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Vocational Education and Training and its Role in Reducing the Risk of High School Dropout in the United States: A Survival Analysis

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ABSTRACT

Vocational Education and Training (or Career and Technical Education, CTE, as is known in the United States) is a viable educational option to increase student engagement, and recent research shows that CTE helps reduce the risk of dropping out among high school students. In the context of changes in the

high school curriculum and CTE at the beginning of the 21st century, advocates for secondary career and technical education have argued that CTE provides many benefits to high school participants. The current study was designed to test one claim, that CTE can reduce the likelihood of students leaving high school prematurely. We analyzed how enrolling in different levels of CTE credit-taking affected students' risk of dropping out of high school when focusing on specific occupational areas. Our approach departed from the traditional classification where students were considered either vocational or academic. Two types of CTE participation were tested: cumulative credits in CTE and fulfilling the requirements in a CTE occupational program by taking three or more credits. Hazard ratios from our survival analysis showed a decreased risk of dropping high school for students taking three or more CTE credits, regardless of whether those credits were taken in an occupational area or not. We also found that while, overall, gender was not a predictor of dropping out, male students who took three or more credits in an occupational area had a reduced risk of dropping out. Also, a higher 9th-grade GPA reduced the risk of dropping out, but older students would see an increase in their risk of dropping out. This study was conducted using restricted data from the Education Longitudinal Study.

INTRODUCTION

The impact of Vocational Education and Training (hereafter career and technical education, CTE, as it is known in the United States) on high school students has been scrutinized in several areas, but more so and with greater emphasis on academic preparation and achievement (Levesque et al., 2008;

McCormick & Tuma, 1995; Michaels & Barone, 2020; Silverberg et al., 2004). An often-asked question has been: Does CTE help prevent students from dropping out? This question has become more critical as CTE has expanded its program and course offerings within the framework of the 16 career clusters (Advance CTE, n. d.).

The current national dropout rate is estimated at 5.1%, which includes about 2 million dropouts as of 2021 (National Center for Education Statistics [NCES], 2022a). While this is an important improvement compared to a decade ago, dropout rates are much higher among Hispanic, Black, Native American/Alaskan Native populations and students of lower socioeconomic status (NCES, 2022b). Although it is still too soon to have a definitive assessment, research conducted so far on the impact of COVID-19 indicates that the pandemic may not have had a significant effect on the dropout rates in the US—contrary to what happened in schools around the world (Moscoviz & Evans, 2022). For example, a study by Harris and Chen (2022) reports that the graduation rate slightly increased in 2020 and came back to levels of prior years in 2021. For other achievement measures, recent reports show statistically significant and profound declines, in 2023 compared to 2012 in score assessments in mathematics (271 v. 285), reading (256 v. 263), and other subjects (National Assessment of Educational Progress, 2023).

Even before the COVID-19 pandemic, there had been a renewed interest in CTE as a viable educational option to help students stay in high school (Stone, 2009; 2014). Most recent studies reported on the positive effect on dropout reduction of CTE coursework in comprehensive schools (e.g., Blowe & Price, 2012; Campbell & Laughlin, 1988; Kulik, 1998; Plank,

2001), but others have expanded the analyses to other settings or populations. For example, some research has looked at the connection between specific models of CTE delivery (e.g., comprehensive high schools, area technical centers, technical high schools, career academies) and dropout reduction, mainly through enrollment in secondary technical schools (Brunner et al., 2021; Neild et al., 2015), CTE-dedicated high schools (Kemple et al., 2023), or career academies (Hemelt et al., 2019). Other studies have reported on the positive effect of CTE on the graduation of students with learning disabilities (Dougherty et al., 2018; Theobald et al., 2019), or on students from racial minorities (Castellano et al., 2007; Conchas & Clark, 2002).

With changes being implemented in the high school and CTE curricula, it is worth exploring whether CTE has continued to have an impact on preventing student dropout.

RESEARCH PROBLEM, PURPOSE, AND RESEARCH QUESTION

The last part of the 1990s and new millennium brought important changes to the education system and CTE. One of the most important changes was the requirement of core academic credits for all high school students to graduate, including CTE students. CTE then became an elective path, and if credits were taken in a sequence, it would place students in a program of study and career pathway for an occupation and postsecondary education (the "new model"). As a result, the formal academic and research distinction and classification of vocational (CTE) and academic students ceased (Aliaga et al., 2012). Therefore, at the beginning of the 21st century, CTE did not look like the "old

model." However, little is known about the impact of CTE on reducing student dropout at that point in time, no analysis has been conducted on that relationship, and no new knowledge has been developed about the impact of those changes. We identify this as our research problem.

The purpose of this study was to explore the impact of taking different levels of CTE credits on reducing the risk of student dropout in high school at a time when major changes were being introduced in the educational system and CTE.

Our study was designed to address the following research question:

Do different levels of CTE credit-taking help reduce the risk of dropping out among high school students?

PERSPECTIVES ON STUDENTS' DROPOUT AND CTE

THE HIGH SCHOOL DROPOUT PROBLEM

Dropouts are those in the 16- to 24-year age range who are unregistered in high school and lack a high school credential (NCES, 2022c). Even though the student dropout rate has decreased significantly in recent years, it still accounts for about 2 million students (NCES, 2022a). However, racial minorities are still more likely to drop out as the status dropout rate for 16- to 24-year-olds in 2020 indicates that the dropout rate is 2.4% for Asian students, 4.2% for Black/African American, 4.8% for White, 7.4% for Hispanic, 11.5% for American Indian/Alaska Native, and 6.5% for those students with two or more races (NCES, 2022b). Males drop out more than females at 6.2% vs. 4.4%, and those in the lowest quarter of the socioeconomic status drop out at 7.2%.

Years of research have shown that the dropout phenomenon cannot be attributed to a single factor. Instead, dropping out is the culmination of a process that involves more than school factors (Rumberger & Rotermund, 2012), including socioeconomic status, gender, family issues, and many more (Doll et al., 2013).

