1.52*	.195	<.001	1.06	1.98
	2+ Years of CTE Program(s)	-.74*	.201	<.001	-1.21	-.27
1 Year of CTE Program(s)	0 Years CTE	-1.52*	.195	<.001	-1.98	-1.06
	2+ Years of CTE Program(s)	-2.26*	.195	<.001	-2.72	-1.81
2+ Years of CTE Program(s)	0 Years CTE	.74*	.201	<.001	.27	1.21
	1 Year of CTE Program(s)	2.26*	.195	<.001	1.81	2.72

Based on observed means.
The error term is Mean Square(Error) = 21.113.

Post hoc B

Multiple Comparisons

Dependent Variable: ACT Scale Score - Composite
Games-Howell

(I) CTE Group	(J) CTE Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
0 Years CTE	1 Year CTE Program(s)	1.22*	.198	<.001	.75	1.68
	2 Years CTE Program(s)	-.99*	.193	<.001	-1.44	-.53
1 Year CTE Program(s)	0 Years CTE	-1.22*	.198	<.001	-1.68	-.75
	2 Years CTE Program(s)	-2.21*	.198	<.001	-2.67	-1.74
2 Years CTE Program(s)	0 Years CTE	.99*	.193	<.001	.53	1.44
	1 Year CTE Program(s)	2.21*	.198	<.001	1.74	2.67

Based on observed means.
The error term is Mean Square(Error) = 21.526.

Post hoc C

Multiple Comparisons

Dependent Variable: ACT Scale Score - Composite

Games-Howell

(I) CTE Group	(J) CTE Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
0 Years CTE	1 Year CTE Program(s)	1.36*	.202	<.001	.88	1.83
	2+ Years CTE Program(s)	-.79*	.189	<.001	-1.23	-.34
1 Year CTE Program(s)	0 Years CTE	-1.36*	.202	<.001	-1.83	-.88
	2+ Years CTE Program(s)	-2.14*	.195	<.001	-2.60	-1.69
2+ Years CTE Program(s)	0 Years CTE	.79*	.189	<.001	.34	1.23
	1 Year CTE Program(s)	2.14*	.195	<.001	1.69	2.60

Based on observed means.

The error term is Mean Square(Error) = 21.721.

Post hoc D

Multiple Comparisons

Dependent Variable: ACT Scale Score - Composite

Games-Howell

(I) CTE Group	(J) CTE Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
0 Years CTE	1 Year CTE Program(s)	1.14*	.203	<.001	.66	1.61
	2+ Years CTE Program(s)	-1.10*	.186	<.001	-1.53	-.66
1 Year CTE Program(s)	0 Years CTE	-1.14*	.203	<.001	-1.61	-.66
	2+ Years CTE Program(s)	-2.23*	.195	<.001	-2.69	-1.78
2+ Years CTE Program(s)	0 Years CTE	1.10*	.186	<.001	.66	1.53
	1 Year CTE Program(s)	2.23*	.195	<.001	1.78	2.69

Based on observed means.

The error term is Mean Square(Error) = 20.367.

Post Hoc E

Multiple Comparisons

Dependent Variable: Days Attended
Games-Howell

(I) CTE Group	(J) CTE Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
0 Years CTE	1 Year of CTE Program(s)	4.99*	1.513	.003	1.44	8.54
	2+ Years of CTE Program(s)	-3.93*	1.238	.004	-6.83	-1.03
1 Year of CTE Program(s)	0 Years CTE	-4.99*	1.513	.003	-8.54	-1.44
	2+ Years of CTE Program(s)	-8.92*	1.427	<.001	-12.27	-5.58
2+ Years of CTE Program(s)	0 Years CTE	3.93*	1.238	.004	1.03	6.83
	1 Year of CTE Program(s)	8.92*	1.427	<.001	5.58	12.27

Based on observed means.
The error term is Mean Square(Error) = 803.543.

Post Hoc F

Multiple Comparisons

Dependent Variable: Days Attended
Games-Howell

(I) CTE Group	(J) CTE Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
0 Years CTE	1 Year CTE Program(s)	3.77*	1.292	.010	.74	6.80
	2 Years CTE Program(s)	-4.74*	1.037	<.001	-7.17	-2.31
1 Year CTE Program(s)	0 Years CTE	-3.77*	1.292	.010	-6.80	-.74
	2 Years CTE Program(s)	-8.51*	1.228	<.001	-11.40	-5.63
2 Years CTE Program(s)	0 Years CTE	4.74*	1.037	<.001	2.31	7.17
	1 Year CTE Program(s)	8.51*	1.228	<.001	5.63	11.40

