



Pathways into the CTE Teaching Profession: A Descriptive Analysis of Degrees, Licenses, and Race in Maryland

David Blazar,¹ Danett Song,¹ Ramon Goings,² Jay Plasman,³ & Michael Gottfried⁴

¹ University of Maryland, College Park

² University of Maryland, Baltimore County

³ The Ohio State University

⁴ University of Pennsylvania

Despite substantial interest in Career and Technical Education (CTE) courses in U.S. high schools—and associated scholarship on this topic—very little is known about characteristics of CTE teachers who are a critical resource for program implementation and expansion. Using eight years of statewide data from Maryland, we document key facts about the CTE teacher workforce and pathways into the profession. First, a sizable share (17%) of CTE teachers enter the profession with a high school diploma or associate’s degree, aligned to state policy that allows Professional and Technical Education-certified teachers to substitute years of professional experience for higher degrees. Relatedly, CTE teachers are substantially more likely than non-CTE teachers to enter the profession through an “alternative” path that bypasses traditional undergraduate teacher education (54% versus 30%). Finally, there is a larger share of Black teachers in CTE versus out of CTE (25% versus 16%), leading to greater opportunities for teacher-student race matching. We hypothesize that these patterns are related: decreased barriers to entry into the CTE teaching profession may support more Black individuals to become CTE teachers.



Introduction

Pathways into the teaching profession for Career and Technical Education (CTE) teachers is described by scholars as the “wild west” because licensure policies can differ fairly substantially from non-CTE teachers (Goldhaber & Theobald, 2024), there is wide variability across states in CTE teacher licensure policies (Bonsu et al., 2013; Kelley et al., 2023; Zirkle et al., 2007), and very little academic scholarship exists on this topic to know how policy translates into practice (Anglum et al., 2023). This gap in the literature is concerning not only because of demand for CTE courses nationwide (Hudson, 2013; Levesque et al., 2008; Theobald et al., 2022) but also because the limited evidence that does exist suggests that CTE teachers, their training, and their characteristics matter substantially for supporting students’ short- and longer-term academic and career success (Chen et al., 2023; Theobald et al., 2024).

Using eight years (2013 to 2020) of statewide data from Maryland, we extend the handful of prior studies on CTE teachers (Gottfried et al., 2022; Nguyen et al., 2023; Theobald et al., 2024) in several key ways. First, we examine incoming degrees and licenses of CTE teachers and how these compare to non-CTE teachers, finding that CTE teachers were substantially more likely than non-CTE teachers to enter the profession with a high school diploma or associate’s degree (17% versus zero). Similarly, amongst teachers who started teaching in Maryland in 2013 or later, CTE teachers were substantially more likely to enter with a “conditional” or “resident teacher” license that allowed them to work full time while completing requirements for full licensure (54% versus 30%). Following other scholarship on CTE teachers (Bonsu et al., 2013; Jacques & Potemski, 2014; Zirkle et al., 2019)—and on teacher licenses more broadly (Walsh & Jacobs, 2007)—we categorize conditional and resident teacher licenses as “alternative” pathways because they bypass traditional undergraduate teacher education.

Disaggregating patterns into specific CTE certification endorsement areas, we find that Professional and Technical Education (PTE) drives much of the overall trend. In Maryland, this certification endorsement area is distinct from all others because it allows individuals to substitute professional experience for higher degrees. Similar policies and pathways exist in other states too (Bonsu et al., 2013; Kelley et al., 2023). Thirty-six percent of newly licensed CTE teachers have a PTE endorsement, and over 85% of them entered the profession through an alternative pathway. Alternative certification rates also were over 50% in several other CTE endorsement areas, including Business Education, Computer Science, and Family and Consumer Sciences. Together, this evidence aligns with policy goals that aim to provide unique avenues for CTE teachers to enter the profession.