When students drop out of high school, they begin their adult lives with many issues that will limit their life choices, and they are expected to face many problems throughout their lives. Often raised is the economic and financial impact of dropouts. Rumberger (2011) reported that the financial and social repercussions have increased as the requirements for a higher-educated workforce have amplified. Young dropouts are more likely to be jobless, welfare receivers, and, if employed, to make less money than those who did obtain a high school diploma (Swanson, 2009). In 2021, the median annual earnings of high school dropouts was 53% of the total labor force, while the percentage was 67.9 for high school graduates (NCES, 2022d), which translates into $200,000 less in a lifetime (Day & Newburger, 2002). The correlation between dropping out of high school and the lack of skills complicates dropouts' entry into and staying in the labor market, locating a job, and earning an adequate salary, and "in any given year, the likelihood of slipping into poverty is about three times higher for high school dropouts than for those who finished high school" (Annie E. Casey Foundation, 1998, as quoted in Schargel & Smink, 2001, p. 4). Belfield et al. (2012) calculated the economic cost of dropouts in the broader social context, arguing that "both taxpayers and society lose out when the potential of these youth is not realized" (p. 1). According to their estimates, the "average opportunity youth imposes a total fiscal burden of $13,890 and a total social burden of $37,440" (p.

15) per year for those aged 16-24. Throughout their lifetime, the social burden is calculated at $704,020, totaling $4,745.1 billion for their cohort (p. 25).

Dropping out of school also "tends to coincide with increased delinquency, teen pregnancy among females and incidents of alcohol drug use and abuse" (Uretsky, 2019, p. 1), as well as poor health and homelessness. Dropouts are more likely to join gangs, participate in other criminal acts, and serve jail time (Battin-Pearson et al., 2000; McFarland et al., 2016; Rumberger, 2011; Swanson, 2009).

CTE AND HIGH SCHOOL DROPOUTS

THE EXPECTATION IN THE BROADER CONTEXT: VIEWS OF THE SOCIETAL ROLE OF CTE

CTE has an important place in the education debate about reducing student dropout. The fact that 88.0% of all students take at least one CTE credit (NCES, n. d.; Table H186) in secondary education has not only increased the interest in CTE but also deepened the scrutiny of its impact on reducing student dropout. Central to that debate is the belief that CTE increases engagement among high school students (Xing & Gordon, 2021).

CTE provides an authentic learning context that fosters students' engagement in school, including affective engagement (Diehl, 2020), where students have a space to apply their knowledge and skills through hands-on learning, collaboration, and practical work experience through work-based learning. The National Assessment of Vocational Education Independent Advisory Panel in 2004 strongly advocated for the unique opportunity CTE provides for learning, indicating that:

> a career focus often gives students a sense of direction and motivates them to achieve and to stay in school. Practically inclined students can become hooked on academic learning through CTE study. This is especially important for young people who learn best by doing, a group that includes disproportionate numbers of disadvantaged and special education students. Just having the option of being able to concentrate in CTE in high school results in more young people staying in school because more individually relevant choices are available to them (p. 6).

The view of CTE is that it supports students' engagement and learning by "providing young people with the academic, technical, and employability skills and knowledge to pursue postsecondary training or higher education and enter a career field prepared for ongoing learning" (American Institutes for Research, 2013, p.1). CTE has benefitted students considered underachieving and those unable, unwilling, or unexpected to graduate for different reasons (Castellano et al., 2003, p. 243). Under this premise, students would enroll in CTE to make their high school experience beneficial—in educational, social, and economic terms. Even today, CTE is viewed as an avenue to the middle class for impoverished students (Aliaga, 2022).

RESEARCH ON CTE AND STUDENT DROPOUT UNDER THE "OLD MODEL" OF CTE

Research on the link between CTE and student dropout reduction is not new. Research conducted in the 1980s and 1990s under the "old model" of CTE was inconclusive about the

effects of CTE on dropouts. One noticeable aspect of the disparity of the reported results is that, at least in part, they may be the artifact of the variability of approaches used, as discussed by Aliaga (2023).

Using regression models with data from the NLS Youth Cohort for 1979 and 1980, Mertens et al. (1982) concluded that vocational education coefficients were "always associated positively with school completion" (p. 90). Similarly, Catterall and Stern (1986), using 1980-1982 California data from the High School & Beyond longitudinal dataset, argued that vocational (CTE) education had a dropout-preventing effect on students. A more neutral conclusion was described by Agodini and Deke (2004), who, using NELS data for the 1980s and 1990s, found that students engaged in CTE had the same chance of dropping out as the average high school student. In their final report to Congress, Silverberg et al. (2004) stated that the research they evaluated slightly positive effects of CTE on students completing high school.

A different approach was taken by Plank et al. (2008). Using data from the National Longitudinal Survey of Youth of 1997, they applied survival analysis models to study students' dropout, for which their academic/vocational credit-taking ratio was examined. They concluded that "some CTE, combined with core academic course taking, may decrease the risk of dropout—but only up to a point" and that "one CTE course for every two core academic courses is associated with the lowest risk of dropping out" (p. 360). Bozick and Dalton (2013) did not see any direct connection between CTE and dropout prevention, indicating that occupational courses "were unrelated to the likelihood of dropping out" (p. 47) but, at the same time, stressed

that "occupational courses may serve as a mechanism to keep those in school who are struggling academically" (p. 50).

Evaluating the impact of CTE, Bishop and Mane (2004) pointed out that enrolling in more CTE would result in an increased high school graduation rate by 2.6%. In a literature review that included several types of research, Cohen and Besharov (2004) summarized that "more credible studies using large databases suggest that CTE has a modest positive effect on high school completion," and more specifically, "taking a vocational course or being on the vocational track as compared with the general track seems to increase students' chances of completing high school" (p. 48).

