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Does Career and Technical Education in High School Increase the Odds of College Enrollment?

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Abstract

The legacy of career and technical education (CTE) in years past, stretching into the vocational education era, was lower college enrollment after participating in CTE. More recently, others have concluded that college enrollment is not affected but that CTE students enroll more frequently in 2-year degrees over 4-year degrees. I revisit the question with more recent data than has been used by other researchers. I adjust my estimates by the level of academic preparation that students have undergone in high school, known as curricular intensity. I use transcripts from the High School Longitudinal Study of 2009 (HSLS:09) to determine participation in meaningful CTE course sequences, known as programs of study, and then follow the students via the HSLS:09 survey administered in the fall after high school. I find that participation in CTE has no association with a student's probability of enrolling in college. Further, participating in CTE has no association with a student's decision to enroll in a two-year or four-year program, after adjusting for curricular intensity. These results are exciting because they allow for the general recommendation of CTE to any interested student, without fear of adverse effects on later educational attainment and the no-harm finding opens the door to many new CTE policy conversations.

Keywords: career and technical education, vocational education, college enrollment, curricular intensity, tracking, program of study

Introduction

College enrollment is an implicit goal of the current design of career and technical education (CTE). This goal is due to three changes that have happened in the last thirty years. First, changes to several industrial sectors in the United States (US) increased the need for workers with at least a two-year degree (Carnevale et al., 2010). Second, the level of educational competition increased among workers themselves (Carnevale et al., 2017). Third, changes were introduced into the federal design of CTE that now encourage the alignment of secondary CTE courses with two-year post-secondary credentials (Gordon, 2014). The first and second changes listed, regarding changes in the labor force, have occurred gradually over time. The third change listed, changes to the federal design of CTE, occurred more suddenly in 2006 when a funding bill, known as Perkins IV, was passed (Threeton, 2007). So far, no one has evaluated the relationship between CTE participation and college enrollment as it existed after the 2006 design changes.

But in spite of the dearth of research regarding secondary CTE and college enrollment after 2006, there has been interest in understanding the relationship. Researchers have made an effort to evaluate the relationship using data from the 1980s, 1990s, and early 2000s (Arum & Shavit, 1995; DeLuca et al., 2006; Gottfried & Plasman, 2018; Kreisman & Stange, 2017). The efforts of these prior researchers have produced a body of literature that shows changes over time in the college enrollment rates of high school CTE participants. To wit, in the 1980s, the probability of a student attending college after participating in CTE was low (Arum & Shavit, 1995). One decade later, in the 1990s, CTE was still associated with decreased probability of enrolling in college, but not to the same magnitude as in the prior decade (DeLuca et al., 2006; Kriesman & Stange, 2017). Yet one more decade later, in the early 2000s, participation in CTE no longer predicted any change in college enrollment; students were just as likely to enroll in college after participating in CTE as were non-CTE participants (Gottfried & Plasman, 2018).

Looking across the studies, it appears that the changes to CTE over time have produced an increased rate of college enrollment among CTE students. However, this is an unsupported conclusion to draw from available evidence because it presumes that while CTE changed to provide more support, general college enrollment rates remained stable over time. This is not the case. College enrollment rates have not remained stable over time, but rose annually during the 1980s, 1990s, and 2000s (Statistica, 2018). During these decades there was a prominent emphasis within schools that all children should be prepared for, and attend college (Rosenbaum et al., 1996). To enable all children to attend college, the level of academic preparation in schools increased. The average number of earned academic credits increased (Hudson, 2013), curricular standards for academic subjects were introduced and refined (Ames, 2014), and legislation like No Child Left Behind was passed.

These increases to students' level of academic preparation correlate with the timing of the increased emphasis on preparation for, and enrollment in college. Thus, estimates of CTE's relationship with college enrollment would be improved by including adjustments for students' academic preparation. A recent refinement (Austin, 2020) on an established instrument (Adelman, 1999; 2006), known as curricular intensity, allows for the measurement of students' academic preparation throughout high school. As such, by measuring and adjusting for students' curricular intensity, I reduced the confounding effect of non-CTE pressures on college enrollment. This allowed me to produce cleaner estimates of the relationship between CTE and college enrollment. I used this procedure in a dataset of students who enrolled in high school after Perkins IV became law.

Literature Review

College enrollment is an implicit goal of the current design of career and technical education (CTE). This is a reasonable conclusion for three reasons, and I will discuss each in turn: the federal design of CTE, changes to US industrial sectors that increase the need for college-trained workers, and the increasing level of educational competition among workers themselves.

