CTE Teachers and Non-Test Outcomes for Students With and Without Disabilities

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January 2023

WORKING PAPER No. 278-0123

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Acknowledgments

The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R324A200092 to the University of Washington. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education. We thank the Washington Office of Superintendent of Public Instruction (OSPI) for providing the confidential data used in this paper through data-sharing agreement 2021DE-009, as well as Carly Urban, advisory board members Kim Bartel, Scott Callahan, Kris Hirschman, and Marcy Stein, and partners at OSPI, including Avram Bourdeau, Rachel Buckle, Jamie Mazzola, Michelle Rogers, Cameron Smith, Kaori Strunk, and Rebecca Wallace, for comments that improved the manuscript.

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Abstract

We use data on high school students and teachers from Washington state to connect the observable characteristics of career and technical education (CTE) teachers to various non-test outcomes (absences, disciplinary incidents, grade point average, grade progression, and on-time graduation) of students with and without disabilities in their classrooms. We find that students participating in CTE tend to have better non-test outcomes when they are assigned to a CTE teacher from the state's Business and Industry pathway—designed for CTE teachers with 3 years of industry experience but no formal teacher preparation—relative to being assigned to a traditionally prepared CTE teacher. These results can inform efforts in Washington and across the country to develop and support similar alternative routes to CTE teacher licensure.

1. Introduction

A large body of research finds that teachers have significant impacts on student outcomes. Much of this literature relies on test scores as the outcome measure (e.g., Aaronson et al., 2007; Goldhaber & Hansen, 2013; Rivkin et al., 2005; Rockoff, 2004), but newer research finds that teachers also influence students' non-test outcomes (Backes et al., 2022b; Backes & Hansen, 2018; Gershenson, 2016; Jackson, 2018, Kraft, 2019; Liu & Loeb, 2019). This evidence has focused overwhelmingly on elementary education teachers or secondary teachers in "core academic subjects" such as math, science, English, and social studies.

On the other hand, almost no empirical attention has been paid to the nearly 20% of the teacher workforce (U.S. Department of Education, 2012) in subjects outside of these core subject areas. Teachers in career and technical education (CTE) represent nearly 5% of the overall public teaching workforce and more than 10% of the high school teaching workforce (U.S. Department of Education, 2012). A focus on non-test outcomes is likely to be particularly important for understanding the contribution that CTE teachers make toward outcomes for students with disabilities (SWDs). There is some evidence that CTE participation predicts later outcomes for SWDs (e.g., Dougherty et al., 2018; Lee et al., 2016; Plasman & Gottfried, 2018; Theobald et al., 2019; Wagner et al., 2006), but surprisingly, there is no empirical research on how and whether CTE teachers contribute to these relationships specifically for SWDs.

In this paper we build on the limited evidence (e.g., Chen et al., 2021) that focuses on CTE teachers by connecting the observable characteristics of CTE teachers to student non-test outcomes. Specifically, we use comprehensive data on high school students in Washington state—which connect students' CTE course-taking, CTE teacher assignments, and the preparation and licensure pathways of those teachers to a suite of non-test outcomes for those students—to address two specific research questions (RQs):

1. To what extent are CTE teachers' characteristics and licensure pathways predictive of the non-test outcomes (absences, disciplinary incidents, grade point average (GPA), and grade progression/graduation) of students in their classroom?
2. How do these relationships vary for students with and without disabilities in these teachers' classrooms?

The remainder of the introduction provides additional motivation and background for these RQs.

Motivation

The primary motivation for this paper is that effective CTE instruction is a potentially important policy lever for improving non-test outcomes for high school students, and SWDs in particular. A focus on SWDs is important because these outcomes for SWDs tend to lag far behind those of their peers both nationally (e.g., Newman et al., 2010) and in the focal state of this study, Washington (Theobald et al., 2019). Emerging evidence suggests that CTE may be a promising avenue for closing these gaps. Four recent studies—all of which use rigorous statistical methods to control for baseline differences between SWDs who do and do not participate in CTE—connect CTE coursework to improved non-test outcomes for SWDs (Dougherty et al., 2018; Lee et al., 2016; Theobald et al., 2019; Wagner et al., 2006). For example, prior research from Washington (Theobald et al., 2019) finds positive associations between the concentrated participation of SWDs in CTE courses the probability that SWDs graduate from high school, conditional on prior student performance and other observable student characteristics. SWDs are also significantly more likely to be enrolled in CTE courses relative to SWDs (Theobald et al., 2022).

However, there is very little evidence about why, and under what conditions, CTE instruction may lead to improved outcomes for SWDs. A natural question is about the role that

CTE teachers play in these relationships, given that a large body of research over the past several decades shows teachers are consistently the most important schooling attribute influencing student testing outcomes (e.g., Rivkin et al., 2005; Rockoff, 2004). However, empirical research on CTE teachers has likely been limited by two significant concerns about the use of test-based measures to evaluate schooling outcomes for SWDs and the impact of CTE participation. First, researchers have raised many empirical concerns about the validity of test scores as an outcome measure for SWDs (e.g., Baker et al., 2010; Buzick & Jones, 2015; Jones et al., 2013; McCaffrey & Buzick, 2014; Steinbrecher et al., 2014). Second, test scores may not capture the contribution that CTE teachers make toward students' education (Borghans et al., 2008; Heckman & Rubinstein, 2001; Lindqvist & Vestman, 2011; Waddell, 2006).

Therefore, this paper draws from recent research investigating teachers' contributions to K–12 non-test outcomes, which lends support to the concern that a narrow focus on tests could miss important schooling effects; in fact, recent findings tend to show that teacher effects on non-test K–12 outcomes are not highly correlated with their effects on student test scores (Backes et al., 2022b; Backes & Hanson, 2018; Gershenson, 2016; Jackson, 2018; Kraft, 2019; Liu & Loeb, 2019). Moreover, Jackson (2018) and Liu and Loeb (2019) have shown that teachers' contributions to these non-test outcomes are more highly correlated with high school graduation outcomes than teachers' contributions to test score gains.

A second motivation for this study comes from concerns that not all CTE teachers have the specialized pedagogical training necessary to address the needs of SWD; for instance, universities operate separate general education and special education programs, and CTE teacher preparation is housed within general education programs (Wolfe et al., 2000). Moreover, many states—including Washington, the setting of this study—have adopted alternative pathways for

CTE teachers to enter the classroom with even less pedagogical preparation than teachers would typically receive if they obtained their licenses through traditional college- and university-based teacher education programs. Concerns about pedagogical preparation for SWDs in CTE classrooms are noted by CTE teachers themselves; for example, Walter and Gray (2002) found that CTE teachers frequently identified a lack of competency to instruct SWDs as their biggest deficiency.

That said, there are good reasons to believe that SWDs likely benefit from having CTE teachers with pedagogical skills to tailor instruction to their needs and the technical experience to engage them through practical application of CTE skills. Researchers tend to believe that pedagogical skills are gained primarily through traditional teacher preparation (e.g., Harvey, 1999), while individuals who enter the teaching profession through alternative (or limited) licensure routes may be more likely to have technical experience and industry connections (e.g., Rojewski, 2002). We are not aware of any empirical evidence supporting these statements for CTE teachers, nor any empirical evidence about the implications of any differences that do exist across licensure status and pathways for the outcomes of SWDs.

The final motivation for this study is a unique CTE teacher licensure system in Washington state. We therefore provide in the next subsection important background information about this licensure system and how it compares to other CTE teacher licensure systems across the country.

2. Background on CTE Teacher Licensure

Bonsu et al. (2013) provides a recent national survey of CTE teacher licensure policies. Their report indicates that all states offer a traditional pathway to CTE licensure in which teachers complete a 4-year program in education, with a specialization in CTE. Many states also

offer at least one alternative CTE training program for applicants that require limited prior pedagogical training (i.e., individuals are not required to attain a teaching degree). CTE teacher preparation and pedagogical requirements vary considerably across states (Zirkle, 2018), far more so than is true for traditional teacher training (as least on the surface). Although most states require work-based experience for CTE certification, which applicants must verify either through completing a minimum number of years of employment or by submitting a valid (nonteaching) license, as we show in Figure 1, states vary widely in the number of hours of work experience—from 2,000 to 12,000 hours, with Washington near the median at 6,000 hours—required for these alternative pathways. This variation in state policy raises the question of whether more experience in the field is predictive of better outcomes for SWDs. Moreover, differences in CTE requirements are not limited to work experience; for example, research by Zirkle et al. (2007) found that about half of alternative CTE pathways require a bachelor's degree, about half required additional coursework, and the majority require some type of licensure test.