Second, we extend prior analyses in the same Maryland data showing that Black teachers were overrepresented in CTE (Gottfried et al., 2022) to consider whether this pattern may be related to those described above on degrees and licenses. Jacques and Potemski (2014) describe certification and licensure policies that allow for high school equivalence and work experience—including Maryland’s PTE endorsement area—to present “low potential for recruitment challenges” (p. 12). This description is similar to other scholarship on pathways into teaching for individuals of color, which argues that policies that decrease barriers to entry (e.g., limiting the financial cost, opportunity cost, and time it takes to gain a teaching credential and license) are “promising practices” for diversifying the profession (Carver-Thomas, 2018; Dilworth & Coleman, 2014; Gist & Bristol, 2022).

Consistent with this theory, we document several key findings relating the degrees, licenses, and race of CTE teachers. There was a larger share of Black CTE teachers in Maryland compared to other high school teachers (25% versus 16%). Black CTE teachers made up an even larger share of individuals with a PTE endorsement (45%) than other race/ethnicity groups and, similarly, had higher rates of entering the profession with a high school diploma or associate’s degree (21% for Black CTE teachers versus 0% to 16% for other race/ethnicity groups). And, Black CTE teachers had the highest

alternative certification rates (69%) compared to non-Black CTE teachers (50%) and non-CTE teachers (30%). Potentially driven by these factors, we find that Black students were more likely to have a race-matched teacher in CTE versus non-CTE high school courses (46% versus 29% of courses).

Together, our descriptive analyses provide insight into the characteristics of CTE teachers and their pathways into the profession, as well as the importance of integrating and attending to race in discussion of CTE teacher licensure and recruitment.

Motivating Literature

Over the past 20 years, significant policy attention (e.g., Carl D. Perkins Act of 2006) to CTE pathways, programs, and courses as a mechanism for boosting college enrollment and career outcomes has led to growing scholarship on this topic (Dougherty, 2023). While the literature base is new and, thus, evolving, studies document several key findings. CTE programs today are “not your father’s vocational education” (Zinth, 2013), meaning that the target audience has changed substantially to include college-aspiring students in addition to those who may enter the workforce directly from high school. CTE course enrollments have actually gone down over several decades—suggesting that some of the negative stigma about career training (Dougherty, 2016; Kreisman & Stange, 2020) has not fully disappeared—but have gone up in some key areas including STEM fields (e.g., information technology, health) where there is significant workforce demand and substantial opportunity for high-wage jobs (Theobald et al., 2022).

Further, well-designed quantitative studies document meaningful and often substantial impacts for students on both margins: college-aspiring and not (Bonilla, 2020; Dougherty, 2018; Gottfried & Plasman, 2018; Hemelt et al., 2019; Page, 2012). For example, Brunner et al. (2023) show that attending a CTE high school boosts male students’ high school graduation and average quarterly earnings, with most of the effects attributed to students who transitioned to the workforce within one

or two years after high school. In Maryland, which is the context of the current study, access to a CTE program aimed at preparing future teachers increases high school graduation and four-year college-going amongst females, with substantial wage effects for Black females (Blazar, Gao, et al., 2024).

Positive impacts on students naturally raise questions about mechanisms and have increased attention on CTE teachers. Like broader scholarship on the importance of teachers to student outcomes (Hanushek & Rivkin, 2010; Jackson, 2018), the characteristics, qualifications, and experiences of CTE teachers matter too—at least in the handful of extant studies on this topic. Chen et al. (2023) show that, in Massachusetts, CTE teachers who earned higher scores on subject-specific licensure tests produced higher longer-run earnings for their students, echoing other scholarship on links between non-CTE teachers’ subject knowledge and student outcomes (Hill et al., 2005; Metzler & Woessmann, 2012). In Washington state, CTE teachers who entered the profession through the state’s Business and Industry pathway—rather than a traditional certification program—outperformed their colleagues in terms of contributions to students’ non-tested outcomes (e.g., absences, suspensions, GPA). This finding suggests that work experience of CTE teachers may be more important for improving some student outcomes than knowledge gained in a traditional teacher education program.

Though limited, this evidence provides some empirical justification for CTE-specific teacher licensure policies that can differ substantially from policies for non-CTE teachers. Some scholars describe the “traditional” teacher certification process as a method of matching course titles on a transcript to a list of state-approved courses, failing to take into account that the knowledge and skills needed to actually teach a course could be obtained through non-academic methods, such as workplace experience (Walsh, 2001). Historically, work experience for CTE teachers was the main factor in their certification due to a stipulation in the Smith-Hughes Act of 1917 that only personnel with practical work experience be permitted to teach in federally reimbursed programs (Miller, 1982).