College can be inferred as a goal of CTE from language in the federal bill that funds it, The Carl D. Perkins Career and Technical Education Act of 2006—widely known as Perkins IV.

This law determined that CTE content should be "aligned with challenging academic standards and relevant technical knowledge and skills needed to prepare for further education and careers in current or emerging professions" (Carl D. Perkins Career and Technical Education Act of 2006; Dortch, 2012, p. 4).

This language is noteworthy because of its contrast with prior funding bills. Perkins IV was the first to include alignment with academic standards in its design for its courses. By changing the design of CTE to align its content with challenging academic standards, lawmakers signaled a shift in the goals of CTE towards those of the academic classroom (Threeton, 2007), where college readiness is arguably paramount (Conley, 2007; Roderick et al., 2009). The same signaling towards general college readiness is seen in the removal of language that existed in prior Perkins funding bills but was removed in the Perkins IV overhaul. Those prior bills stated that CTE's scope was limited to preparation for careers "other than [those] requiring a baccalaureate, master's, or doctoral degree" (Carl D. Perkins Vocational and Applied Technology Education Act of 1998, p. 112). This language was removed in Perkins IV, implicitly allowing for CTE to support college enrollment.

College may also be viewed as an implicit goal of CTE due to changes in the workplace. Because a primary objective of CTE and its predecessors has always been to prepare students for the workforce, it inherently carries the objective of delivering to students the education and training required for entry and success in the workforce. Such education and training increasingly means college (Carnevale et al., 2017) because of three trends. First, the industries experiencing the most growth are those which require post-secondary education (Deutsch, 2019). Second, industries that have traditionally relied on manual-labor are becoming more tech-heavy (Eckelkamp, 2018). Third, blue-collar jobs are disappearing (Baker & Buffie, 2017).

The changes in the workplace have largely come as the supply of college-educated workers in the workforce has increased. This increase on the labor market, is third reason CTE may be seen to have an implicit goal of college enrollment since the educational bar to be competitive with others on the job market is rising. In 1991, 60% of the workforce with good jobs had less than a bachelor's degree and 32% of all workers' highest level of education was high school or less. In 2015, proportions decreased to 45% and 20% respectively (Carnevale et al., 2017). This decrease in workers with only a high school education represents an increase in the supply of workers with higher levels education. However, it does not necessarily indicate that higher levels of education were required for the job positions that they were hired into. The increasing bar for educational competitiveness is not limited to jobs for which higher education is actually required. Of all US workers with a bachelor's degree, 38% of them work in a job that does not require any college degree (Abel & Deitz, 2014). This trend increases the need to pursue secondary education credentials to be competitive within the applicant pool, even for jobs that do not require it.

These labor market trends affect CTE because the goal of CTE is to increase participants' technical skills and training to make them competitive in the labor market. Increasingly, that means college enrollment after high school (Carnevale et al., 2010; Hanushek et al., 2017). As noted previously, one of the ways that CTE was redesigned to support students was to introduce programs of study that articulate high school offerings with local two-year programs (Passarella, 2018).

One way that Perkins IV changed the design of CTE to align with post-secondary education was to introduce the concept of a program of study. The programs of study that Perkins IV called for amount to deliberate sequencing of courses to provide a cohesive, targeted CTE curriculum (Castellano et al., 2012). They are intended to guide the student so when they finish high school they are primed to enter an aligned two-year post-secondary program above the entry-level (Dortch, 2012). To construct a program of study, the school must not only determine which courses should be taken together, but also determine which courses need to be offered to support targeted industries. These components of a well-designed program of study require lots of resources and are therefore not personalized to students. Rather, after a school has completed the process of designing a program of study it is sent to the state office of education for approval, whereupon it is used as a template for interested students (Dortch, 2012).

Deliberately progressing through CTE in a program of study that has been aligned with local two-year programs contrasts starkly with the à la carte method of selecting CTE courses prior to Perkins IV. Of course, students still often have the flexibility to participate à la carte if they prefer, but programs of study provide clear structure and goals that align with post-secondary education. These changes to the design of CTE, along with evolutions in United States industries and workforce all coalesce to connect CTE implicitly to the goal of college enrollment. They do so because it is now more occupationally expedient to enroll in college than ever before. CTE students preparing for today's labor market have a self-interested reason to pursue post-secondary education.