RESEARCH UNDER THE "NEW MODEL" OF CTE

Research studies conducted after the implementation of the comprehensive school reform (i.e., under the "new model" of CTE) show more consistent findings about the positive effect of CTE in reducing student dropout. The variety of studies using nationwide, regional, or state data helps us understand CTE and its connection to student dropout in a broader context since it captures the phenomenon at different levels.

Rumberger and Arellano (2007) studied the experiences of students in 63 high schools in California that were part of the Education Longitudinal Survey of 2002. They observed that students enrolling in the vocational track were twice as likely to graduate high school. Analysis of data from the Commonwealth of Virginia for the academic years 2008 through 2010 indicated that CTE completers "attained mean high school cohort graduation rates of 6% to 13% higher than non-CTE completers for the years of the study" (Blowe & Price, 2012, p. 7)

Recent studies about the impact of CTE on reducing dropout rates have focused on the different types of CTE delivery models, bringing in a broader discussion about CTE and dropouts. In a study conducted in three schools in a school district in the western United States, Castellano et al. (2017) found that "holding student characteristics constant, enrolling in a POS [program of study] high school increased students' probability of graduation by an average of 11.31 %" (p. 61). They also reported that for each CTE course a student took, their likelihood of graduation increased by 4%.

In a study of students attending the school district of Philadelphia in 2003, 2004, and 2005, Neild et al. (2015) found that students attending CTE had between 20% and 36% higher odds of graduating high school. Using data from Massachusetts, Dougherty (2018) concluded that "CTE participation in an RVTS [regional vocational and technical high schools] is associated with higher probabilities of graduating from high school on time" (p. 129). Hemelt et al. (2019) examined participation in a technology career academy, and their results showed it increased the likelihood that a student graduates from high school by about eight percentage points. Focused on technical high schools, a different model, Brunner et al. (2021) used a regression discontinuity approach to analyze data for students in the academic years 2005-06 to 2012-13. They concluded that enrolling in that type of school increased high school graduation rates by six percentage points overall. Kemple et al. (2023) examined the impact of 37 CTE-dedicated high schools in New York City and found that by the end of 12th grade, CTE and non-CTE students graduated at the same rate.

Other studies have been conducted at the national level, usually looking at the impact of CTE coursework. Gottfried and

Plasman (2018) analyzed the timing of dropping out of school and how that related to CTE credit-taking. They observed that "taking a greater number of CTE units across Grades 9 through 12 was associated with a lower chance of dropping out" (p. 343). Similarly, Gottfried (2022) concluded that "there was a positive association between early high school AS [Applied STEM] course taking and high school completion" and that "the odds were approximately 2.22-to-1 [of graduating] for those who took an AS course" (p. 187). Xing and Gordon (2021) estimated that "for all students, participation in CTE coursework had a significant and positive influence on high-school on-time completion over non-completion. Specifically, the change from a CTE non-participant to a participant (or from a participant to a concentrator) resulted in 1.68 times the odds of the student completing high school on time over the odds of non-completion" (p. 15).

CONCEPTUAL FRAMEWORK

POLICY CHANGES IMPACTING THE HIGH SCHOOL CURRICULUM AND CTE

By the early 2000s, high school students attended schools with a curriculum that emphasized academic content and included a set of standards and core requirements for all students, including those enrolling in CTE.

CTE, too, was different because of "the inclusion of rigorous academic coursework in CTE programs and instruction" (Cushing et al., 2019, p. 4), the consistent offering of work-based learning, and the articulation agreements with postsecondary institutions (Castellano et al., 2003; Young et al., 2011). Thus, students enrolling in CTE at the turn of the new century started to be exposed to more academic content, a different set of expanded

CTE programs, curriculum, and instructional designs that were unlike the ones that existed under the "old model" (vocational education). Two underlying new educational concepts for CTE students in the late 1990s and early 2000s were programs of study, the completion of which became an accountability indicator (see Imperatore & Hyslop, 2017), and career pathways, which was instituted as a matter of policy later on with the adoption of the Strengthening Career and Technical Education for the 21st Century Act (2018), also known as Perkins V.

Changes in the high school curriculum and CTE had as a goal the increase of students' academic achievement and the development of knowledge and skills that would prepare them for a career. The ultimate purpose was to help students complete high school, graduate, and be prepared "concomitantly for employment *and* higher education" (Lynch, 2000, p. 158). Consequently, the improved curricula and instructional designs would help reduce student dropout by providing engaging learning activities, hands-on experience, and educational pathways to help them stay in school. At that historical moment, these CTE policies and school changes provide an important context to evaluate the impact of CTE on student dropout.

CONSTRUCTIVISM AND CTE: ENGAGING IN LEARNING TO REDUCE STUDENT DROPOUT

Although research has not concluded on specific factors that lead to student dropout, several studies have pointed out the role played by engagement (Archambault et al., 2009; Janosz et al., 2008; Manzuoli et al., 2019; Piscitello et al., 2022; Robison et al., 2017; Rumberger & Rotermund, 2012), proposing that both social and academic engagement, as well as other individ-

ual and institutional factors, can lead to school completion, thus preventing or reducing dropping out of schools (Rumberger & Rotermund, 2012).

Constructivism provides a more comprehensive approach to understanding student learning and engagement in school in connection to CTE. The relationship between constructivism and CTE can be traced back to the 19th century when there was much discussion about the philosophy informing the model for vocational education. Social efficiency and constructivism, in particular, were debated in connection to the passing of the Smith-Hughes Act of 1917, with the former becoming the prevailing philosophical influence (DeFalco, 2016). The current policy in Perkins V and its emphasis on programs of study, career pathways, and work-based learning, to some extent brings back a framework that focuses on learning and preparing students for further education, for a career and employability—beyond the preparation only for an occupation (Patton, 2005), thus taking on the premises of constructivism.