Within Washington state, the requirements associated with different CTE teacher licensure pathways vary dramatically.[1] Under the state's current policies, traditional pathway teachers must obtain a bachelor's degree with a minimum of 45 quarter hours of study in a specific CTE specialty area. They must also complete a state-approved CTE program in one of four broad areas: Agriculture Education, Business and Marketing Education, Family and Consumer Sciences Education, or Technology Education. These programs are typically short; for example, Central Washington University offers a 5-week course for in-service teachers and includes detailed coursework within a field of CTE (e.g., Apparel, Textiles, and Merchandising; Event Planning; Recreation; Tourism). Teachers must also pass an approved content knowledge

[1] See https://app.leg.wa.gov/wac/default.aspx?cite=181-77&full=true&pdf=true.

test, called the WEST-E (or approved alternative). Finally, they must have 1 year of paid occupational experience in their CTE subject area.

The state's Business and Industry (B&I) CTE teacher licensure pathway is quite different from the traditional pathway. Unlike the traditional pathway or approximately half of alternative pathways in other states (Zirkle et al., 2007), this pathway does not require any degree attainment; instead, it involves completion of specific B&I CTE programs. While the traditional pathway offers current teachers 5-week programs, B&I pathways include greater course loads to address the fact that they do not require a degree in teaching, which is consistent with prior research on alternative pathways (Zirkle et al., 2007). For example, Central Washington University provides a 1- to 2-year program that requires additional courses on teaching methods, occupational analysis and safety, course organization and curriculum design, coordination techniques, history and philosophy of CTE, student and professional leadership, school law and issues related to abuse, and practicum. Washington state requires B&I teachers to have 6,000 hours of paid work experience to ensure these individuals are well-familiar with their CTE area. Lastly, B&I CTE teachers are licensed for specific CTE courses (e.g., Electronics, Engineering and Design), while in contrast, traditional pathway CTE teachers are licensed for broad CTE areas (e.g., Science, Technology, Engineering, and Mathematics).

To explore potential differences in CTE teacher preparation to teach SWDs within these two licensure pathways in Washington, we surveyed the program director of each traditional and B&I CTE teacher preparation program in the state. We sent the survey to 14 different program directors and received responses from seven directors representing eight distinct programs, for a response rate of 50%. The lack of higher response rates suggests that we should use caution in generalizing survey results to the full state. That said, one of the striking findings from the

survey was that four of the five directors of traditional CTE teacher preparation programs reported that their program requires a separate course on methods for teaching SWDs, while none of the three directors of B&I programs reported that they require a similar course. This provides preliminary evidence that formal training for teaching SWDs differs across these two licensure pathways.

A final important piece of context is that districts that are not able to hire a traditional or B&I pathway teacher must pursue hiring a teacher with a limited CTE license. CTE administrators or district superintendents must affirm that they cannot hire a regularly licensed teacher for the CTE course in question to initiate this process. Certificates are issued for a maximum of 2 years, and according to the state, it allows the district to hire an applicant who is highly qualified and experienced in the knowledge and occupational skills of the CTE program to be licensed; meets the occupational experience requirements for CTE licensure; and will be employed in new and emerging occupations as defined by the Professional Educator Standards Board and/or its designee. This license includes almost any possible level of teaching preparation, from teachers licensed in non-CTE subjects to individuals with no teacher training whatsoever.

These licensure policies have been in place over the past several decades, but several currently employed CTE teachers entered the state's workforce under earlier policies with fewer formal requirements (which allowed CTE teachers to teach with a "vocational" or just a high school degree as in the current B&I pathway, as opposed to academic teachers who have always been required to have at least a bachelor's degree). Throughout the analysis, we distinguish between CTE teachers who entered the workforce through the current B&I pathway and CTE

teachers who do not hold a college degree and were grandfathered into the state's current licensure policies.

3. Data and Methods

3.1 Data and Measures

The student-level data for this project were provided by the Washington Office of the Superintendent of Public Instruction (OSPI). The OSPI data include annual files between 2013–2014 and 2018–2019 from the state's Comprehensive Education Data and Research System (CEDARS) that consist of longitudinal records for all K–12 students in the state, including, for example, information about student demographics (e.g., disability, race/ethnicity) and student program participation (e.g., free/reduced priced lunch [FRL] eligibility, English language learners services). The CEDARS data also include detailed information about the special education services each SWD receives, such as the extent of inclusion in general education classrooms, as well as assessment files that allow us to control for students' eighth grade test scores in both math and English language arts.

We can consider four categories of student non-test outcomes: student attendance, including the number of excused and unexcused absences each year; student disciplinary incidents, including the total number of disciplinary incidents and suspensions each year; students' cumulative GPA at the end of each year; and grade retention (students show up in the subsequent grade the following year) after Grades 9, 10, and 11, and graduation in 4 years at the end of 12th grade. Student attendance and disciplinary incidents are calculated from the annual CEDARS Student Absence and CEDARS Student Discipline files, respectively, while student GPA is calculated from the CEDARS Grade History file. We calculate student grade progression from the "Exit Codes" in the CEDARS Student Enrollment files, which allow us to distinguish between students who legitimately drop out of school and students who simply do not appear in

the following year of data because they moved or switched to a private school. Finally, our primary analysis considers whether each student graduates "on time" (i.e., 4 years after they entered ninth grade), though we consider all valid diploma types (including regular diplomas and diplomas specific to students with Individual Education Plans) because of our focus on SWD.

The CEDARS Student Schedule files include every course taken by each student in the state and include Classification of Instructional Programs codes that allow us to identify CTE courses and the specific CTE cluster and program areas associated with each course.[2] The Student Schedule file is collected on the student and term levels, and different schools and districts in Washington use different term structures. Given this, we weight all results in the paper by student-course weights that indicate the proportion of the year a student spent in a specific course; for example, this weight equals 1 for yearlong courses, 0.5 for semester courses, 0.333 for trimester courses, and so on.

Students can be linked to their classroom teachers through unique identifiers in the Student and Staff Schedule files.[3] These links in turn allow us to connect these files to OSPI teacher data, including the S275 (which includes information about teacher demographics, experience, and degree level for each teacher in the state) and teacher licensure data (including all teaching licenses, endorsements, and licensure test scores issued for all teachers in the state). These licenses include both full and limited ("temporary") licenses, so we create indicators for whether each CTE teacher in the sample had a full or limited teaching license in each school year. We also consider teacher scores on the state's Washington Educator Skills Test – Basic

[2] We use Appendix S of the CEDARS Data Manual to map Classification of Instructional Programs codes onto specific CTE clusters and programs: see https://www.k12.wa.us/data-reporting/reporting/cedars.
[3] CEDARS data include fields designed to link students to their individual teachers, based on reported schedules. However, limitations of reporting standards and practices across the state may result in ambiguities or inaccuracies around these links.

(WEST-B), averaged across the math, reading, and writing subtests, and the Washington Educator Skills Test – Endorsement (WEST-E), from which we use each teacher's first test score and create indicators for the specific test field (since prior work has demonstrated considerable variability in the difficulty of these tests: see Goldhaber et al. [2017]). These test scores are only available for a subset of teachers since they have only been required in recent years (since 2002 for the WEST-B and since 2010 for the WEST-E), so we only consider these scores in subsample analyses.

Central to this analysis is identifying CTE teachers who entered the state's teaching workforce through different licensure pathways. The licensure data also provide information on the CTE areas according to "vocational" (V) codes that can be mapped onto traditional and B&I pathways using crosswalks on the OSPI website.[4] We therefore create indicators for whether each CTE teacher entered through a traditional pathway, the state's B&I pathway, or a different pathway (typically before these formal pathways were introduced). Additionally, a number of CTE teachers entered the state's workforce under earlier policies with fewer formal requirements (which allowed CTE teachers to teach with a "vocational" or just a high school degree as in the current B&I pathway, as opposed to academic teachers who have always been required to have at least a bachelor's degree). Thus, we distinguish between CTE teachers who entered the workforce through the current B&I pathway and those who entered the workforce under prior requirements and do not hold a college degree.

3.2 Samples and Summary Statistics

This paper focuses exclusively on students enrolled in CTE courses between Grades 9 and 12 in Washington (see Appendix Table A1 for comparisons between students in CTE and

[4] See https://www.k12.wa.us/student-success/career-technical-education-cte/cte-resources/cip-codes?combine=&order=field_program_area&sort=asc&page=5.

non-CTE courses in the state). In **Table 1,** we present summary statistics separately by student grade and disability status for the key measures in this analysis. Comparing students without disabilities to SWDs, we see that (in each high school grade) SWDs tend to have more absences and disciplinary incidents, considerably lower GPAs, and are less likely to be retained across grades and ultimately graduate on time than students without disabilities. SWDs also have much lower average eighth grade test scores (by over a standard deviation) and are disproportionately male, Black, and eligible for FRL.

The next several rows of Table 1 highlight two important sources of data specific to SWDs (as thus not observed for students without disabilities) that are important for our analysis. First, we divide this group of SWDs into specific disability categories; more than half of SWDs in each grade are receiving special education services for a specific learning disability; about a quarter have a health impairment, and the remaining students are divided roughly evenly between emotional/behavioral disorder, autism, intellectual disability, and other disability. About half of SWDs in CTE courses spend 80–100% of their school day in general education courses, about 40% are in general education 40–80% of the school day, while the remainder are in other inclusion settings (e.g., 0–40% general education or separate school settings).