In addition to this self-interest aspect, CTE may also inspire students to attend college more frequently than they would have otherwise because their educational engagement increases after participating in CTE. This theory of increased engagement due to CTE participation is commonly used to explain associated benefits of CTE in reduced high school dropout rates (Dougherty, 2018; DeLuca et al, 2006; Gottfried & Plasman, 2018; Plank, 2001; Plank et al., 2008). Educational engagement is defined as having four facets: academic, social, cognitive, and affective. It is strongly tied to educational outcomes of persistence and achievement (Finn & Zimmer, 2012), and CTE may increase levels of overall academic engagement because it offers increased autonomy, provides a sense of competency, and connects its subject matter more immediately to the real-world (Gentry et al., 2007). Each of those factors has been noted as being associated with students' overall motivation (Pintrich, 2003). Students report that CTE courses are more positive experiences over and above academic classes (Gentry et al., 2007). This may indicate that CTE makes social engagement—interacting appropriately in classroom behavior and activities—easier.

Affective engagement, or the level of personal emotional response from involvement, may also be affected because participation in CTE is associated with improvements in self-worth (Kelly & Price, 2009). This particular form of educational engagement may be especially pronounced for students with low academic achievement (Dougherty, 2018), possibly because they have the greatest need to identify with a structured, reliable program or hobby (DeLuca et al., 2016).

Students who experience a boost in educational engagement through CTE may feel to persist in their education and reach for the next rung of success (Finn & Zimmer, 2012). In the current climate, success is often seen as going to college—a mindset that is held by most high-school students (Rosenbaum, 2001), and is the expected outcome for life after high-school of most students (Rosenbaum et al., 2010). Therefore, participation in CTE may lead a student to pursue further education. It is also possible that the introduction of programs of study may amplify engagement when compared to engagement levels found in CTE students who participate à la carte (Castellano et al., 2017). The increased engagement would then be channeled, via their program of study, into a course structure that purposefully leads up to post-secondary enrollment.

Efforts to measure the potential effect of CTE participation on post-secondary enrollment, or to evaluate CTE's effectiveness at articulating with two-year programs, are complicated by some of the same factors that led to its 2006 redesign. Those factors were the need to redesign the American education system to better educate and prepare students, per the landmark 1983 report, *A Nation at Risk*. The report indicated that if another nation had thrust on the United States its current educational system that the US would have seen it as an act of war (National Commission on Excellence in Education, 1983). That report served as something of a turning point in United States education (Bell, 1993), leading to the establishment and refinement of educational academic standards (Smith, 2004). The movement for reform not only included academics but also focused on encouraging all students to prepare for college (Rosenbaum et al., 1996; Schneider & Stevenson, 1999). This focus is embodied in the name of legislation stemming from that time period: *The No Child Left Behind Act of 2001*. During the early 2000s math, science, and social studies course loads increased (Hudson, 2013) and colleges saw 33% more students enrolling than they did 10 years earlier (Statistica, 2018). These changes are relevant to research about CTE and college enrollment because they represent non-CTE pressures on college enrollment. Ignoring them could lead to a misattribution of the causes for changing trends in college enrollment.

Indeed, the trends in college going among CTE students have changed. College enrollment rates for CTE students overall increased through the 1980s and into the 2000s (Dalton et al., 2013). Although this is the simple overall trend of raw college enrollment rates among CTE students, the trend does not change when adjusting for confounders of student background, aptitude, and performance (Arum & Shavit, 1995; DeLuca et al., 2006; Gamoran & Mare, 1989; Kreisman & Stange, 2017). Just before Perkins IV was passed, students were no more and no less likely to attend college after participation in CTE (Gottfried & Plasman, 2018). This was the first time in decades that students in CTE were not less likely to enroll in college. However, students who enrolled in college after participating in CTE were more likely to enroll in a two-year program than their non-CTE, college-enrolled peers (Dougherty, 2016; Gottfried & Plasman, 2018; Kreisman & Stange, 2017). This is possibly explained by the emphasis through programs of study on articulation with two-year college programs. Throughout all of the prior research, a gap exists in the literature because no one has included adjustments for students' level of academic preparation, which as discussed above, was increasing during the same time period.

A recent refinement (Austin, 2020) on an established measure (Adelman, 1999; 2006) of academic course taking, known as curricular intensity, represents academic preparation levels. Curricular intensity combines both the quantity and quality of an academic schedule across all four core subjects—math, English, science, and social studies into a single numeric indicator (Adelman, 2000; 2006; Austin, 2020). Although it is has been widely used (Attewell & Domina, 2008; Long et al., 2012), it was not readily available for use in prior studies of CTE and college because it was only available in datasets from several decades ago (Adelman, 2000; 2006) until its recent refinement (Austin, 2020). The recent refinements to its algorithm make it more calculable in myriad datasets as explained below, while also slightly outperforming the original construction of the measure (Austin, 2020).