Unsurprisingly, in 1994, more than 45% of secondary trade and industrial education teachers did not have bachelor's degrees (Lynch, 1996). For non-CTE teachers, "alternative" certification programs and pathways still require bachelor's degrees, just not in teacher education, and hands-on work experience comes from teaching full time while pursuing necessary requirements for full licensure (e.g., coursework, testing) (Walsh & Jacobs, 2007).

Today, almost every state allows for an alternative method to credential CTE teachers, primarily choosing to substitute years of occupational experience for higher levels of formal education (Bonsu et al., 2013). However, specific requirements can vary across states. Policy tracking from Education Commission of the States identifies five categories of requirements to become a CTE teacher today (Kelley et al., 2023): 48 states place an emphasis on work experience, including specified hours/years of work or apprenticeship experience in the occupational area; 45 states have degree requirements, but not always at or above the bachelor's level (as is the case for traditional teacher education programs); 41 states require teacher or CTE training, including completion of professional development, mentorship experience, or other pedagogical training; 26 states seek certification, including industry-recognized licenses; and 17 states require assessments, including completion of testing in CTE subject matter, content area expertise, or other relevant knowledge. By emphasizing subject-matter expertise through accumulated experience and decreasing emphasis on specific types of education, CTE pathways align with some scholars' concerns that would-be qualified teachers are deterred from the career path due to the very restrictions that are in place, particularly around testing (Goldhaber & Hansen, 2010; Petchauer, 2014).

In Maryland, state CTE licensure policies are at the lower end of restrictiveness (Jacques & Potemski, 2014). Generally speaking, teaching certificates in Maryland require candidates to earn a bachelor's degree and passing scores on an accepted standardized exam such as the Praxis I or Basic Skills tests, but there is variation in the amount of prior professional experience with which they enter.

However, the PTE certification area within CTE is the exception to this rule. Prospective teacher candidates can enter with an associate's degree and two years of previous occupational experience in the career area to be taught, or with a secondary school diploma (or equivalent) and official verification of three years of occupational experience (13A CMR § 12.02.15). Unsurprisingly, then, we show below that a PTE endorsement often is associated with an alternative pathway into the profession that bypasses traditional undergraduate teacher education.

There are two types of alternative licenses in Maryland: conditional and resident. Both allow individuals to work full time for two years while completing additional requirements for full licensure, which is valid for five years. The key distinction between the two alternative licenses is that resident teacher certificates are associated with state-approved alternative preparation *programs* (e.g., Teach for America, TNTP, other teacher residency programs), while conditional certificates generally are not associated with a program. As we describe below, in Maryland, conditional certificates are quite common while resident teacher certificates are not.

Within this literature base, we aim to make two contributions. First, despite documentation on the varied ways that CTE teachers can enter the profession—and why this might matter for the teaching profession and for students—we know very little about how these policies play out in practice. Theobald et al. (2024) document patterns in Washington state, where roughly 25% of CTE teachers enter with a bachelor's degree and roughly 15% without any degree. Depending on the grade level, between 40% and 50% of CTE teachers enter through the states' Business and Industry pathway, which is similar in spirit to the PTE pathway in Maryland. Compared to traditionally certified CTE teachers, teachers in the Business and Industry pathway are substantially more likely to enter without a college degree (roughly 36% versus 5%). Nguyen et al. (2023) also examine characteristics of CTE teachers, with the benefit of national data, but focus on fairly broad categories (e.g., graduate degree, CTE qualification) that do not align entirely with details from policy tracking. Assessing the state of

the CTE teacher literature as a whole, Anglum et al. (2023) argue that, “...our understanding of the current workforce and training needs of CTE teachers is insufficient to inform necessary action. Failing to build our collective knowledge could undermine the overarching objectives of the CTE movement—to ensure students are sufficiently prepared to meet their own future workforce needs.” Our study aims to address this concern, with detailed descriptive analyses on Maryland CTE teachers and how they compare to non-CTE high school teachers.