The final rows of Table 1 provide summary statistics for the key CTE teacher variables considered in this analysis. Given that we see relatively minimal differences in average CTE teacher characteristics between students with and without disabilities, we focus primarily on the aggregated summary statistics provided in Appendix Table A2 (which also provides summary statistics for the course cluster and program information that we use as controls in all models).

The average teacher of students in CTE courses has slightly less than 15 years of teaching experience, a little more than half are female, and the vast majority are White. A little more than

half of students' CTE teachers have a master's degree, about a quarter have a bachelor's degree, and nearly 20% have no college degree. This last statistic is in stark contrast to general education teachers, nearly all of whom are reported to have at least a bachelor's degree given state requirements.

Finally, focusing on certification information, more than two-thirds of students' CTE teachers have a full teaching certificate (compared to a limited certificate) and more than 95% are certified in CTE. Finally, these CTE teachers are relatively evenly split between the traditional and B&I pathways described in the introduction, with CTE teachers from traditional pathways more likely to teach CTE courses in earlier grades and CTE teachers from the B&I pathway more likely to teach CTE courses in later grades. We provide further differences between traditional and B&I pathway teachers in Appendix Table A3, showing that B&I pathway teachers tend to be less experienced and more racially and ethnically diverse than traditionally licensed CTE teachers.

3.3 Analytic Approach

The underlying basis for much of the analysis is the estimation of the relationships between specific CTE teacher characteristics and the various student non-test outcomes previously discussed. We closely follow the methodology that has been used in prior work that has estimated the contributions of teachers to non-test high school outcomes (e.g., Jackson, 2018) and effects of CTE teachers in particular (Chen et al., 2021). We begin by estimating a principal-components model separately by grade to assess the extent to which the different non-test outcomes load onto a single underlying "non-test factor." This is useful because it provides an aggregated measure of student non-test "success" that can be used as the outcome variable in subsequent analyses.

Table 2 summarizes the results of this analysis and shows that—consistent with Jackson (2018)—log excused absences, log unexcused absences, log disciplinary incidents, and log suspensions all load negatively onto this underlying factor, while cumulative GPA and on-time grade retention/graduation load positively onto this factor. We then use factor loadings from Table 4 to create a single predicted non-test factor for each student and year that represents a single measure of each student's non-test outcomes in a specific year.

For the remainder of this section, let Y_{ijkt}^{O} be the outcome *O* for student *i* who has CTE teacher *j* in district *k* and year *t* (note that this could be the non-test factor described above or any of the individual non-test outcomes listed in Table 2). Following Chen et al. (2021), we estimate the relationship between teacher characteristics T_{jt} and these student outcomes in a model that controls for lagged outcomes and the student and class characteristics discussed above:

$$Y_{ijkt}^{O} = \alpha^{O} Y_{i(t-1)} + \beta^{O} X_{ijkt} + \delta^{O} T_{ijkt} + \delta_{k}^{O} + \theta_{t}^{O} + \varepsilon_{ijkt}^{O}. \quad (1)$$

In the above model, $Y_{i(t-1)}$ is a vector of lagged student non-test outcomes (i.e., lagged versions of all the non-test outcomes listed in Table 2), while X_{ijkt} is a vector that includes students' prior test scores, demographics, and program participation (FRL, English language learner, special education), and indicators for the specific CTE cluster and program area of the course. The coefficients of interest for RQ1 are in δ^{O}, and represent the relationships between each of the CTE teacher characteristics in T_{ijkt} (e.g., experience, degree level, license type, and licensure pathway) and the student outcome, all else equal.

Following prior work on CTE in Washington (Theobald et al., 2019), our primary model specifications control for district fixed effects to account for the considerable variation in CTE offerings and student outcomes across the 295 school districts in the state. All models also

account for year effects, and we cluster standard errors at the teacher level to account for nonindependence between outcomes for different students receiving CTE instruction from the same teacher. Students assigned to multiple CTE teachers in a year are weighted to individual teachers following the "full roster method" of Koedel (2009) and Hock and Isenberg (2017). We first estimate these models separately by grade and then pool across grades by interacting all student- and class-level variables by student grade. Finally, to explore RQ2 (differences in these relationships for students with and without disabilities), we estimate the models described in equation 1 separately for students with and without disabilities.

The intuition behind the models in equation 1 is that, after controlling for the student, classroom, and district factors in equation 1, the relationships between the CTE teacher variables in equation 1 and the student outcome should represent the "effect" of being assigned to a CTE teacher with a given characteristic. However, there are at least two important threats to this type of causal interpretation. The first is that CTE teachers with different observable characteristics are non-randomly distributed across districts, CTE courses, and students. Indeed, when we explore the distribution of CTE teacher characteristics across educational settings and students, we find that specific districts, different CTE clusters and program areas, and various categories of students can have substantially different observable CTE teacher characteristics. For example, CTE teachers who enter through the state B&I pathway tend to teach slightly higher-performing students and disproportionately teach in technology science programs relative to CTE teachers from other pathways. If CTE teachers with a given characteristic are more likely to teach students who have unobserved (i.e., after controlling for the variables in X_{ijkt}) attributes that are correlated with the outcomes of interest, we may misattribute these attributes to the effect of CTE teacher characteristics.

The inclusion of district fixed effects alleviates the concern about nonrandom distribution of CTE teachers and students *across* districts, and as described in Koedel et al. (2015), estimating models in one stage as shown in equation 1 accounts for partial correlations between teacher characteristics and student/class characteristics that further help account for this source of bias. As we discuss in the next section, our estimates of CTE teacher "value added" from the model in equation 1 exhibit little evidence of forecast bias, so we are relatively less concerned about this source of bias.

A second and potentially more serious concern—related to our focus on pathway into teaching—is that prospective CTE teachers may non-randomly sort to specific CTE licensure pathways. If individuals with stronger skills or teaching potential are more likely to pursue one type of licensure pathway than another, then we may again misattribute this non-random selection to the effect of the licensure pathway itself. For some purposes, the distinction does not matter; for example, as a parent or principal interested in expected student outcomes associated with assignments to diverse kinds of CTE teachers, it does not matter if these relationships are driven by selection into pathways or the preparation of CTE teachers within these pathways. But from a policy perspective (e.g., in deciding whether to expand or eliminate specific pathways), the distinction is quite important. We therefore estimate subsample models that control for the licensure test scores of CTE teachers on the state's WEST-B basic skills tests that have been required for teacher licensure since 2002 (and thus are only observable for more recently credentialed CTE teachers in the sample) to account for some of this non-random sorting. We also estimate models that consider subject-specific WEST-E licensure test scores (required for most teaching licenses since 2010), though these tests are only required for the traditional CTE

pathways and thus represent a variable of interest rather than a control for this type of non-random sorting.

4. Results

Before discussing the results aligned with RQs 1 and 2, we first estimate specifications of the model in Equation 1 omitting CTE teacher characteristics to provide some background about the relationships between the student characteristics in Table 1 and the non-test factor that is the outcome in the main results discussed below. As shown in **Table 3,** students with higher eighth grade test scores and "better" lagged outcomes (i.e., fewer absences) tend to have higher values of the non-test factor, all else equal. Female students have higher non-test outcomes than male students; Asian, Hispanic, and Native Hawaiian/Other students tend to have higher values of this non-test factor than White students while Black students tend to have lower values; and special education students in Grades 10–12 have considerably lower values of the non-test factors than students without disabilities. Finally, students with limited English proficiency have higher values of the non-test factor, all else equal, while students eligible for FRL have lower values. All results discussed in the remainder of this section control for these differences across students (and the differences across CTE clusters and programs not reported in Table 3) to identify the relationships between CTE teacher characteristics and these non-test outcomes.

We also use the residuals from the models in Table 3—pooled across grades and fully interacted by student grade level—to quantify the magnitude of CTE teacher effects on these non-test outcomes. Specifically, following Kane and Staiger (2008), we take the mean of these residuals by teacher and year and estimate the standard deviation of CTE teacher effects as the square root of the covariance between these average residuals between consecutive years for the same teachers. We estimate that the standard deviation of CTE teacher effects on non-test

outcomes is 0.13 standard deviations of the non-test factor. This estimate is like effect sizes reported elsewhere for teacher impacts on both test and non-test student outcomes (e.g., Kane et al., 2013). This provides evidence that CTE teachers do have significant impacts on students' non-test outcomes that will be the focus of subsequent results.

Finally, we estimate versions of the model in equation 1 using the "leave-out" specification and forecast bias tests from Chetty et al. (2014). These tests suggest that our estimates of CTE teacher contributions to student non-test outcomes exhibit little forecast bias, meaning that a one-unit change in CTE teacher value added between consecutive years within a given school and grade causes a corresponding increase in students' aggregated non-test outcomes ($\hat{\beta} = 0.91$, $p = 0.46$ in test against 1) for students participating in CTE in that school and grade. That said, we do not formally consider individual CTE teacher effects for the remainder of the analysis because we estimate all models in one stage. Moreover, we are cautious about interpreting the relationships between CTE teacher characteristics and student non-test outcomes as causal because of the threats to validity we have outlined.