The use of curricular intensity may also provide a second benefit in studies of CTE, in addition to accounting for academic preparation. As the course taking complement to CTE, the measurement of one's academics may serve as a measure of personal interest in CTE. This may seem counterintuitive, but scheduling courses is a balancing act. In order to schedule additional CTE courses a student must decrease the number of additional academic courses he might have taken instead. Although students could also balance their schedule by changing their participation in foreign language or fine arts classes, adjusting CTE and academic courses appears more likely. This is because CTE and academic courses have the largest volume of credits; students take approximately two times more credits in CTE than either foreign languages or fine arts (NCES, 2016).

Using curricular intensity as an adjustment variable provides distinct advantages when estimating the association between CTE and college enrollment. It also allows for additional insight into the decision for students enrolling into college about whether to enroll in a two-year or four-year degree. These advantages occur because it accounts for the changes in academic preparation brought on by contemporary societal pressures. Its rich variation allows for more informed and better fitting statistical models. Lastly, it is well suited to questions of a national and generalizable nature.

Method

Data and Sample

It is imperative to use data from 2007 or later to assess any question about CTE as it existed after Perkins IV. I used the High School Longitudinal Study of 2009 which collected data about students who were ninth graders in the 2009-2010 school year. The same students were followed longitudinally at data collections in the spring of 2012, and fall of 2013 (the fall immediately after high school graduation for most of the cohort). In addition to being collected at an appropriate time point HSLS:09 captured appropriate data for research about CTE and college enrollment: high school transcripts as well as a rich set of variables about students' backgrounds. The background data was collected in the fall of 2009 (i.e., the base year), which was 9^{th} grade for the respondents, and which is meaningful because it establishes student characteristics that predated their curricular selections.

The base year information was collected both from the students and the parents, while a base year math score was also calculated for each student through a computer adaptive algebraic assessment. An additional follow-up survey was administered in 2016, and a final follow-up is planned for 2025. These future follow-ups are ideal in questions of educational attainment, because it will set up future inquiry into topics of post-secondary persistence, choice of major, and earnings.

The analytic sample for this study included all first-time 9th graders in public schools where CTE was offered, who graduated by the end of the 2012-2013 school year, and for whom a high school transcript and college matriculation outcome is available. Additionally, to ensure that all students had equal opportunity to pursue their CTE program without interruption, only students who did not transfer schools were included in the sample. Students could only be included in the nationally representative analysis if they had a non-zero analytic weight. (N = 9,400). Private school students were excluded from the sample because private schools do not receive Perkins funding and were not under equal pressure to comply with its design changes.

Missing data were treated via multiple imputation using chained equations, which reduces bias more than listwise deletion or alternative forms of imputation (Allison, 2002). I conducted the imputation with all analytic variables as well as sampling frame variables and analytic weights to preserve the relationships in the data between variables (Enders, 2010; Reiter et al., 2006). Observations with imputed dependent variables were deleted after imputation (Von Hippel, 2007).

Measures

The dependent variable of student enrollment in college was measured through a survey that was mailed several months after graduation, in the fall. Students who indicated they were attending college were asked what degree or credential they were seeking. The provided options were: a bachelor's degree (usually a four-year degree), an associate's degree (usually a two-year degree), a certificate or program from a school that provides occupational training (e.g., cosmetology), or classes towards no specific program. I used these differing responses to create two different dependent variables: the first is whether the student enrolled in any college course (i.e., taking courses at any of the above listed levels). The second dependent variable is, among those that are seeking a credential, whether they enrolled in a two-year (associate's degree or certificate/program) or a four-year (bachelor's degree) program.

I measured exposure to CTE as the number of non-duplicative courses completed in a program of study. To create this measure, I specified courses taken in a program of study as courses taken within one of the 79 programs of study from Advance CTE (Advance CTE, n.d.)—an organization of state CTE leaders. In order to match the courses from the Advance CTE programs of study to the HSLS:09 transcripts I leveraged course codes in the nationally available School Courses for the Exchange of Data (SCED) catalog. The transcripts already have a SCED code attached to every course students took, and I matched a SCED code to every course prescribed in one of the 79 programs of study. SCED codes were then used as the crosswalk between the transcript data and the program of study documentation, which allowed me to determine progress for every student in any of the 79 possible programs of study.

The strength of this approach allowed me to assess student participation in CTE in the way that CTE is designed under Perkins IV using a national dataset. The limitation that must be accepted as a trade-off for these strengths is that by using the programs of study provided openly as a sample or guide, I did not capture the true programs of study in place at students' schools. This limitation is mitigated somewhat because the captured course taking combinations can be interpreted as meaningful CTE experiences, which is what programs of study are designed to provide. For additional details about the construction of student progress in a program of study please see additional work by the author (Ames, 2020).