Based on observed means.
The error term is Mean Square(Error) = 584.66

Post hoc G

Multiple Comparisons

Dependent Variable: Days Attended
Games-Howell

(I) CTE Group	(J) CTE Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
0 Years CTE	1 Year CTE Program(s)	11.13*	2.888	<.001	4.36	17.91
	2+ Years CTE Program(s)	-12.49*	2.386	<.001	-18.09	-6.90
1 Year CTE Program(s)	0 Years CTE	-11.13*	2.888	<.001	-17.91	-4.36
	2+ Years CTE Program(s)	-23.62*	2.667	<.001	-29.88	-17.37
2+ Years CTE Program(s)	0 Years CTE	12.49*	2.386	<.001	6.90	18.09
	1 Year CTE Program(s)	23.62*	2.667	<.001	17.37	29.88

Based on observed means.
The error term is Mean Square(Error) = 3354.872.

Post hoc H

Multiple Comparisons

Dependent Variable: Days Attended
Games-Howell

(I) CTE Group	(J) CTE Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
0 Years CTE	1 Year CTE Program(s)	11.22*	3.587	.005	2.80	19.63
	2+ Years CTE Program(s)	-21.06*	2.715	<.001	-27.42	-14.69
1 Year CTE Program(s)	0 Years CTE	-11.22*	3.587	.005	-19.63	-2.80
	2+ Years CTE Program(s)	-32.27*	3.265	<.001	-39.93	-24.61
2+ Years CTE Program(s)	0 Years CTE	21.06*	2.715	<.001	14.69	27.42
	1 Year CTE Program(s)	32.27*	3.265	<.001	24.61	39.93

Based on observed means.
The error term is Mean Square(Error) = 4411.148.

Post hoc I

Multiple Comparisons

Dependent Variable: Count of Out of School Suspensions During HS

Games-Howell

(I) CTE Group	(J) CTE Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
0 Years CTE	1 Year of CTE Program(s)	-.09	.048	.126	-.21	.02
	2+ Years of CTE Program(s)	.16*	.033	<.001	.08	.24
1 Year of CTE Program(s)	0 Years CTE	.09	.048	.126	-.02	.21
	2+ Years of CTE Program(s)	.26*	.044	<.001	.15	.36
2+ Years of CTE Program(s)	0 Years CTE	-.16*	.033	<.001	-.24	-.08
	1 Year of CTE Program(s)	-.26*	.044	<.001	-.36	-.15

Based on observed means.

The error term is Mean Square(Error) = .905.

Post hoc J

Multiple Comparisons

Dependent Variable: Count of Out of School Suspensions During HS

Games-Howell

(I) CTE Group	(J) CTE Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
0 Years CTE	1 Year CTE Program(s)	-.13*	.052	.036	-.25	-.01
	2 Years CTE Program(s)	.18*	.035	<.001	.10	.26
1 Year CTE Program(s)	0 Years CTE	.13*	.052	.036	.01	.25
	2 Years CTE Program(s)	.31*	.047	<.001	.20	.42
2 Years CTE Program(s)	0 Years CTE	-.18*	.035	<.001	-.26	-.10
	1 Year CTE Program(s)	-.31*	.047	<.001	-.42	-.20

Based on observed means.

The error term is Mean Square(Error) = .996

Post hoc K

Multiple Comparisons

Dependent Variable: Count of Out of School Suspensions During HS

Games-Howell

(I) CTE Group	(J) CTE Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
0 Years CTE	1 Year CTE Program(s)	.02	.048	.882	-.09	.14
	2+ Years CTE Program(s)	.18*	.035	<.001	.10	.26
1 Year CTE Program(s)	0 Years CTE	-.02	.048	.882	-.14	.09
	2+ Years CTE Program(s)	.16*	.041	<.001	.06	.25
2+ Years CTE Program(s)	0 Years CTE	-.18*	.035	<.001	-.26	-.10
	1 Year CTE Program(s)	-.16*	.041	<.001	-.25	-.06

Based on observed means.

The error term is Mean Square(Error) = .917.

Post hoc L

Multiple Comparisons

Dependent Variable: Count of Out of School Suspensions During HS

Games-Howell

(I) CTE Group	(J) CTE Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
0 Years CTE	1 Year CTE Program(s)	-.20*	.058	.002	-.33	-.06
	2+ Years CTE Program(s)	.13*	.029	<.001	.07	.20
1 Year CTE Program(s)	0 Years CTE	.20*	.058	.002	.06	.33
	2+ Years CTE Program(s)	.33*	.055	<.001	.20	.46
2+ Years CTE Program(s)	0 Years CTE	-.13*	.029	<.001	-.20	-.07
	1 Year CTE Program(s)	-.33*	.055	<.001	-.46	-.20

Based on observed means.

The error term is Mean Square(Error) = .848.