Second, as policy and academic discussion on CTE teachers and their pathways into the profession grows, we argue that one piece of the story is largely missing: race. Sims (2010) makes a similar argument in a short commentary, but without companion empirical analyses. In the broader literature on teachers, alternative pathways and certification processes are described amongst the “promising practices” for diversifying the teacher workforce (Carver-Thomas, 2018; Dilworth & Coleman, 2014; Gist & Bristol, 2022). Alternative pathways into the profession may be important for prospective teachers of color for several reasons. Many first-generation college students of color face acute economic challenges that make it difficult or impossible to major in teaching, which requires up-front capital (Harper & Griffin, 2010; Hrabowski & Sanders, 2015). Traditional certification processes and testing also are shown to be a deterrent for Black and other teacher candidates of color who may otherwise be successful in the classroom (Goldhaber & Hansen, 2010; Petchauer, 2014), which aligns with additional scholarship highlighting systemic racial biases and barriers in traditional teacher preparation programs and certification processes (Chávez-Moreno et al., 2022). Conversely, alternative routes to teacher certification can provide re-entry points to the pathway from K12 to college and career, fast-track the time it takes to earn a license, and, thus, more readily support individuals of color to balance employment with course obligations, student teaching, and other opportunity costs of teacher preparation programs (Berger et al., 2019; Dinkins & Thomas, 2016). Indeed, descriptive analyses show that in Maryland (Blazar, Anthenelli, et al., 2024), Massachusetts (Bacher-Hicks et al.,

2023), and Washington state (Backes & Goldhaber, 2023), there is substantially more diversity in recruitment pathways where barriers to entry are low.

While the literature on decreasing barriers to entry for prospective teachers of color generally has focused on teaching as a whole, there are some hints in existing scholarship that CTE certification pathways may be particularly fertile ground. Theobald et al. (2024) show that Black individuals make up a larger share of CTE teachers certified in the Business and Industry pathway compared to traditional teacher preparation programs (1.9% versus 0.7%), though the share of Black teachers in Washington state as a whole and in their CTE program is quite low. In Maryland, the share of Black teachers overall is much higher (16%), and Gottfried et al. (2022) show that there is a larger share of Black individuals who teach in CTE (23% to 30%, depending on teachers' CTE course load). However, that study did not examine the entering pathways, certificates, and degrees of teachers and how these differed between CTE and non-CTE and by race/ethnicity. Our study builds from this prior work to examine characteristics of CTE teachers, how these differ from non-CTE teachers, and how they also vary across race/ethnicity groups.

Data and Methods

Our analyses draw on statewide public-school data from Maryland, which we access through the Maryland Longitudinal Data System Center (MLDS). The data system includes records for all teachers and students in the state beginning in the 2008-09 school year. We limit the broader population data in two ways. First, we focus on high schools, which is the context in which CTE courses are offered. Second, we limit our sample to a subset of years. To define CTE teachers, we leverage course roster data, which is available statewide starting in 2012-13. We further exclude data after the onset of the Covid-19 pandemic (i.e., excluding 2020-21 school year and after), which reshaped course taking and entry into the teaching profession.

We define CTE teachers as those individuals whose course load in any given year is at least 50% CTE.¹ In the data, courses are flagged by the State Department of Education as associated with one of the 10 career clusters, and we count all of these within our definition of CTE courses (and CTE teachers). The career clusters include: arts, media, and communications; business management and finance; construction and development; consumer services, hospitality, and tourism; environmental, agriculture, and natural resources; health and biosciences; human resource services; information technology; manufacturing, engineering, and technology; and transportation technologies. Our approach is similar to Nguyen et al. (2023), who identify CTE teachers as those whose main teaching assignments include classes in a federally defined CTE career clusters (which are similar to Maryland's). We also narrow the group of CTE teachers to those who have a specific "teacher" code in the human resources data. Although a small subset (6%) of non-teachers teach CTE courses (e.g., school counselors, administrators), this restriction ensures that we have consistent information about entering pathways and licenses, which differ between teachers and other school-based staff.