To address the quantity and quality of students' academic experiences I used Austin's (2020) measure of curricular intensity. To compute this, I used values for a student's total number of English credits taken, total number of laboratory science credits taken, the highest math course taken, and whether a student ever took an advanced placement (AP) course. The highest math course is on a nominal scale, ranging from zero (no math) to six (calculus); participation in an AP course is given a value of zero (did not ever take) or one (took at least one AP course). These four values were multiplied by standardized factor loadings that indicate their relationship with the latent construct of curricular intensity. These factor loadings are dataset specific, but loadings for HSLS:09 are available publicly (Austin, 2020). The loadings from the confirmatory factor analysis effectively act as weights for the contribution of each of the four factors within this cohort to the overall curricular intensity. After weighting, each of the four variables was summed to create one single value of curricular intensity for each student.

Table 1
Mean Values and Proportions of Sample

	All High School Graduates	College Enrollees
Background		
Age at Sep 1, 2009	14.61	14.56
Female	0.52	0.53
Socioeconomic Status	-0.01	0.15
Math Score	0.11	0.28
Expect to Attend College	0.86	0.92
Race		
White	0.56	0.59
Black	0.11	0.10
Hispanic	0.21	0.18
Asian	0.04	0.05
Other	0.08	0.08
Transcript Variables		
GPA	2.87	3.06
Curricular Intensity	5.37	5.85
Total Progress in a CTE Program	1.75	1.74
N	9,400	6,420

Other independent variables used to adjust for differences between students at the beginning of high school, before exposure to CTE, were included as measured at the outset of high school. These variables included student characteristics of age, sex, race, socioeconomic status (SES), math score, and educational attainment expectations. Transcript-derived variables included the aforementioned student progress in CTE, curricular intensity, and student GPA. Descriptive statistics of the sample for these variables are reported in Table 1. In this regard, it should be noted that standard deviations were not included in the table because means are average point estimates from imputed datasets. Socioeconomic status and math score were constructed as standardized variables with a standard deviation of 1. Before imputation, the standard deviation of GPA, curricular intensity, and CTE progress were respectively 0.70, 2.05, and 1.10. Analytic weights used. Sample sizes rounded to the nearest 10, in line with NCES guidelines for restricted-use data.

Analytic Approach

If it were possible to randomize the assignment of students to participate in CTE, then assessing the relationship between CTE and the level of college enrollment would be straightforward. A causal graph could be used to depict the relationship under the randomized conditions. It would show a direct arrow from CTE to college enrollment (Morgan & Winship, 2015). Such a causal graph is offered in Figure 1.

Figure 1
Naïve Causal Diagram of Career and Technical Education and College Enrollment

Randomization is not ethically possible. However, I still estimate this model as the naïve estimation of the relationship between CTE participation and college enrollment in order to establish the baseline relationship and inform later models. By establishing the naïve model, I set an anchor for what happens in general trends without including any adjustment variables, and provide context for discussing results. This logistic regression model is specified as follows:

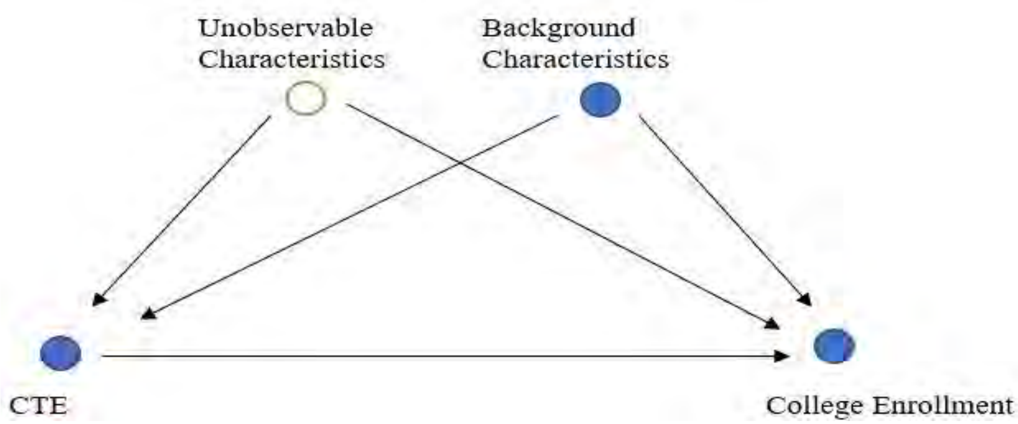
$$\log\left(\frac{p(CollegeEnrolled)}{1 - p(CollegeEnrolled)}\right) = \beta_0 + \beta_1 CTE \quad (1)$$