4.1 Results RQ1: To what extent are CTE teachers' characteristics and licensure pathways predictive of the non-test outcomes of students in their classroom?

The findings reported in **Table 4** are organized as follows: We first pool estimates across grades (column 1), and then estimate the models separately by grade to explore heterogeneity across grade levels (in columns 2–5). Focusing first on the pooled results (also shown graphically for selected teacher characteristics in **Figure 2**), we find that CTE teacher gender, experience, birth cohort, and certificate type (full or limited) are not significantly predictive student non-test outcomes. Due to the large sample sizes in these models (more than 2 million student/year observations), these null effects are precisely estimated, so we can rule out even

small relationships between these characteristics and student non-test outcomes with 95% confidence.

Two CTE teacher characteristics are significantly predictive of student non-test outcomes in these models. Students assigned to a CTE teacher with no college degree tend to have better non-test outcomes than students assigned to a CTE teachers with a bachelor's degree, while students assigned to a CTE teacher from the state's B&I pathway tend to have better outcomes than students assigned to a CTE teacher from a traditional pathway. In each case, the difference is about 0.02 standard deviations of the non-test factor. Given controls for licensure pathway, teacher age, and experience, the relationship for teachers with no college degree is likely driven by older CTE teachers who were "grandfathered in" to the state's current licensure requirements. Scanning across the grade-specific results in columns 2–5, both relationships are driven by older grades, as both relationships are positive and significant for 11th grade students, while the relationship with B&I pathway is significant in 12th grade as well.

The results from Table 4 focus exclusively on the aggregated non-test factor from the principal components analysis in Table 2, but to better understand whether there is heterogeneity in the relationships across different outcomes, we report results for each outcome in **Table 5.** For comparison, the results in column 1 are copied from column 1 in Table 4, while the remaining columns each consider a different non-test outcome named at the top of the table (in each case pooling across high school grades). The relationship between CTE teachers without a college degree and student non-test outcomes is driven by a lower number of excused and unexcused absences (columns 2 and 3) and higher GPA (column 6), while the relationship for the B&I pathway is driven by a lower number of absences and disciplinary incidents (column 4). To put the magnitudes of these results in context, students assigned to CTE teachers from the B&I

pathway have 6.4% fewer excused absences, 4.7% fewer unexcused absences, and 0.5% fewer disciplinary incidents than students assigned to a CTE teacher from the traditional pathway, all else equal.

Finally, as discussed in the previous section, we observe licensure test scores on the state's WEST-B basic skills test and WEST-E subject test for a subset of CTE teachers in the sample. We include these licensure test scores as additional control variables in separate specifications reported in **Table 6,** estimated only for the subset of CTE teachers with these test scores. In both cases, CTE teachers' licensure test scores are not significantly predictive of students' non-test outcomes. Importantly, the relationship between the B&I pathway and student non-test outcomes in these specifications is roughly comparable to the overall relationship reported in column 1, which provides one robustness check for this result.

4.2 Results RQ2: How do these relationships vary for students with and without disabilities in these teachers' classrooms?

We now turn to the second RQ and, in **Table 7,** estimate models separately for students with (column 2) and without (column 3) disabilities, again in comparison to the pooled results in column 1; **Figure 3** graphically presents results for selected CTE teacher characteristics. None of the coefficients are statistically significant in column 2 due to the smaller sample sizes of SWDs, but the magnitude of the relationship between the B&I pathway and student non-test outcomes is even greater for SWDs than students without disabilities. In contrast, the relationship between assignment to a CTE teacher without a college degree and non-test outcomes is considerably lower (and even slightly negative) for SWDs, though the difference between the estimates in columns 2 and 3 are not statistically significant. As shown in Appendix Table A4, the relationships between the B&I pathway and the different specific non-test outcomes are comparable in direction and magnitude to the results for all students.

5. Discussion

This is one of the first studies to explore the connections between CTE teacher characteristics and student non-test outcomes (following Chen et al., 2021), and, to our knowledge, it is the first to disaggregate outcomes separately for SWDs. There are important limitations to consider in this study, outlined in the next subsection, but also some potential policy implications that we discuss in the last subsection.

5.1 Limitations

The primary limitation of this study is that the estimation of teacher effects on non-test outcomes is relatively new empirical terrain, particularly when it comes to CTE. Our robustness checks suggest that our estimates exhibit little forecast bias (Chetty et al., 2014), but we are still cautious to discuss all results in this paper in descriptive terms, as we do not believe there is sufficient evidence about the types of empirical models used in this paper to support causal conclusions. Future work could seek to further validate the estimates from these models following emerging research on academic teachers and impacts on other non-test outcomes (e.g., Backes et al., 2022a).

We are also concerned that our focus on non-test outcomes at the high school level may miss important relationships with longer-term outcomes such as college attendance, employment, and earnings. Indeed, the strongest relationships for CTE participation tend to be with employment outcomes (e.g., Theobald et al., 2019), and prior work from Massachusetts has connected CTE teacher licensure directly to student earnings after high school (Chen et al., 2021). In follow-up work, we plan to leverage data from Washington's P-20 data warehouse to study these relationships in the state's context to capture the full range of potential relationships between CTE teacher characteristics and student outcomes.

Finally, while Figure 1 provides some evidence that the B&I pathway in Washington is at least comparable to licensure pathways that exist in other states, it is not clear whether the results from this analysis will generalize to other settings and states. A principal conclusion of cross-state studies of CTE (e.g., Goldring et al., 2021) is that relationships between CTE participation and later student outcomes can vary considerably across states, so we urge further research that leverages data from additional states to explore the robustness of these findings.

5.2 Policy Implications

Despite the limitations discussed, we believe that this analysis can support some preliminary policy conclusions. The first is related to concerns, outlined extensively in the introduction, that CTE teachers who enter the profession through alternative pathways may not have sufficient pedagogical preparation to serve students, particularly students with diverse learning needs such as SWDs. In terms of the non-test outcomes we investigate, the findings reported in this paper assuage these concerns as students actually tend to have better non-test outcomes (i.e., fewer absences and disciplinary incidents) when assigned to CTE teachers from this pathway (as well as older teachers without a college degree who entered prior to the formal B&I pathway) relative to traditionally prepared CTE teachers. It is unclear what the mechanism for this relationship might be, and it will be important for future work to explore whether these relationships extend to longer-term outcomes such as employment and earnings, as there are good reasons to believe that these teachers have better employment and industry connections given the requirements of the pathway.

Given the precision of our estimates, some of the nonsignificant findings are also worth noting. For example, despite considerable statistical power, we do not find a significant difference in non-test outcomes between students assigned to CTE teachers who are fully licensed compared to students who are assigned to CTE teachers with a limited license (e.g.,

emergency or temporary). Finally, the relatively minimal differences in the relationships for students with and without disabilities also suggests that we need to better understand the importance of the preparation that CTE teachers receive to serve SWDs in these different licensure pathways. For example, the fact that SWDs tend to have better outcomes when assigned to CTE teachers from the B&I pathway may be surprising given that these teachers receive limited formal preparation to instruct these students. More evidence is therefore necessary about CTE preparation to teach SWDs to inform program policies and improvement.

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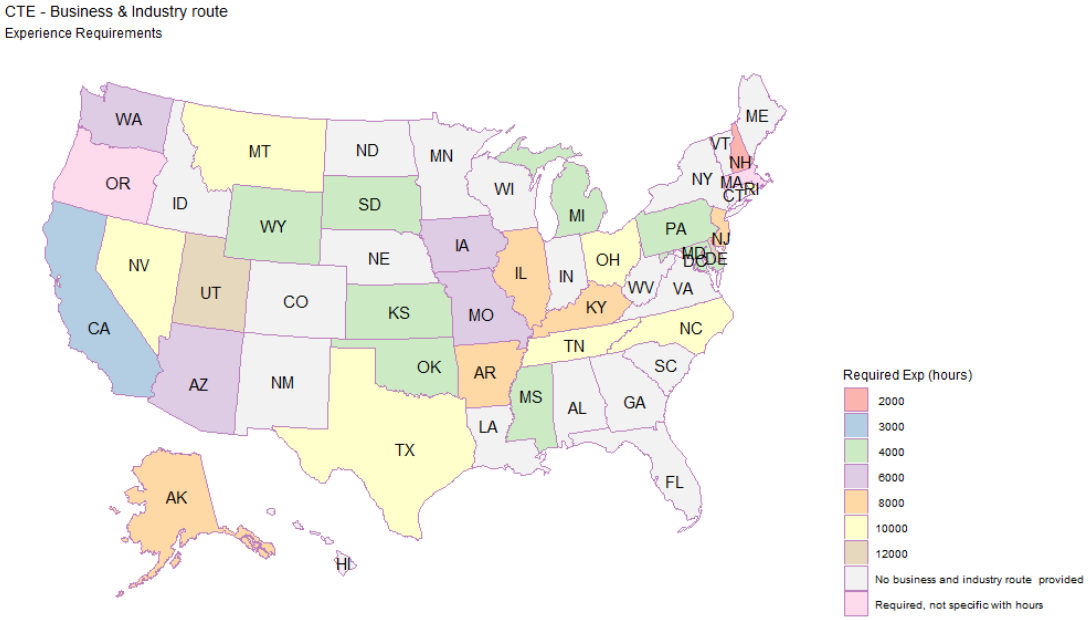
Tables and Figures

Figure 1. Required Employment Hours for CTE Teachers in Alternative Pathways



Source. Authors' calculations from Bonsu et al. (2013).