In our analytic sample, we are interested in three groups of individuals: (i) all high school teachers ($n = 121,381$ teacher-years and 28,091 unique teachers), so that we can make comparisons between CTE and non-CTE; (ii) CTE teachers ($n = 12,561$ teacher-years and 4,055 unique teachers); and (iii) non-censored teachers who started teaching in 2012-13 or later, for whom we can observe whether or not they taught CTE at the time of entry as well as their entering certification pathway, degree, endorsement area, and license ($n = 10,259$ unique high school teachers and 1,005 unique CTE teachers).

¹ Broadening the definition to include individuals who teach at least one CTE course or narrowing to those who teach 100% CTE courses does not change our results.

Our analyses are descriptive. The first set of analyses examine characteristics (e.g., degree, certification endorsement area, license, race) of CTE teachers for whom we can observe their first year in the classroom. The second set of analyses examine differences between CTE and non-CTE, including teacher demographics and alternative certification rates. Given our close attention to race, we also examine student demographics in/out of CTE and rates of teacher-student race/ethnicity matching. In the latter analyses that compare between CTE and non-CTE, we supplement summary statistics with regression analyses that control for factors that may serve as confounders. We consider year and district or school fixed effects to account for labor market conditions where CTE programs may operate in larger school systems that also tend to have large shares of Black teachers, for example. We also consider models that control for teachers' years of classroom experience, age, and gender. Work requirements for CTE teachers generally means that they are older than non-CTE teachers, and other studies show that CTE teachers are more likely to be male than the teacher workforce more broadly (Gottfried et al., 2022).

Results

Characteristics of CTE Teachers

In Table 1, we examine the certification endorsement areas, license/certificate type, and highest degree of CTE teachers. The most common certification area amongst CTE teachers in Maryland is Professional and Technical Education (PTE; 36%), which equips individuals to teach in all 10 career clusters in the state (depending on the specific professional experience that teachers come in with and alignment to the content of the career cluster). Other common CTE-specific certification areas include Business Education (12%), Technology Education (7%), Family and Consumer Sciences (6%), Computer Science (4%), and Agriculture (3%). To avoid small cell sizes, we include Marketing with Business Education and Environmental Science with Agriculture.

According to state guidelines, teachers also can teach CTE classes with CTE-adjacent certification areas that align with a specific cluster. For example, to teach courses in the Health and Biosciences cluster, teachers can receive certification in Biology or Chemistry, as well as in PTE or Technology Education. Together, these CTE-adjacent certification areas account for 14% of entering CTE teachers, including Biology and Chemistry (combined into one group; 4%), Mathematics (4%), Health and Physical Education (4%), and Art (2%).

We also observe that many teachers (17%) teach 50% or more CTE courses in their first year as a teacher, but enter the profession with a certification endorsement area not associated with CTE. These areas include: Special Education (5%), Social Studies (4%), Elementary Education (2%), English, Reading, and ESOL (combined into one group; 2%). There also are a small share of individuals missing certification area (3%) and a smattering of other non-teaching certificates (2%). It is possible that teachers may have multiple endorsement areas that we cannot observe; the data system only tracks the primary endorsement. That said, these patterns are similar to national data showing that, in the same time period and depending on the school year, 12% to 16% of teachers teaching CTE did not have a CTE qualification (Nguyen et al., 2023).

Table 1 also tracks teachers' entering certificate/license and highest degree, by certification endorsement area. As a first pass, we include three license types: traditional, conditional, and resident teacher, where the latter two both fall under the category of "alternative". Conditional certificates are very common amongst PTE-certified teachers (86%), but also are common in several other CTE certification areas (e.g., 55% in Business Education and Marketing and 68% for Computer Science). Resident teacher certificates are not particularly common in these areas and are not observed at all for PTE-certified teachers. This finding indicates that none of the state-approved alternative certification programs in Maryland (e.g., Teach for America, Baltimore Teacher Residency) train and certify PTE teachers, which makes sense given PTE's emphasis on work experience accumulated outside of a

teacher preparation program. Conversely, resident teacher certificates are more common in some CTE-adjacent certification endorsement areas (e.g., 7% for Biology and Chemistry), while conditional certificates are slightly less common (19% to 33%). Closely aligned to state policy, PTE-certified teachers can and do enter with a high school diploma or associate's degree (46%). Bachelor's degrees are the most common entry point for other certification endorsement areas.