where p is the probability of enrolling in college and *CTE* is a count of the number of courses taken within a program of study. All standard errors are clustered at the school level and weights are used for nationally representative estimates. The interpretation of β_1 is the naïve representation of the relationship between participation in CTE and enrolling in college. The naïve estimate shows what the overall trend is for CTE students without accounting for any other factors. I then move to a model that adjusts for background characteristics in order to see how the association between CTE participation and college going changes in a more informed model:

$$\log\left(\frac{p(CollegeEnrolled)}{1 - p(CollegeEnrolled)}\right) = \beta_0 + \beta_1 CTE + \beta_2 \boldsymbol{X} \quad (2)$$

where *p* is the probability of enrolling in college, *CTE* is a count of the number of courses taken within a program of study, and ***X*** is a vector of student characteristics measured in the fall of 9th grade. The inclusion of these characteristics adjusts for differences among students that predated their CTE selections, and which may have driven their CTE selections. The vector ***X*** also includes student GPA, which is influential in a student's likelihood of persisting to additional education. All standard errors are clustered at the school level and weights are used for nationally representative estimates. In this model β_1 represents the association between CTE and college enrollment after adjusting for observable background characteristics. This is the model used in early observational work into college and CTE (Arum & Shavit, 1995; DeLuca et al., 2006), but does not account for unobserved characteristics as shown in Figure 2, where the hollow bubble indicates an unobservable variable. This inability to account for unobserved characteristics that are correlated with both participation in CTE and enrollment in college biases the estimations of the relationship.

Figure 2
Causal Diagram between Career and Technical Education and College Enrollment with Background Accounted for



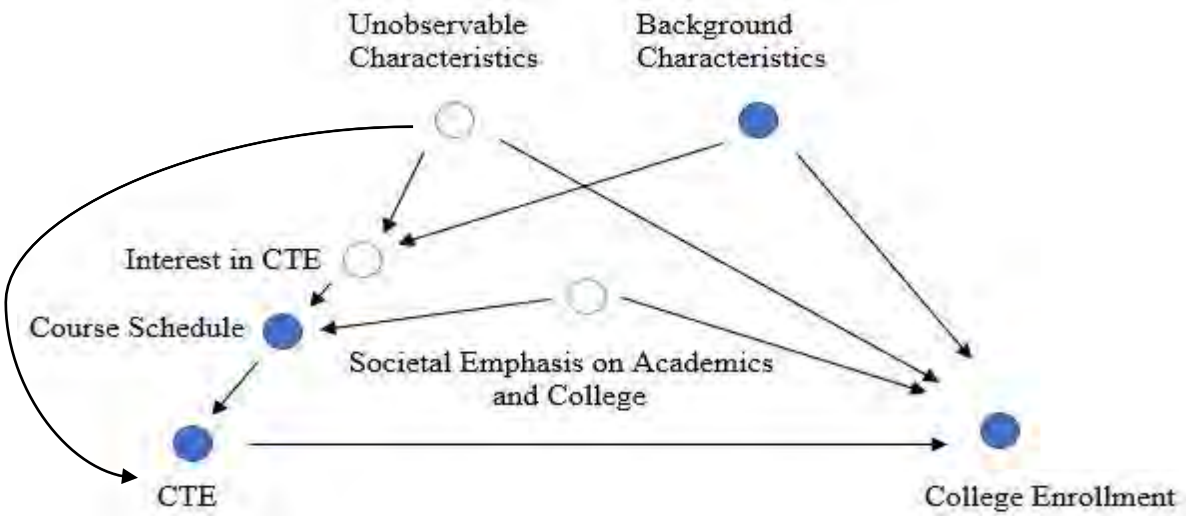
I then proceed to include the adjustment for curricular intensity into the model. The intuition for how academic course scheduling, and scheduling in general fits into the map is shown in Figure 3. Both background and unobservable characteristics affect CTE through the scheduling of academic courses. If a student is unable to schedule CTE courses, the background and unobservable characteristics continue to affect the outcome variable (as well as all other variables they influence), but they do not influence the effect of the student's CTE experience. It is impossible for them to influence it because the student was precluded by scheduling obstacles from ever having a CTE experience.