Figure 2. Expected Changes in Student Non-Test Outcomes Associated with Select CTE Teacher Variables

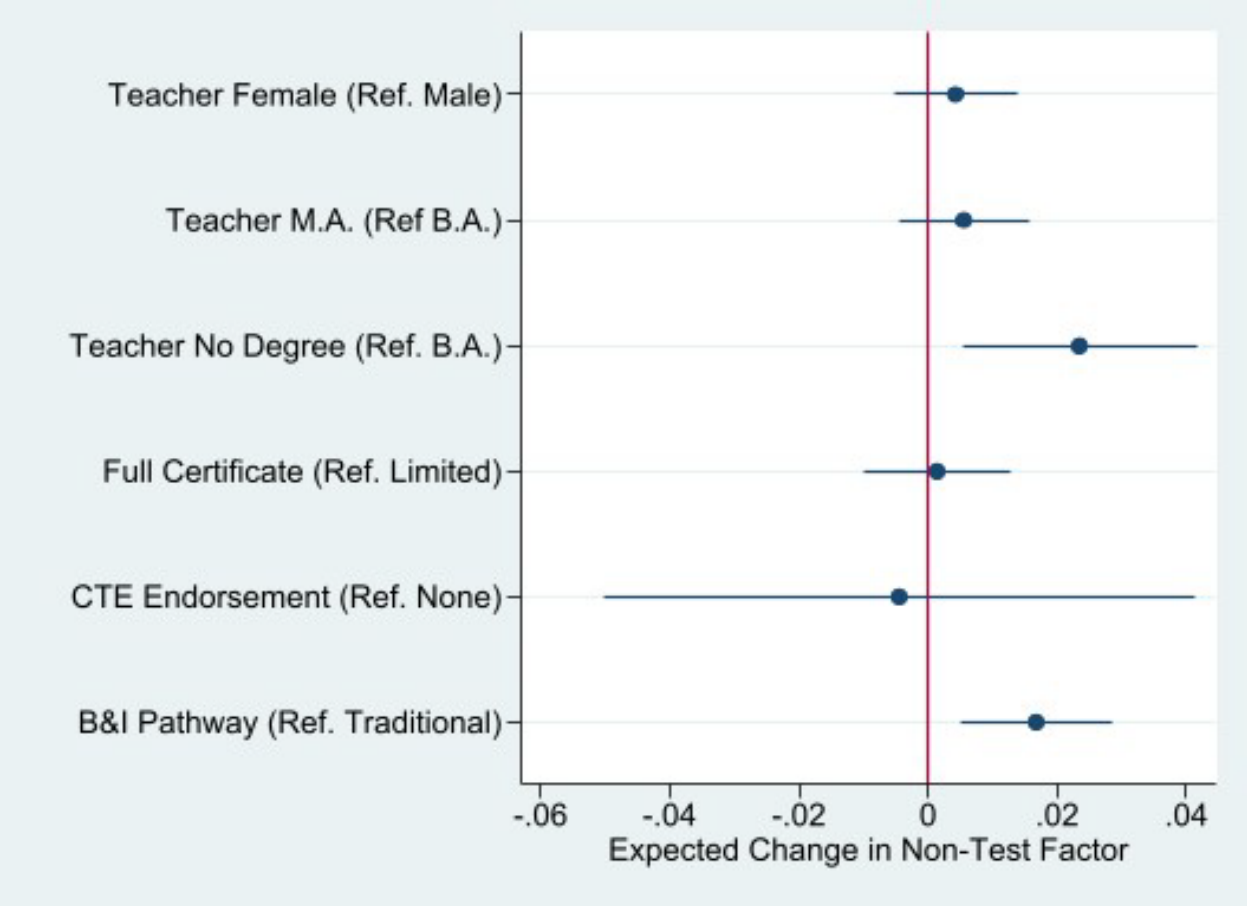


Figure 3. Expected Changes in Non-Test Outcomes Associated With Select CTE Teacher Variables, SWD and Non-SWD