We visualize these patterns in Figure 1. For parsimony, we categorize the 16 certification endorsement areas into four groups: (i) PTE, which is unique from other CTE endorsement areas because of the ability to substitute professional experience for higher degrees; (ii) other CTE-specific endorsement areas, excluding PTE; (iii) CTE-adjacent endorsement areas that are meant to support individuals to teach both CTE and non-CTE classes; and (iv) non-CTE certifications. We also group conditional and resident teacher certificates into one "alternative" certification category. Here, we observe that traditional certification is rare amongst PTE-certified teachers and become increasingly common across the next three groups of teachers. Similarly, high school diplomas and associate's degrees are observed almost exclusively amongst PTE-certified teachers, and master's degrees become increasingly common across the next three groups of teachers.

The bottom panel of Figure 1 extends the initial findings by disaggregating by teacher race/ethnicity. Appendix Table 1 shows the same patterns in table form, and disaggregates by each certification area rather than the four broader groups. For completeness, Appendix Table 1 also includes the small share of teachers identified as multiple races/ethnicities or with missing information. In Figure 1, we observe that PTE certifications are the most common amongst Black and Hispanic CTE teachers (over 40%). Black CTE teachers are the most likely to have a CTE-specific endorsement area that includes PTE and other areas (roughly 80%), whereas CTE-adjacent and non-CTE certification areas are more common for other groups. Asian, Hispanic, and White CTE teachers

have similar shares of CTE-adjacent certification areas (16% to 18%). Non-CTE endorsement areas are more common for Asian CTE teachers (over 25%) than for other groups (less than 20%).

Closely related to these patterns, Black CTE teachers have the largest share of individuals entering the profession with a high school diploma or associate's degree (21%, compared to 0% to 16% for other groups), reflecting Black teachers' overrepresentation in PTE. Black, Hispanic, and White CTE teachers have similar shares of individuals entering the profession with a master's degree (roughly 30%). For Asian CTE teachers, we do not observe anyone entering with a high school diploma or associate's degree, and master's degrees are more common than for other groups (56%).

Comparing Between CTE and non-CTE

To what extent are CTE teachers unique from the broader population of high school teachers? We start these analyses in Figure 2, where bars capture characteristics of non-CTE teachers and dots capture characteristics of CTE teachers. We exclude 95% confidence intervals and formal tests of statistical significance between CTE and non-CTE in Figure 2 because standard errors generally are quite small and not easily observed in the figure. In turn, almost all differences are statistically significant. Instead, we show these formal tests in Tables 2 through 4. All panels in Figure 2 disaggregate by race/ethnicity, given our earlier findings showing distinct patterns in entering degrees, licenses, and certification areas by teacher race/ethnicity, at least for CTE teachers on their own. To the extent that these patterns reflect the theory that prospective teachers of color benefit from decreased barriers to entry to the profession, we hypothesize that we may also observe differences by race/ethnicity when comparing outside of CTE.

The top left panel of Figure 2 shows differences in teacher race/ethnicity between CTE and non-CTE. Because this figure does not rely on information related to entry into the profession, we include the full sample of teachers rather than limiting to those for whom we can observe their entry year. Here, we observe that Black teachers are overrepresented in CTE (25% versus 16%) with a 9-

percentage point difference, while other race/ethnicity groups are slightly underrepresented (2- to 3- percentage points). The share of Black teachers in Maryland is higher than the national average (closer to 7%), consistent with population characteristics of Mid-Atlantic states.

We extend these analyses in Table 1, using in a regression framework that conditions on covariates that may serve as confounders. It is possible, for example, that CTE programs operate in larger school systems that also tend to have large shares of Black teachers. However, this possibility does not explain our results. Point estimates are quite similar in models that include versus exclude district or school fixed effects. In fact, in all 24 school districts in Maryland—urban, suburban, and rural—there is a larger share of Black teachers in CTE than outside of CTE. Estimates also are robust to models that control for teachers’ years of classroom experience, age, and gender.