A central tenet of social constructivism is the learner's role in knowledge creation and the significance of experience in that process (Applefield et al., 2000; Fosnot, 1996; Steffe & Gale, 1995). Experience is seen as a knowledge catalyst, whether it is socially-oriented or object-oriented (Doolittle & Camp, 1999). The more the experience is enhanced, the more the knowledge will be improved. Real-life experiences are essential, and this way, individuals can construct an accurate portrayal of the real world (Burhanuddin et al., 2021). Constructivism also emphasizes the importance of content and skills aligning to the individual's current situation, knowledge, goals, and cultural background (Richardson, 2003). This elevates one's motivation to

continue experiences that will strengthen their skills (Pintrich & Schunk, 1996).

Equally crucial for CTE and student learning, from a social constructivism approach, are two concepts: the first one is situated learning, which indicates that "knowledge is conceived as being embedded in and connected to the situation where the learning occurs" (Applefield et al. 2000, p. 38). Because of the nature of the CTE programs and fields, the learning always occurs in the context of, for example, agriculture, engineering, health, and other areas.

The second concept is working on collaboration, in contact with other learners, including the instructor. This is particularly clear in the case of work-based learning, "where one learns on the job by closely working" with others (Applefield et al., 2000, p. 39), and reinforces the idea of "the social nature of knowledge and the belief that knowledge is the result of social interaction and language usage and, thus, is a shared, rather than an individual, experience" (Marques, 2017, p. 183).

The CTE curriculum is ideal for tapping on these constructivist pedagogical elements, thus ensuring that shared meaning and knowledge are created within a group process (Richardson, 2003). Adopting a constructivist pedagogy in CTE enhances the likelihood of students engaging in school and thus reducing the chances of dropping out.

METHOD

This is a causal-comparative research study that used a longitudinal cohort survey. Causal-comparative designed studies look into the relationships between variables and the possible causes "for a behavior pattern by comparing subjects in whom this pat-

tern is present with similar subjects in whom it is absent or present to a lesser degree" (Borg & Gall, 1983, p. 533). A central feature of causal-comparative research is that it "focuses on making group comparisons" (Mertens, 1998, p. 86), which is the primary objective of this study.

The first part of our analysis provides descriptive statistics of the relationships between background characteristics and variables of interest. We used Chi-square to test independence between those variables and whether the relationship between them varied by the categories used. In the second part of our analysis, we used a survival model.

DATA AND SAMPLE

We used data from the Education Longitudinal Study of 2002 [ELS:2002]. The ELS:2002 "follows a nationally representative cohort of students from the time they were high school sophomores through the rest of their high school careers" (NCES, 2010, Overview section, ¶ 3).

By the time data for ELS:2002 started to be collected, students had begun to be exposed to a new high school curriculum and CTE programs, and the new school reality provided an ideal policy and programmatic context to analyze the CTE credit-taking patterns and whether and how they impacted student dropout. Although there is a preference that the newness of data is superior to older counterparts, we concur that "dichotomizing research into 'old' and 'new' creates an arbitrary duality that promotes dismissal of valuable knowledge from earlier time periods and an artificial limitation of accepted knowledge based on the value of newness" (Hong et al., 2022). Even though the

ELS:2002 data are older, they still have value that can enlighten our views of CTE in the classroom, particularly at the beginning of the 21st century.

We used two sets of the ELS:2002 data. The first is the *public* file, which is data publicly available to any user, that we used to explore the relationships between background characteristics and variables of interest displayed in Tables 2 through 4. The second includes data from the *restricted-data* file, available only through restricted licenses granted by NCES. We used the restricted ELS:2002 datasets for the primary analysis of this study (Tables 5 and 6, and Figure 1). The reporting sample in the survival model is restricted to graduates of U.S. public high schools, grades 10 to 12, with an overall reporting sample of N=9,243.

VARIABLES

EXPLANATORY VARIABLES

We conducted our study using a set of exploratory variables, including CTE credit-taking, and three types of variables that are more commonly used in CTE research (see, among others, Alexander et al., 1997; Bowers et al., 2013; Christle et al., 2007; Dougherty, 2018; Gottfried & Plasman, 2018; Plank, 2001; Pong & Ju, 2000; Xing et al., 2020): (a) students' demographic and background characteristics, that includes gender, race, socioeconomic status, and age; (b) students' prior achievement, specifically math tests scores at 10th grade, 9th-grade and overall high school GPA, and expectations of the high level of educational achievement; and (c) students' high school type.

We used a variable that represents three different groups of CTE credit-taking students: a) Those who took three or more

credits focusing on an occupational area (or specific labor market preparation area), b) those who took three CTE credits but did not focus on an occupational area, and c) those who took less than three CTE credits (Table 1). The latter group became our comparison group. Students in the comparison group choose to take a more limited exposure to CTE possibly because such enrollment complemented a more academically-oriented curriculum, lacked an interest in a specific occupational area, or because their school may not have offered other courses in the same occupational area.

DEPENDENT VARIABLE

We used a "dropout status" variable in our descriptive analysis that describes students' dropout status as of 2004—the Spring semester of the student's senior year in the survey cohort. The dependent variable in our hazard model is the event when students drop out of high school.

ANALYTICAL FRAMEWORK

Our survival analysis models the time for some event to occur—in this case, dropping out of high school, which is an event that represents a transition from one state to another (Hougaard, 2000). Consequently, survival analysis allows us to "observe something that develops dynamically over time" (p. 36), as it "focuses on the distribution of survival times" (Fox, 2002, p. 1).

We used a condensed version of the CTE typology reported by Aliaga et al. (2014). The typology informs participation in CTE for *all* high school students and whether those cred-

its were taken in the same specific labor market preparation (SLMP) area. The typology is a practical framework because it is based on the actual number of credits students took. Furthermore, the typology brings a different paradigm for analysis that avoids analysis based on the divide between academic and CTE students. Their typology originally used eight categories, but the authors indicated that those categories could be grouped according to the research needs. Thus, we included three groups (see Table 1). We focused our analysis on those students taking three or more CTE credits because it reveals an intent to focus on an occupational area or make a combination that may be useful for their future endeavors (Stone & Aliaga, 2007).