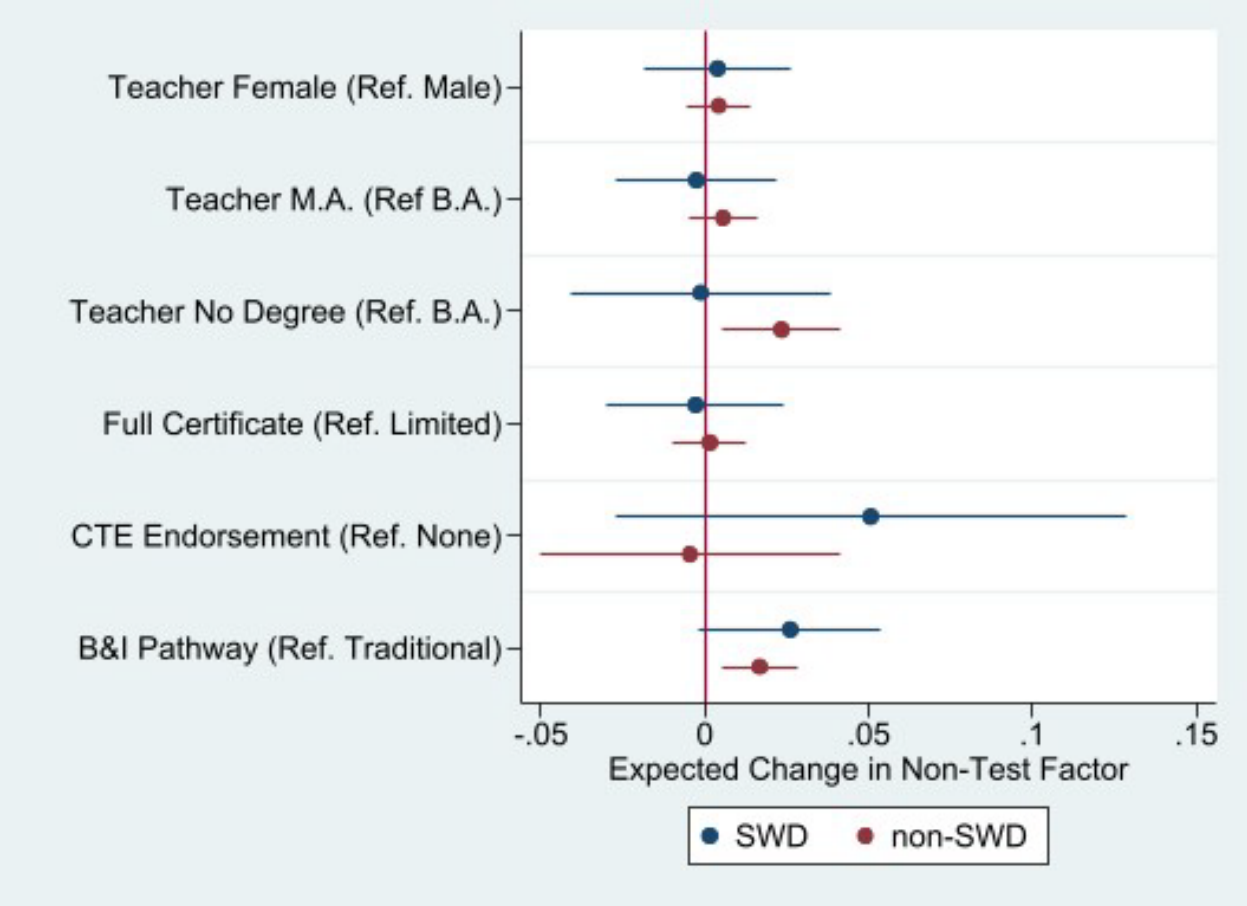


Table 1. Summary Statistics of Student Variables for Students in CTE Courses

Grade	9		10		11		12	
Student Category	NSWD	SWD	NSWD	SWD	NSWD	SWD	NSWD	SWD
Total Excused Absences	12.63 (11.66)	15.37 (14.69)	14.15 (12.91)	16.22 (15.64)	14.73 (14.15)	16.88 (16.49)	16.14 (15.44)	16.41 (17.21)
Total Unexcused Absences	8.519 (16.23)	14.09 (22.34)	11.79 (20.05)	17.38 (25.57)	14.78 (22.65)	20.11 (27.92)	19.49 (27.16)	23.74 (31.02)
Number of Disciplinary Incidents	0.230 (1.038)	0.566 (1.723)	0.191 (0.902)	0.464 (1.536)	0.144 (0.737)	0.350 (1.267)	0.0990 (0.564)	0.205 (0.833)
Number of Suspensions	0.129 (0.624)	0.342 (1.072)	0.111 (0.548)	0.296 (0.972)	0.0835 (0.437)	0.229 (0.833)	0.0587 (0.333)	0.141 (0.592)
Cumulative GPA	2.737 (1.004)	2.190 (0.936)	2.653 (0.991)	2.190 (0.877)	2.616 (0.925)	2.256 (0.811)	2.720 (0.830)	2.368 (0.767)
On-Time Grade Retention	0.970	0.967	0.957	0.954	0.936	0.902		
On-Time Graduation							0.925	0.864
Standardized Eighth Grade Math Score	0.0683 (0.880)	-1.128 (0.811)	0.0504 (0.892)	-1.160 (0.791)	0.0228 (0.890)	-1.150 (0.750)	0.0528 (0.886)	-1.158 (0.756)
Standardized Eighth Grade English Language Arts Score	0.0782 (0.876)	-1.171 (0.868)	0.0604 (0.881)	-1.217 (0.868)	0.0354 (0.881)	-1.211 (0.882)	0.0651 (0.879)	-1.230 (0.913)
Female	0.474	0.324	0.486	0.335	0.467	0.345	0.467	0.349
Black	0.0377	0.0588	0.0440	0.0657	0.0461	0.0696	0.0457	0.0734
Am. Indian/Alaskan Native	0.0142	0.0265	0.0125	0.0255	0.0131	0.0254	0.0118	0.0237
Asian	0.0645	0.0231	0.0719	0.0268	0.0704	0.0301	0.0733	0.0352
Hispanic/Latinx	0.220	0.248	0.212	0.231	0.212	0.231	0.211	0.227
Native Hawaiian / Other	0.0112	0.00796	0.0120	0.00845	0.0118	0.00841	0.0113	0.00843
Limited English Proficiency	0.0487	0.115	0.0491	0.100	0.0433	0.0926	0.0375	0.0855
Eligible for FRL	0.474	0.651	0.448	0.618	0.413	0.603	0.390	0.589
Learning Disability		0.522		0.508		0.514		0.502
Health Impairment		0.259		0.275		0.270		0.261
EBD		0.0411		0.0456		0.0405		0.0366
Autism		0.0696		0.0721		0.0717		0.0856
Intellectual Disability		0.0282		0.0341		0.0406		0.0514
Other Disability		0.0553		0.0537		0.0503		0.0529
80–100% General Education		0.493		0.480		0.501		0.555
40–80% General Education		0.437		0.434		0.415		0.339
Other Inclusion Setting		0.0707		0.0858		0.0844		0.107
Teacher Experience	14.47 (9.820)	14.42 (9.819)	14.23 (9.749)	14.14 (9.818)	14.41 (9.633)	14.53 (9.854)	14.81 (9.692)	14.73 (9.798)
Teacher Female	0.526	0.520	0.509	0.502	0.497	0.510	0.505	0.535
Teacher Master's Degree	0.574	0.560	0.559	0.541	0.536	0.537	0.547	0.533
Teacher Bachelor's Degree	0.267	0.270	0.253	0.258	0.233	0.254	0.230	0.256
Teacher No College Degree	0.133	0.142	0.160	0.170	0.195	0.178	0.184	0.180
Teacher Limited Certificate	0.214	0.211	0.216	0.203	0.218	0.202	0.226	0.200
Teacher Full Certificate	0.690	0.685	0.688	0.697	0.683	0.695	0.678	0.697
Teacher CTE Certificate	0.955	0.949	0.959	0.951	0.959	0.949	0.945	0.932
Teacher B&I Pathway	0.384	0.371	0.453	0.424	0.496	0.449	0.448	0.431
Teacher Traditional Pathway	0.522	0.528	0.452	0.470	0.402	0.442	0.424	0.434
Observations	729010	95335	564848	73643	607984	81892	979886	116559

Notes. Summary statistics collapsed to the student-year level through course-level weights.

Table 2. Results From Factor Analyses of Non-Test Outcomes

Grade	9	10	11	12
Log Total Excused Absences	-0.259	-0.219	-0.200	-0.129
Log Total Unexcused Absences	-0.468	-0.432	-0.347	-0.238
Log Number of Disciplinary Incidents	-0.870	-0.880	-0.894	-0.895
Log Number of Suspensions	-0.865	-0.870	-0.888	-0.893
Cumulative GPA	0.477	0.416	0.311	0.208
On-Time Grade Retention	0.093	0.076	0.093	
On-Time Graduation				0.087

Table 3. Student Predictors of Non-Test Factor Outcome in CTE Courses

Column	(1)	(2)	(3)	(4)
Grade	9	10	11	12
Outcome	Non-Test Factor	Non-Test Factor	Non-Test Factor	Non-Test Factor
Standardized Eighth Grade Math Score	0.0698*** (0.002418)	0.0220*** (0.002782)	0.0123*** (0.002820)	0.0057* (0.002272)
Standardized Eighth Grade English Language Arts Score	0.0763*** (0.002393)	0.0524*** (0.002785)	0.0244*** (0.002679)	0.0193*** (0.002411)
Lag GPA		0.0920*** (0.003347)	0.0768*** (0.003411)	0.0790*** (0.003365)
Lag Disciplinary Incidents	-0.0937*** (0.005388)	-0.1930*** (0.012951)	-0.2352*** (0.012571)	-0.2788*** (0.025456)
Lag Suspensions	-0.2791*** (0.009662)	-0.2213*** (0.020003)	-0.1877*** (0.018680)	-0.2096*** (0.034202)
Lag Unexcused Absences	-0.0176*** (0.000254)	-0.0127*** (0.000233)	-0.0095*** (0.000174)	-0.0060*** (0.000122)
Lag Excused Absences	-0.0150*** (0.000247)	-0.0114*** (0.000251)	-0.0085*** (0.000241)	-0.0057*** (0.000171)
Female	0.1759*** (0.003377)	0.1634*** (0.003956)	0.1730*** (0.004162)	0.1612*** (0.003565)
Black	-0.1055*** (0.009074)	-0.0922*** (0.010121)	-0.1492*** (0.011035)	-0.1313*** (0.009306)
American Indian/ Alaskan Native	0.0187 (0.016200)	-0.0108 (0.019306)	0.0243 (0.017238)	0.0015 (0.014222)
Asian	0.0200*** (0.004733)	0.0080 (0.004510)	0.0163*** (0.004796)	0.0238*** (0.004409)
Hispanic/Latinx	0.0181*** (0.004185)	0.0334*** (0.005010)	0.0292*** (0.005031)	0.0292*** (0.004679)
Native Hawaiian/ Other	0.0839*** (0.012756)	0.0142 (0.016193)	0.0054 (0.016984)	-0.0507*** (0.015333)
Special Education	-0.0184 (0.022360)	-0.1451*** (0.029129)	-0.2005*** (0.041641)	-0.1510*** (0.027724)
Limited English Proficiency	0.0833*** (0.006671)	0.0495*** (0.008114)	0.0120 (0.008343)	0.0172* (0.007729)
Eligible for FRL	-0.0840*** (0.003111)	-0.0578*** (0.003625)	-0.0729*** (0.004194)	-0.0480*** (0.003983)
Observations	812172	629443	678005	1086886

Notes. Regressions weighted by student-course weights and control for missing indicators for eighth grade test scores, lagged variables, student race/ethnicity, course cluster and program indicators, and (for SWDs only) disability type and inclusion designation. Standard errors are clustered at the teacher level. P-values from two-sided t-test: *p<.05, **p<.01, ***p<.001.