Figure 3 also includes the unobservable societal emphasis that influences both student's academic coursework and their interest in college and degree type. However, this influence is likely to be almost entirely observed through the quantity and quality of academic courses in students' schedules. Therefore, I next iterate on my model to include an adjustment for curricular intensity, which blocks the path from societal emphasis on academics and college to CTE and removes bias. The statistical model only changes from previous models as follows:

$$\log\left(\frac{p(CollegeEnrolled)}{1 - p(CollegeEnrolled)}\right) = \beta_0 + \beta_1 CTE + \beta_2 CurricularIntensity + \beta_3 \boldsymbol{X} \quad (3)$$

where p is the probability of enrolling in college, *CTE* is a count of the number of courses taken within a program of study, curricular intensity is a measure of academic experience, and $\boldsymbol{X}$ is a vector of student characteristics measured in the fall of 9th grade in order to represent students at the outset of high school when they begin to choose their CTE type, as well as GPA throughout school. All standard errors are clustered at the school level and weights are used for nationally representative estimates.

Figure 3
Causal Diagram between CTE and College Enrollment with Curricular Intensity as an adjustment



Model three allows for the interpretation of CTE on college enrollment without the bias of the contemporary emphasis on college and academics. It falls short of providing a causal inference, however, because it does not intercept all unobserved information about students that affects both participation in CTE and college enrollment decisions. There is likely still an arrow between CTE and unobservable characteristics that is driven by variables such as neighborhood characteristics. These unobservable characteristics can determine whether CTE is even offered within a local school, which programs are offered, and whether the student has approval from his parents to pursue personal interests in courses.

Next, I estimated the association between CTE and the decision among eventual college students to select into a four-year degree or a two-year degree. The model remains the same, except for the change in dependent variable and conditional sample. The following model shows how the slight changes affect model three. Changes to models one and two are not shown, but follow the same pattern of change in dependent variable and conditional sample.

$$\log\left(\frac{p(4yrDegree)}{1-p(4yrDegree)}\right) \mid (CollegeEnrolled = 1) = \beta_0 + \beta_1 CTE + \beta_2 CurricularIntensity + \beta_3 \boldsymbol{X} \quad (4)$$

where the probability of attending a four-year degree is compared to the probability of attending a two-year degree, conditional on having enrolled in college. When evaluating the β_1 coefficient from the models predicting two- or four-year college (i.e., college level), a negative coefficient would indicate a higher probability of enrolling in a two-year program. If CTE participants are more likely to enroll in a two-year program it may be due to CTE's articulation with two-year programs. A positive β_1 coefficient would indicate that CTE participants are more likely to attend four-year programs, which could be due to an increased level of engagement or confidence derived through CTE participation.

Results

Descriptive information about the two samples is reported in Table 1. Students who enrolled in college had higher levels of GPA, curricular intensity, and algebraic math scores. Somewhat surprisingly, there was no discernable difference in CTE progress between the two groups. This lack of difference is likely at the root of why the models estimating the association between CTE and college enrollment all indicate a non-significant relationship between them as shown in Table 2.

The results in Table 2 collectively indicate that CTE has no relationship with college enrollment. The steady, non-significant estimates of the association between CTE participation and college enrollment suggests an absence of any relationship. The remarkable lack of change in the coefficient of CTE as adjustment variables are included may indicate a complete absence of a relationship between CTE and college enrollment.

The third model in Table 2 indicates that curricular intensity is highly correlated with attending college. Its inclusion in model three reduces the magnitude of the association between several predictors and college enrollment. The association between being Asian, expecting to attend college, and GPA decrease to a greater extent that the others.

Table 3 reports results from the models that estimate the likelihood of enrolling in a four-year degree instead of a two-year degree, upon deciding to enroll in college. The naïve model indicates that students who participate in CTE are more likely to enroll in a two-year program instead of a four-year. This association is robust to the inclusion of background and high school performance characteristics, but becomes insignificant when curricular intensity is included in model three. This indicates that there is no evidence that participation in CTE influences a student's decision when deciding between two-year or four-year programs. It does provide some evidence that the decision about two-year or four-year programs is associated with the student's level of academic preparation, as measured through curricular intensity.

Table 2
Log Odds of Enrolling in College at any Degree Level

	1	2	3
Background			
Age		-0.29**	-0.26**
		(0.09)	(0.09)
Female		0.15	0.15
		(0.09)	(0.09)
Socioeconomic Status		0.56***	0.51***
		(0.08)	(0.08)
Math Score		0.05	-0.07
		(0.06)	(0.06)
Expectation of Attending College		0.59***	0.19***
		(0.14)	(0.14)
Race			
Black		0.78***	0.63***
		(0.17)	(0.17)
Asian		0.80***	0.58*
		(0.23)	(0.23)
Hispanic		0.70***	0.58***
		(0.15)	(0.15)
Other		0.51**	0.46*
		(0.18)	(0.18)
Transcript Descriptives			
GPA		1.19***	0.96***
		(0.07)	(0.08)
CTE Progress	-0.01	-0.04	-0.04
	(0.04)	(0.04)	(0.04)
Curricular Intensity			0.21***
			(0.03)
Constant	1.55***	1.05***	0.12
	(0.09)	(0.15)	(0.22)
N	9,400	9,400	9,400

Note. GPA centered around mean GPA. Weights used for nationally representative estimates.