RESULTS

DESCRIPTIVE DATA

Chi-square tests were used to identify the relationships between gender, race, socioeconomic status, prior student achievement, expectation of the highest educational achievement, and school location with GPA and dropout status.

First, we examined the association between background variables and the categorical cumulative GPA for grades 9 through 12 (Table 2). We started with GPA because it has been associated with students' engagement and staying in school (Bridgeland et al., 2006; Rumberger & Rotermund, 2012). Our analysis showed that more male students reported having lower levels of GPA, while more female students had a GPA between 2.51-3.00 and higher. White students, the largest group of students in the sample, had higher GPAs throughout high school than any other students, but they were also the largest group with GPAs

of 3.00 or lower. In both cases, they were followed by Hispanic and African-American students. Students from the lowest socio-economic status quartile have a lower GPA than all other quartiles, with 19.2% having a GPA of 3.00 and lower, while students with a GPA of 3.0 or lower in the highest quartile amounted to 10.7%—almost half as many. Noteworthy is that few students in the lowest quartile of the SES had a GPA above 3.00 compared to those in the highest quartile. Students in the highest quartile with a GPA of 3.0 or higher were almost three times the number of students with the same GPA in the lowest quartile.

Math test results confirmed other studies about tests predicting academic achievement (Christle et al., 2007; Jimerson et al., 2000). The math test standardized score used in this study was collected in the Spring of 2002 among 10th-grade students and was divided into quartiles. First, 20.9% of all students classified in the lowest math quartile had a GPA of 3.00 or lower, and only 2.2% of students in the same quartile earned a GPA higher than 3.00. The number of students earning a GPA of 3.00 or lower decreased with higher quartiles of math achievement. Students in the highest math quartile with a GPA of 3.00 or lower were almost three times smaller than their counterparts in the lowest quartile (7.5% compared to 20.9%). Conversely, the percentage of students in the highest quartile with a GPA higher than 3.00 was 18.3%, compared to only 2.2% of students in the lowest quartile with the same overall GPA.

Data on the expectation of the highest level of education achievement show that students who didn't know what the highest level of education achievement they would complete, those who were to complete less than high school, students who thought they would get a GED or another high school creden-

tial, and those students who would complete high school only, combined represented 14.1% of all students who would also have a GPA of 3.00 or lower. On the other hand, students who belonged to those groups and had a GPA of 3.00 or higher were only 1.8% of all students. Students who had a GPA of 3.00 or lower expected to attend and complete 2-year college degrees and 4-year college degrees in higher numbers than those with a GPA higher than 3.00, but more students with a GPA of 3.00 or higher expected to complete a graduate degree at the Master or doctoral levels.

Finally, students in rural schools were the smallest group with a GPA of 3.0 or lower, followed by students in urban and suburban schools—the latter registered the highest percentage of all students with a GPA of 3.0 or lower. By contrast, those in suburban schools had the highest rate of students with a GPA higher than 3.0, followed by students in urban and then rural schools.

We also report the relationships between background characteristics and dropout status (see Table 3). ELS:2002 provides three indicators of dropout status: a) dropout, which indicates a student who had dropped out as of Spring of 2004, the Spring semester of their senior year; b) prior dropout, which is described as a student still enrolled in the "Spring term of 2004 at time of survey day but with dropout status at any of the 3 enrollment status updates" (NCES, 2012, p. 207); and c) alternative completer, which is a student who had earned an early GED, before March 15, 2004 (NCES, 2012). For this study, we focused on the dropout-only data.

Overall, dropout rates are higher in male students than among female students, a fact that previous research has also found (Fortin et al., 2013; Kaufman et al., 1996; National Center for Education Statistics, 2022c; Rumberger, 1983). Also, White

students had the highest dropout rate in this cohort, followed by Hispanic and African Americans. In past research, Black/African American students had higher dropout rates (Behnke et al., 2010; Griffin, 2002; Kaufman et al., 1996; Robison et al., 2017; Rumberger, 1983).

Students in the lowest SES quartile showed a dropout rate of 3.2%, the highest among all students, which is consistent with existing literature (O'Connell & Sheikh, 2009; Robison et al., 2017; Rumberger, 1983; Suh et al., 2007; Wood et al., 2017). It decreases as the SES quartiles go up. Prior achievement in the form of a math test taken in 10th grade revealed that those with the lowest scores had the highest dropout rate, which also decreased in the higher quartiles of the test scores. Results in the category of expectations of highest educational achievement confirmed prior studies about school engagement: students who did not know the highest level of education they would achieve registered the highest dropout rate. What is also revealing is that the second highest dropout rate was among students who would expect to attend and complete a 2-year college degree, followed by those who would expect to attend and complete a 4-year college degree. Students who expected to obtain a GED also had a high graduation rate. Lastly, urban and suburban students have the highest dropout rates.

In Table 4, we report the relationships between cumulative GPA for grades 9th through 12th and dropout status. As expected, dropout rates among students with an overall high school GPA of 3.0 or lower were the highest, totaling 5.8%, which is the dropout rate calculated more recently for all students (NCES, 2022a). Interestingly, there were practically no dropouts among students with the highest GPA of 3.51 to 4.00.

SURVIVAL ANALYSIS MODEL: CTE CREDIT-TAKING AND THE RISK OF DROPPING OUT

We start by pointing out that our model reports a chi-square of 234.916, with a *p*-value of <0.000, which indicates a good model fit.