Table 4. Teacher Predictors of Non-Test Outcomes in CTE Courses

Column	(1)	(2)	(3)	(4)	(5)
Grade	Pooled	9	10	11	12
Outcome	Non-Test Factor	Non-Test Factor	Non-Test Factor	Non-Test Factor	Non-Test Factor
Teacher Female	0.0046 (0.005097)	0.0041 (0.005478)	0.0010 (0.006289)	0.0038 (0.006685)	0.0059 (0.005901)
Teacher MA Degree (Ref. BA)	0.0044 (0.005461)	0.0004 (0.005459)	0.0058 (0.006608)	0.0037 (0.006890)	0.0050 (0.006545)
Teacher No Degree (Ref. BA)	0.0222* (0.009601)	-0.0019 (0.010248)	0.0018 (0.009777)	0.0336** (0.011500)	0.0224 (0.011905)
Teacher 5-10 Years Exp (Ref. 0-5 Years)	-0.0210 (0.028269)	0.0085 (0.009099)	0.0075 (0.008924)	-0.0041 (0.009947)	0.0059 (0.009920)
Teacher 10-20 Years Exp (Ref. 0-5 Years)	0.0032 (0.008033)	0.0102 (0.007853)	0.0085 (0.009091)	-0.0004 (0.009735)	0.0070 (0.009720)
Teacher 20+ Years Exp (Ref. 0-5 Years)	0.0051 (0.008012)	0.0121 (0.008440)	-0.0020 (0.010357)	0.0060 (0.011809)	0.0025 (0.011215)
Teacher Born in 1960s (Ref. <1960)	0.0026 (0.009481)	-0.0009 (0.005756)	0.0052 (0.006701)	0.0151 (0.008289)	-0.0005 (0.007729)
Teacher Born in 1970s (Ref. <1960)	0.0052 (0.006422)	-0.0058 (0.007149)	-0.0068 (0.008334)	0.0022 (0.009061)	-0.0047 (0.008925)
Teacher Born in 1980s (Ref. <1960)	-0.0039 (0.007377)	0.0021 (0.008839)	-0.0002 (0.009187)	0.0082 (0.010768)	0.0032 (0.010125)
Teacher Born in 1990s (Ref. <1960)	0.0036 (0.008552)	0.0179 (0.020409)	0.0153 (0.021964)	0.0216 (0.024478)	0.0077 (0.020186)
Full Certificate (Ref. Limited)	0.0137 (0.018632)	0.0021 (0.006638)	0.0032 (0.007232)	-0.0001 (0.007264)	-0.0037 (0.007279)
CTE Endorsement (Ref. None)	0.0005 (0.006017)	-0.0197 (0.023934)	0.0166 (0.027253)	0.0241 (0.036281)	-0.0106 (0.024780)
B&I Pathway (Ref. Traditional)	0.0182** (0.006230)	0.0031 (0.006815)	-0.0001 (0.007316)	0.0254** (0.008087)	0.0184* (0.007402)
Observations	2248935	777129	598319	638949	1011666

Notes. BA = bachelor's, B&I = business and industry, MA = master's, Ref = reference. Regressions weighted by student-course weights and control for all student variables in Table 5 (interacted by grade in the model in column 5) and missing indicators for teacher experience, licensure pathway, and credential type. Standard errors are clustered at the teacher level. P-values from two-sided t-test: *p<.05, **p<.01, ***p<.001.

Table 5. Teacher Predictors of Non-Test Outcomes in CTE Courses, Pooled Across Grades by Outcome

Column	(1)	(2)	(3)	(4)	(5)	(6)
Grade	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
Outcome	Non-Test Factor	Log Excused Absences	Log Unexcused Absences	Log Disciplinary Incidents	Log Suspensions	GPA
Teacher Female	0.0046 (0.005097)	-0.0179 (0.010772)	-0.0330** (0.011426)	-0.0025 (0.001661)	-0.0007 (0.000944)	-0.0115* (0.004572)
Teacher MA Degree (Ref. BA)	0.0044 (0.005461)	0.0056 (0.010176)	-0.0154 (0.010707)	-0.0015 (0.001791)	-0.0004 (0.001013)	0.0017 (0.004721)
Teacher No Degree (Ref. BA)	0.0222* (0.009601)	-0.0770*** (0.020662)	-0.0561** (0.019701)	-0.0052 (0.003121)	-0.0033 (0.001711)	0.0176* (0.008228)
Teacher 5-10 Years Exp (Ref. 0-5 Years)	-0.0210 (0.028269)	-0.0173 (0.022928)	0.0009 (0.026543)	0.0071 (0.008860)	0.0018 (0.005697)	0.0044 (0.015347)
Teacher 10-20 Years Exp (Ref. 0-5 Years)	0.0032 (0.008033)	-0.0001 (0.013189)	-0.0127 (0.014673)	-0.0004 (0.002671)	-0.0006 (0.001462)	-0.0005 (0.006115)
Teacher 20+ Years Exp (Ref. 0-5 Years)	0.0051 (0.008012)	0.0081 (0.014379)	-0.0099 (0.015514)	-0.0005 (0.002727)	-0.0015 (0.001441)	-0.0071 (0.006137)
Teacher Born in 1960s (Ref. <1960)	0.0026 (0.009481)	0.0102 (0.016829)	-0.0012 (0.017402)	0.0003 (0.003229)	-0.0008 (0.001682)	0.0010 (0.007155)
Teacher Born in 1970s (Ref. <1960)	0.0052 (0.006422)	0.0068 (0.013564)	-0.0014 (0.014334)	-0.0013 (0.002094)	-0.0015 (0.001116)	0.0067 (0.005957)
Teacher Born in 1980s (Ref. <1960)	-0.0039 (0.007377)	0.0172 (0.014631)	0.0201 (0.015132)	0.0023 (0.002393)	0.0003 (0.001308)	0.0097 (0.006417)
Teacher Born in 1990s (Ref. <1960)	0.0036 (0.008552)	0.0153 (0.015592)	0.0127 (0.016178)	-0.0001 (0.002785)	-0.0010 (0.001599)	0.0059 (0.006751)
Full Certificate (Ref. Limited)	0.0137 (0.018632)	0.0116 (0.027019)	0.0360 (0.022911)	-0.0058 (0.005510)	-0.0011 (0.004209)	-0.0125 (0.014120)
CTE Endorsement (Ref. None)	0.0005 (0.006017)	-0.0336** (0.011522)	-0.0045 (0.012876)	-0.0005 (0.001970)	-0.0000 (0.001080)	-0.0170** (0.005938)
B&I Pathway (Ref. Traditional)	0.0182** (0.006230)	-0.0641*** (0.012743)	-0.0473*** (0.013563)	-0.0054** (0.001970)	-0.0020 (0.001191)	-0.0043 (0.005347)
Observations	2248935	2248935	2248935	2248935	2248935	2248935

Notes. BA = bachelor's, B&I = business and industry, MA = master's, Ref = reference. Regressions weighted by student-course weights and control for all student variables in Table 5 interacted by grade and missing indicators for teacher experience, licensure pathway, and credential type. Standard errors are clustered at the teacher level. P-values from two-sided t-test: *p<.05, **p<.01, ***p<.001.

Table 6. WEST-B/WEST-E Robustness Check

Column	(1)	(2)	(3)
Grade	Pooled	Pooled	Pooled
Outcome	Non-Test Factor	Non-Test Factor	Non-Test Factor
Teacher Female	0.0046 (0.005097)	0.0052 (0.012307)	-0.0020 (0.011306)
Teacher MA Degree (Ref. BA)	0.0044 (0.005461)	0.0102 (0.010103)	0.0023 (0.012200)
Teacher No Degree (Ref. BA)	0.0222* (0.009601)	-0.0071 (0.039150)	0.1620** (0.049643)
Teacher 5-10 Years Exp (Ref. 0-5 Years)	-0.0210 (0.028269)	-0.0109 (0.013144)	0.0047 (0.019303)
Teacher 10-20 Years Exp (Ref. 0-5 Years)	0.0032 (0.008033)	0.0062 (0.015023)	0.0139 (0.021151)
Teacher 20+ Years Exp (Ref. 0-5 Years)	0.0051 (0.008012)	-0.0178 (0.038884)	0.0616** (0.022657)
Teacher Born in 1960s (Ref. <1960)	0.0026 (0.009481)	0.0317 (0.025424)	-0.0051 (0.019192)
Teacher Born in 1970s (Ref. <1960)	0.0052 (0.006422)	0.0033 (0.022957)	-0.0156 (0.018601)
Teacher Born in 1980s (Ref. <1960)	-0.0039 (0.007377)	0.0113 (0.018446)	0.0298* (0.014187)
Teacher Born in 1990s (Ref. <1960)	0.0036 (0.008552)	0.0238 (0.023847)	0.0270 (0.026559)
Full Certificate (Ref. Limited)	0.0137 (0.018632)	-0.0008 (0.011543)	-0.0031 (0.014895)
CTE Endorsement (Ref. None)	0.0005 (0.006017)	0.0531 (0.049030)	0.0699 (0.053167)
B&I Pathway (Ref. Traditional)	0.0182** (0.006230)	0.0246 (0.013130)	0.0141 (0.017447)
Average Std. WEST-B Score		0.0003 (0.000471)	
Average Std. WEST-E Score			0.0005 (0.000299)
Observations	2248935	450729	272894

Notes. BA = bachelor's, B&I = business and industry, MA = master's, Ref = reference, WEST-B = Washington Educator Skills Test – Basic, WEST-E = Washington Educator Skills Test – Endorsement. Regressions weighted by student-course weights and control for all student variables in Table 5 interacted by grade and missing indicators for teacher experience, licensure pathway, and credential type. Model in column 3 also controls for WEST-E field indicators. Standard errors are clustered at the teacher level. P-values from two-sided t-test: *p<.05, **p<.01, ***p<.001.