Table 3

Log Odds of Enrolling in Two-Year vs Four-Year Programs, Among College Enrollees

	1	2	3
Background			
Age		-0.13	-0.07
		(0.10)	(0.10)
Female		-0.17	-0.18
		(0.10)	(0.10)
Socioeconomic Status		0.56***	0.48***
		(0.07)	(0.07)
Math Score		0.39***	0.13
		(0.07)	(0.08)
Expectation of Attending 4 Yr. College		0.96***	0.77***
		(0.19)	(0.18)
Race			
Black		0.64**	0.47*
		(0.19)	(0.19)
Asian		0.56**	0.15
		(0.19)	(0.19)
Hispanic		0.11	-0.12
		(0.15)	(0.14)
Other		0.02	-0.08
		(0.14)	(0.14)
Transcript Descriptives			
GPA		1.16***	0.79***
		(0.09)	(0.09)
CTE Progress	-0.12**	-0.11**	-0.08
	(0.04)	(0.04)	(0.04)
Curricular Intensity			0.41***
			(0.04)
Constant	0.87***	-0.25	-2.24
	(0.08)	(0.20)	(0.20)
N	6,420	6,420	6,420

Note. GPA centered around mean GPA. Weights used for nationally representative estimates.

Discussion

My finding that CTE has a null relationship with college enrollment means that participation in high school CTE does not appear to have any relationship with a student's decision of whether to enroll in college. Students participating in CTE after the redesign effected through Perkins IV are just as likely to attend college as students who never enroll in CTE. This differs from earlier work that showed dramatic decreases in college enrollment for CTE students (DeLuca et al., 2006), but is in line with work that used more recent data, from the early 2000s data (Gottfried & Plasman, 2018). This finding can be considered a win for educational stakeholders that worked to update CTE away from a design that tracked students into the labor force and away from college.

Once students decide to go to college their decision to enroll in a two-year instead of a four-year program is surprisingly insignificant, after accounting for academic rigor and preparation. There is no meaningful relationship between participating in CTE and choosing a two-year versus a four-year program.

Taken together, the finding is that CTE is entirely disconnected from college enrollment decisions, whether to attend and what length of degree to pursue. This finding continues a pattern shown throughout the literature of CTE gradually becoming less connected to college decisions for students. However, this is the first time that students have been observed making college decisions entirely independent of CTE. This is potentially good news for CTE advocates who emphasize positive associated benefits of CTE like decreased dropout likelihood, career exploration experiences, and wage increasing technical training opportunities. Counselors can encourage students to participate in CTE without concern that they may be placing students on the old non-college, vocational track.

These implications, however, must be interpreted in light of the average student. The findings do not indicate that there are zero students whose postsecondary decisions and options are affected by CTE—only that the average effect on any random student is expected to be zero. Counselors should still use prudence and discretion in working with students.

Future research is recommended to pursue these findings further and validate or expand them. These findings are limited to the association of CTE participation as a single experience, common to all participants. In actuality, students participate within a specific area of CTE, known as career clusters. Although CTE is designed to articulate with two-year local programs, some career clusters, such as STEM, may be more naturally amenable to four-year programs. This presents the potential for those students who are swayed after participating in CTE towards a two-year degree to be “balanced out” by those who were swayed to a four-year degree. Future research is needed to determine if the same results are found for students in every career cluster, or if students in career clusters that have lower average levels of curricular intensity attend college less frequently. The data I used for this study do not allow for the pursuit of this follow-up question because although large overall, they do not have a large enough sample of all CTE clusters to allow for estimates by career cluster.

An additional thread of research that is recommended regards earning potential for college students who participated in high school CTE. We know that students who participate in high school CTE have higher post-high school earnings (Bishop & Mane, 2004), but if CTE students are enrolling in college at the same rates as non-CTE students, do those who participate in CTE graduate from college with less student debt because of their increased wage-earning potential?

The findings presented here of a non-significant relationship between CTE and college-going, and choice of two- or four-year program bode well for CTE. It is currently riding a wave of support at local and federal levels because of its perceived role in increasing levels of college and career readiness. These findings cannot indicate the definitive absence of any relationship between CTE participation and college enrollment decisions, but it does provide some evidence that students may indeed prepare for careers without reducing college readiness.

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AUTHOR'S NOTES

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