The results from our survival model appear to confirm the positive effect of CTE credit-taking on reducing student dropout (Table 5). The hazard ratio of students who took 3 or more CTE credits focusing on an occupational area is less than 1, indicating a reduced risk of dropping out of about 36%, compared to those taking less than 3 CTE credits. Similarly, the group of students who took 3 or more CTE credits without focusing on an occupational area had a higher reduced risk of dropping out of school of about 51%, compared to those taking less than 3 CTE credits. Overall, this is a significant finding that confirms recent research on the positive impact of CTE on helping students finish high school. The hazard model is depicted in Figure 1.

Our model also showed that overall, for each point increase in the 9th-grade GPA, the risk of dropping out decreased by 73%. On the other hand, for each additional overage year, the likelihood of dropping out increased by 4.1%. It is important to note that neither gender, race, or SES were statistically significant contributors to predicting dropping out in our model.

Because gender was not statistically significant in the overall model, we replicated the same model separately for each the male and female student groups (Table 6). Both gender models reported chi-squares of 123.947 and 90.743, with a *p*-value of <0.000, indicating a good model fit in both cases. In the male students' model and at a 95% confidence level, only those stu-

dents who took three or more CTE credits focusing on an occupational area had a reduced risk of dropping out of high school of about 70%, compared to students who took less than 3 CTE credits. However, there was no significant effect for males taking more than three credits and not focusing on an occupational area. For female students, CTE credit-taking, whether or not focusing on an occupational area, was not a significant factor in reducing their risk of dropping out.

Additionally, 9th-grade GPA and age were strong predictors in both gender-based models, predicting a lower risk of dropping out of about 73% to 76% with a unit increase in 9th-grade GPA for male and female students, respectively, but a higher risk of dropping out of between 4% and 5% with each additional year of age. Race and SES were non-significant factors.

DISCUSSION AND CONCLUSIONS

In the context of the new and improved CTE curriculum and program designs implemented at the turn of the 21st century, this study aimed to examine if different levels of CTE credit-taking had any impact on reducing the risk of dropping out of school. Although dropout rates have decreased in recent years, dropping out still represents a problem to address, particularly for some student populations. Research on CTE and student dropouts conducted in the last two decades has consistently shown that CTE has a positive impact on reducing high school dropouts.

The descriptive data from this study (Tables 2-4) show significant relationships between main background factors and dropout rates. Those associations do not entirely explain, *per se*, the phenomenon of dropping out, but they reveal more intricate

interactions at the family and social levels (see Audas & Willms, 2001). Concerning academic performance, there is a clear association between lower GPAs and lower Math test scores by 10th grade with dropping out.

The primary analysis we conducted in this study, using a survival model, confirms the connection between CTE credit-taking and reducing student dropout risk. We began our report by arguing the importance of changes in CTE policy that resulted in changes in the high school curriculum and CTE in the late 1990s and early 2000s. Our analysis confirms that credit-taking patterns that followed those policy changes, specifically changes in CTE, positively impacted high school completion at the onset of the 21st century.

From a constructivist perspective, we have argued that CTE provides an authentic learning context that favors student engagement and that CTE curriculum and program designs contribute to student high school completion. In this study, we focused on coursework as part of our constructivist perspective because CTE courses bring alternative and more meaningful ways of learning. CTE engages students more effectively through project-based, hands-on experience, as well as through its collaborative learning approach, which are characteristics of most CTE courses. In addition, enrolling in CTE coursework that is part of a sequence of courses in CTE programs of study and career pathways (e.g., manufacturing, health sciences, business, etc.) sets a more articulated and relevant context for students to stay and graduate.

Our overall survival analysis model indicates that any student taking three credits in CTE, whether or not those credits were focused in an occupational area, significantly reduces

the risk of high school dropout. In our gender-based survival analysis models, that effect is particularly relevant to male students who took three or more CTE credits but only when those credits focused on an occupational area. In their specific model, female students who enrolled in 3 or more CTE credits do not register an increase or decrease in their risk of dropping out, whether those credits were in an occupational area or not. However, knowing that male students drop out of high school at higher rates, this finding is positive news. It means that while CTE positively affects male students' likelihood of completing school, simultaneously, it does not translate into CTE harming the trajectories for female students who take the same amount of CTE coursework.

In addition to the effect of the CTE coursework, our general model and our models for male and female students also showed a critical variable that helps reduce the risk of dropping out of high school: 9th-grade GPA. Prior academic achievement, namely performance in 9th-grade, signals potential success or failure in completing high school. This is why it is very important to adopt programs and curricula to strengthen students engagement in school as early as possible, and CTE can undoubtedly play an essential role from that perspective. However, we need to be cautious about participation in CTE as early as 9th-grade because, for a majority of schools and students, CTE is offered mainly in comprehensive high schools and usually in the 11th and 12th grades only (Silverberg et al., 2004, p. 20; U.S. Department of Education, 2014, p. 105).

Similarly, it is important to note the role of age in predicting the risk of dropping out. In our three models, the overage the student, the higher the risk of dropping out of high school. Age may be associated with disengagement and other factors

(family challenges, risky behavior, etc.), and as students grow older, those issues may be accentuated. If CTE can engage these students in school, it faces the challenges referred to above—that since, for a vast majority of students, CTE is offered in the last two years of high school, it may be a little too late for them as a viable option.

It is intriguing, however, that gender, race, and socioeconomic status are not predictors of reducing or increasing the risk of dropping out while controlling for other key characteristics, even though policies have been designed to target students with those characteristics with greater dosage of CTE because of their perceived greater likelihood of dropping out. This would justify further research.

The discussion about the impact of CTE on reducing dropouts in the context of the current curriculum also poses the question of the impact of programs of study and, more broadly, career pathways. Career pathways are "templates for [1] the integration of academic and technical content and [2] the articulation of secondary and postsecondary instruction within specific career clusters" (Lewis, 2008, p. 166) that provide "knowledge and skills, both academic and technical, that must be acquired to prepare for occupations at varying levels within these [career] clusters" (p. 169).