Table 7. Results for Students With and Without Disabilities

Column	(1)	(2)	(3)
Grade	Pooled	Pooled	Pooled
Outcome	Non-Test Factor	Non-Test Factor	Non-Test Factor
Students	All	SWD	Non-SWD
Teacher Female	0.0046 (0.005097)	0.0040 (0.011443)	0.0042 (0.004867)
Teacher MA Degree (Ref. BA)	0.0044 (0.005461)	-0.0025 (0.012543)	0.0056 (0.005183)
Teacher No Degree (Ref. BA)	0.0222* (0.009601)	-0.0013 (0.020129)	0.0235* (0.009197)
Teacher 5-10 Years Exp (Ref. 0-5 Years)	-0.0210 (0.028269)	-0.0411 (0.057173)	-0.0213 (0.026793)
Teacher 10-20 Years Exp (Ref. 0-5 Years)	0.0032 (0.008033)	0.0008 (0.018036)	0.0040 (0.007710)
Teacher 20+ Years Exp (Ref. 0-5 Years)	0.0051 (0.008012)	-0.0017 (0.017971)	0.0071 (0.007715)
Teacher Born in 1960s (Ref. <1960)	0.0026 (0.009481)	-0.0132 (0.019957)	0.0051 (0.009129)
Teacher Born in 1970s (Ref. <1960)	0.0052 (0.006422)	0.0079 (0.013237)	0.0048 (0.006139)
Teacher Born in 1980s (Ref. <1960)	-0.0039 (0.007377)	0.0042 (0.015822)	-0.0049 (0.007093)
Teacher Born in 1990s (Ref. <1960)	0.0036 (0.008552)	0.0107 (0.018098)	0.0038 (0.008180)
Full Certificate (Ref. Limited)	0.0137 (0.018632)	0.0061 (0.037993)	0.0151 (0.017299)
CTE Endorsement (Ref. None)	0.0005 (0.006017)	-0.0029 (0.013728)	0.0014 (0.005739)
B&I Pathway (Ref. Traditional)	0.0182** (0.006230)	0.0260 (0.014186)	0.0167** (0.005944)
Observations	2248935	254324	1994610

Notes. BA = bachelor's, B&I = business and industry, MA = master's, Ref = reference, WEST-B = Washington Educator Skills Test – Basic, WEST-E = Washington Educator Skills Test – Endorsement. Regressions weighted by student-course weights and control for all student variables in Table 5 interacted by grade and missing indicators for teacher experience, licensure pathway, and credential type. Model in column 3 also controls for WEST-E field indicators. Standard errors are clustered at the teacher level. P-values from two-sided t-test: *p<.05, **p<.01, ***p<.001.

Appendix

Table A1. *Summary Statistics of Student Variables for High School Students in CTE and Non-CTE Courses (Student-Course Level)*

Grade	9		10		11		12	
Course Type	Not CTE	CTE	Not CTE	CTE	Not CTE	CTE	Not CTE	CTE
Total Excused Absences	12.44 (12.17)	12.95 (12.08)	13.84 (13.05)	14.38 (13.26)	14.65 (14.27)	14.98 (14.46)	15.76 (15.65)	16.17 (15.64)
Total Unexcused Absences	8.880 (17.53)	9.156 (17.13)	11.44 (20.24)	12.43 (20.83)	14.36 (23.01)	15.41 (23.40)	19.35 (27.68)	19.93 (27.61)
Number of Disciplinary Incidents	0.243 (1.745)	0.269 (1.142)	0.195 (0.952)	0.222 (0.999)	0.152 (0.964)	0.168 (0.820)	0.102 (0.577)	0.110 (0.599)
Number of Suspensions	0.137 (0.665)	0.153 (0.693)	0.116 (0.580)	0.132 (0.614)	0.0898 (0.484)	0.100 (0.502)	0.0630 (0.365)	0.0673 (0.370)
Cumulative GPA	2.726 (1.059)	2.674 (1.012)	2.709 (0.991)	2.600 (0.990)	2.680 (0.939)	2.573 (0.920)	2.718 (0.884)	2.683 (0.831)
On-Time Grade Retention	0.966	0.970	0.960	0.957	0.933	0.932		
On-Time Graduation							0.900	0.919
Standardized Eighth Grade Math Score	0.0121 (1.007)	-0.0663 (0.951)	0.0118 (0.998)	-0.0856 (0.961)	0.0191 (1.001)	-0.114 (0.953)	0.0164 (1.007)	-0.0703 (0.948)
Standardized Eighth Grade English Language Arts Score	0.0114 (1.005)	-0.0628 (0.960)	0.0115 (0.994)	-0.0837 (0.968)	0.0185 (0.998)	-0.110 (0.967)	0.0156 (1.004)	-0.0668 (0.966)
Female	0.490	0.457	0.489	0.469	0.483	0.453	0.485	0.454
Black	0.0507	0.0401	0.0504	0.0464	0.0520	0.0489	0.0529	0.0486
American Indian/Alaskan Native	0.0151	0.0156	0.0149	0.0140	0.0154	0.0145	0.0151	0.0131
Asian	0.0826	0.0597	0.0815	0.0667	0.0812	0.0658	0.0810	0.0693
Hispanic/Latinx	0.208	0.224	0.204	0.214	0.202	0.215	0.201	0.212
Native Hawaiian/Other	0.0110	0.0108	0.0106	0.0116	0.0107	0.0114	0.0108	0.0110
Special Education	0.125	0.114	0.117	0.114	0.120	0.117	0.126	0.105
Limited English Proficiency	0.0636	0.0563	0.0576	0.0549	0.0534	0.0490	0.0508	0.0425
Eligible for FRL	0.459	0.494	0.443	0.468	0.433	0.435	0.425	0.411
Observations	4510654	824285	4546023	638413	4060550	689937	4680672	1096526

Notes. Summary statistics collapsed to the student-year level through course-level weights.

Table A2. Summary Statistics of Teacher and Class Variables in CTE Courses

Grade	9	10	11	12
Teacher Experience	14.47 (9.821)	14.22 (9.756)	14.42 (9.660)	14.80 (9.701)
Teacher Female	0.525	0.508	0.498	0.508
Teacher American Indian/Alaskan Native	0.00445	0.00635	0.00720	0.00740
Teacher Asian/Pacific Islander	0.0147	0.0164	0.0147	0.0169
Teacher Black	0.0143	0.0120	0.0108	0.0121
Teacher Hispanic	0.0212	0.0194	0.0189	0.0201
Teacher White	0.912	0.912	0.905	0.897
Teacher Master's Degree	0.572	0.557	0.536	0.546
Teacher Bachelor's Degree	0.267	0.253	0.235	0.233
Teacher No Degree	0.134	0.161	0.193	0.184
Teacher Limited Certificate	0.214	0.214	0.216	0.223
Teacher Full Certificate	0.690	0.689	0.685	0.680
Teacher CTE Certificate	0.955	0.958	0.957	0.944
Teacher B&I CTE Pathway	0.383	0.450	0.490	0.447
Teacher Traditional CTE Pathway	0.523	0.454	0.406	0.425
Course Human Services Cluster	0.0490	0.0560	0.0714	0.0805
Course Heath Sciences Cluster	0.190	0.166	0.133	0.112
Course Arts & Communication Cluster	0.144	0.184	0.182	0.175
Course Business Management Cluster	0.0151	0.0189	0.0458	0.0876
Course Agriculture Cluster	0.0930	0.119	0.0900	0.0665
Course STEM Cluster	0.0969	0.0703	0.0716	0.0598
Course Information Technology Cluster	0.207	0.0882	0.0691	0.0629
Course Hospitality Cluster	0.0281	0.0371	0.0425	0.0412
Course Architecture Cluster	0.0111	0.0153	0.0162	0.0166
Course Law Cluster	0.00284	0.00800	0.0226	0.0291
Course Education Cluster	0.0288	0.0670	0.0572	0.0273
Course Manufacturing Cluster	0.0415	0.0445	0.0428	0.0414
Course Transportation Cluster	0.0136	0.0196	0.0304	0.0262
Course Marketing Cluster	0.0352	0.0537	0.0464	0.0430
Course Finance Cluster	0.00371	0.0156	0.0383	0.0722
Course Government Cluster	0.0140	0.0156	0.0111	0.00767
Course Technology Science Program	0.229	0.283	0.299	0.279
Course Business Marketing Program	0.266	0.187	0.212	0.287
Course Human Services Program	0.258	0.263	0.219	0.187
Course Health Sciences Program	0.0440	0.0691	0.0837	0.0724
Course Agriculture Education Program	0.0930	0.119	0.0900	0.0665
Course STEM Program	0.0851	0.0566	0.0610	0.0508
Observations	824285	638413	689937	1096526

Notes. Summary statistics collapsed to the student-year level through course-level weights.

Table A3. CTE-Certificated Teacher Summary Statistics by Licensure Pathway

Grade	Traditional	B&I
Teacher Experience	16.75 (10.58)	11.59 (9.21)
Teacher Female	0.584	0.442
Teacher American Indian/Alaskan Native	0.00628	0.00870
Teacher Asian/Pacific Islander	0.0102	0.0242
Teacher Black	0.00764	0.0188
Teacher Hispanic	0.0104	0.0347
Teacher White	0.951	0.897
Teacher Master's Degree	0.634	0.448
Teacher Bachelor's Degree	0.315	0.185
Teacher No Degree	0.0451	0.355
Teacher Limited Certificate	0.117	0.322
Teacher Full Certificate	0.854	0.618
Teacher CTE Certificate	1.0	1.0
Number of Teachers	1579	1659