In addition to coursework, further research should include work-based learning participation, earning industry-recognized credentials, participation in CTE student organizations, and the combined effect of these designs on student dropout to have a more rounded perspective.

A critical contribution of this study is that it relies on CTE credit-taking levels to understand students' risk of dropping

out of high school, and thus avoids the analysis based on CTE concentration categorization and the use of the student dichotomy of CTE vs. academic. These findings are important because they confirm, through a different analytical framework, the positive impact of CTE on student engagement and dropout reduction.

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Table 1
CTE Credit-Taking Experience of Public High School Students. ELS:2002. (Restricted File)

Original Classification			Classification for this Study		
		%			%
1	No CTE credits	8.0	1	Less than 3 CTE credits	56.1
2	More than 0 and less than 1 CTE credits	7.5			
3	1 CTE credit	10.7			
4	More than 1 and less than 3 CTE credits	29.9			
5	3 CTE credits, no occupational area fulfilled	7.6	2	3 CTE credits of more, no occupational area fulfilled	27.2
6	More than 3 CTE credits, no occupational area fulfilled	19.6			
7	3 CTE credits, 1 occupational area fulfilled	0.8	3	3 CTE credits or more, one or more occupational area fulfilled	16.8
8	More than 3 credits, at least 1 occupational area fulfilled	16.0			
	TOTAL	100.0		TOTAL	100.0

Source: Aliaga, Kotamraju & Stone (2014)

Table 2
High School GPA, by Selected Variables (Percentages). ELS:2002. (Public File). Chi-Square

	GPA for All Courses Taken in the 9th - 12th Grades							Total
	0.00 - 1.00	1.01 - 1.50	1.51 - 2.00	2.01 - 2.50	2.51 - 3.00	3.01 - 3.50	3.51 - 4.00	
Gender								
Female	0,8	2,1	4,9	8,6	11,0	11,7	11,0	49,9
Male	1,5	3,8	8,0	10,9	10,7	9,2	6,0	50,1
Race								
Amer. Indian/Alaska Native	0,0	0,1	0,1	0,3	0,2	0,1	0,1	1,0
Asian, Hawaii/Pac. Islander	0,1	0,1	0,3	0,5	0,8	1,0	1,2	4,1
African American	0,9	1,5	3,0	3,5	2,9	1,6	0,5	13,7
Hispanic	0,6	1,5	3,1	3,7	3,2	2,3	1,2	15,7
More than one race	0,1	0,3	0,6	0,8	1,0	0,8	0,4	4,1
White	0,6	2,3	5,8	10,6	13,6	15,0	13,6	61,5
Socio-Economic Status								
Lowest quartile	1,0	2,3	4,8	5,9	5,2	3,3	1,8	24,4
Second quartile	0,9	1,9	3,9	5,4	5,5	4,5	3,1	25,1
Third quartile	0,3	1,2	2,7	4,8	5,7	6,1	4,3	25,1
Highest quartile	0,1	0,5	1,5	3,4	5,2	6,9	7,8	25,4
Student Prior Achievement								
Math Quartile 10th Grade - Low	1,3	2,9	5,6	6,7	4,4	1,9	0,3	23,1
Math Quartile 10th Grade	0,6	2,0	4,4	6,2	6,2	4,3	1,5	25,2
Math Quartile 10th Grade	0,3	0,8	2,0	4,5	6,6	6,8	4,7	25,8
Math Quartile 10th Grade - High	0,0	0,2	0,8	2,0	4,5	7,8	10,5	25,9
Expectation of Education								
Don't know	0,5	1,0	2,0	2,6	1,8	1,0	0,3	9,2
Less than high school	0,1	0,1	0,1	0,1	0,0	0,0	0,0	0,4
GED or other	0,3	0,4	0,4	0,3	0,1	0,0	0,0	1,4
High school only	0,2	0,5	1,4	1,4	0,8	0,4	0,1	4,8
Attend/complete 2-year college	0,6	1,5	3,1	4,6	3,5	1,8	0,5	15,5
Attend/complete 4-year college	0,4	1,6	4,0	7,0	8,7	8,6	5,4	35,7
Master's degree or equivalent	0,1	0,5	1,2	2,2	4,3	5,9	6,1	20,3
Doctoral/advanced degree	0,1	0,3	0,7	1,3	2,5	3,1	4,6	12,6
School Location								
Urban	1,1	2,3	4,0	5,8	5,9	5,3	4,3	28,7
Suburban	0,9	2,6	6,4	9,6	11,6	11,2	9,1	51,5
Rural	0,2	1,0	2,5	4,1	4,1	4,3	3,6	19,8

All relations statistically significant at p <.001

Table 3
High School Dropouts, by Selected Variables (Percentages).
ELS:2002. (Public File). Chi-Square

	Dropout Status				Total
	Not dropout	Dropout	Prior dropout	Alternative completer	
Gender					
Female	45,7	2,9	0,6	0,5	49,7
Male	45,0	3,7	0,9	0,7	50,3
Race					
Amer. Indian/Alaska Native	0,9	0,0	0,0	0,0	1,0
Asian, Hawaii/Pac. Islander	4,0	0,1	0,1	0,0	4,2
African American	12,3	1,4	0,5	0,1	14,4
Hispanic	13,7	1,8	0,3	0,2	16,1
More than one race	3,6	0,3	0,1	0,1	4,1
White	56,2	2,9	0,5	0,7	60,3
Socio-Economic Status					
Lowest quartile	20,5	3,2	0,6	0,4	24,8
Second quartile	22,3	1,9	0,4	0,3	25,0
Third quartile	23,6	1,0	0,3	0,2	25,2
Highest quartile	24,3	0,4	0,2	0,2	25,1
Student Prior Achievement					
Math Quartile 10th Grade - Low	19,5	3,2	0,6	0,3	23,7
Math Quartile 10th Grade	22,2	2,2	0,5	0,5	25,3
Math Quartile 10th Grade	24,1	0,9	0,3	0,3	25,6
Math Quartile 10th Grade - High	24,8	0,3	0,1	0,2	25,4
Expectation of Education					
Don't know	7,5	2,0	0,2	0,0	9,7
Less than high school	0,3	0,2	0,0	0,0	0,4
GED or other	0,6	1,0	0,0	0,1	1,7
High school only	4,3	0,3	0,1	0,2	4,9
Attend/complete 2-year college	13,5	1,5	0,3	0,2	15,4
Attend/complete 4-year college	33,3	1,3	0,5	0,4	35,5
Master's degree or equivalent	19,6	0,3	0,3	0,1	20,3
Doctoral/advanced degree	11,8	0,2	0,1	0,1	12,2
School Location					
Urban	26,2	2,7	0,7	0,4	30,0
Suburban	46,4	2,7	0,6	0,5	50,2
Rural	18,0	1,2	0,2	0,3	19,7

All relations statistically significant at p <.001

Table 4
High School Dropouts, by Cumulative 9th-12th Grades GPA (Percentages). ELS:2002. (Public File). Chi-Square

	Dropout Status				Total
	Not dropout	Dropout	Prior dropout	Alternative completer	
Cumulative GPA 9th-12th Grade					
0.00 - 1.00	0,9	1,2	0,1	0,1	2,3
1.01 - 1.50	3,4	1,9	0,3	0,2	5,9
1.51 - 2.00	10,6	1,5	0,4	0,4	12,9
2.01 - 2.50	18,1	0,9	0,3	0,2	19,5
2.51 - 3.00	21,1	0,3	0,2	0,1	21,7
3.01 - 3.50	20,6	0,1	0,1	0,0	20,8
3.51 - 4.00	16,9	0,0	0,1	0,0	17,0

All relations statistically significant at p <.001

Table 5
Model Estimates of a Survival Model for Career and Technical Education Credit-Taking and Dropping Out of High School. ELS:2002 (Restricted File)

Predictor	*Exp(B)*	Sig.
Gender (Female. Reference: Male)	0.817	0.288
Age	1.041	0.000
Socioeconomic Status (Reference: Highest quartile)	0.687	0.01
9th-Grade GPA	0.272	0.000
CTE Credit Taking (Reference group: Less than 3 CTE credits)		0.012
3 or more CTE credits, No Focus on Occupational Area	0.644	0.045
3 or more CTE cr, Focus on Occupational Area	0.495	0.009

Cases in Analysis		
Event	120	
Censored	9123	
Total	9243	
Chi-Square	234.916	
df	6	
Sig	0.000	

Figure 1.
Hazard function of dropping out and CTE credit-taking categories
ELS:2002 (Restricted File)

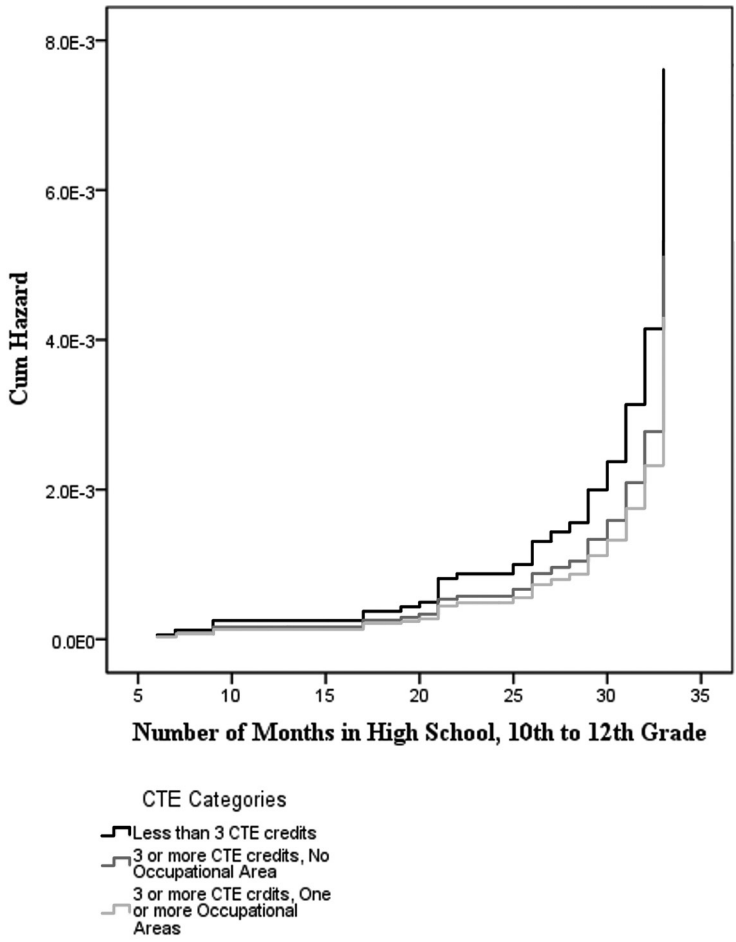

Table 6
Model Estimates of a Survival Model for Career and Technical Education Credit-Taking and Dropping Out of High School, by Gender. ELS:2002 (Restricted File)

Predictor	Male		Female	
	Exp(B)	Sig.	*Exp(B)*	Sig.
Age	1.044	0.002	1.051	0.009
9th-Grade GPA	0.267	0.000	0.243	0.000
CTE Credit Taking (Reference: Less than 3 CTE credits)		0.007		0.692
3 or more CTE credits, No Focus on Occupational Area	0.615	0.080	0.736	0.391
3 or more CTE cr, Focus on Occupational Area	0.305	0.004	0.914	0.809
Cases in Analysis				
Event	72		48	
Censored	4358		4765	
Total	4430		4813	
Chi-Square	123.947		90.743	
df	4		4	
Sig	0.000		0.000	