Next, we examine alternative certification rates by race/ethnicity and in/out of CTE. We limit the sample to entering, non-censored teachers, as we rely on information gathered at the point of entry to the profession. Similar to Figure 1, we focus on the broad category of “alternative” certification that combines conditional and resident teacher certificates. On average across teachers in Maryland between 2012-13 and 2019-20, roughly 30% of entering teachers were alternatively certified, with the vast majority of those receiving a conditional license rather than a resident teacher certificate. Figure 2 shows that alternative certification rates of non-CTE teachers were highest amongst Black individuals (50%) and also are common for Hispanic individuals (39%). Roughly 20% of entering White, non-CTE teachers were alternatively certified. Because White teachers make up a plurality of all Maryland teachers, this group drives down the average across teachers.

Figure 2 further shows that alternative certification rates were higher for CTE teachers than non-CTE teachers, across all four race/ethnicity groups. Black CTE teachers were the most likely to enter through an alternative pathway (roughly 70%), with a 19-percentage point difference between CTE and non-CTE teachers. This difference is statistically significant and robust to inclusion versus

exclusion of various controls (see Table 3). We observe a similar 19-percentage point difference for Hispanic teachers (58% in CTE versus 39% for non-CTE), though the difference is not statistically significant due to the small number of non-censored Hispanic CTE teachers in our data. For White teachers, the gap in alternative certificate rates between CTE and non-CTE is even larger (27 percentage points), though the absolute share of alternatively certified teachers in CTE (47%) and non-CTE (20%) is smaller than for both Black and Hispanic teachers. Asian non-CTE teachers were more likely than White teachers to enter through an alternative pathway (31%), though the increase for CTE teachers is fairly small (8 percentage points, or 38% in total). This finding aligns with evidence presented earlier that Asian CTE teachers were less likely than other race/ethnicity groups to have a PTE endorsement and much less likely to enter with a high school diploma or associate's degree.

While a key finding of the analyses that look at CTE teachers on their own relates to entry degrees, we do not make formal comparisons to non-CTE teachers. This is because our primary focus—and primary finding—is on the unique affordances of the PTE certification area, which does not apply to non-CTE teachers. Indeed, only a handful of non-CTE teachers in our data enter the profession with a high school diploma or an associate's degree—compared to 17% of CTE teachers—implying a 17-percentage point (statistically significant) difference between CTE and non-CTE teachers.

Finally, we consider some implications of the patterns presented thus far related to teachers for their students. In Figure 2 (bottom left panel), we show that, like Black teachers, Black students were overrepresented in CTE courses, though the difference of 2 percentage points is not large (36% Black students in CTE compared to 34% Black high school students in the state as a whole). Asian and White students also were slightly overrepresented, while Hispanic students were slightly underrepresented.

The starker finding relates to teacher-student race-matching, bringing together patterns on teacher and student demographics in and outside of CTE. We find that Black students were more likely to have a Black teacher in CTE than outside of CTE (see bottom right panel in Figure 2). We conduct these analyses in a student-course-year dataset. The absolute difference of 15 percentage points is quite large. In other words, for Black students, roughly one out of four academic/non-CTE courses were taught by a Black teacher. In comparison, roughly one out of two CTE courses of Black students was taught by a Black teacher. Similar to our earlier findings, patterns of results are similar when we estimate differences in a regression framework with various controls (see Table 4). For other groups, teacher-student race/ethnicity-matching rates were slightly lower in CTE than outside of CTE, reflecting the fact that Asian, Hispanic, and White teachers were underrepresented in CTE (see top left panel of Figure 2). For these other groups, while the differences are statistically significant given a very large sample size, the magnitudes of the differences (1 to 4 percentage points) are not large relative to the estimates for Black students.

Discussion and Conclusion

Our analyses, which draw on statewide data from Maryland, identify several important patterns regarding CTE teachers. CTE teachers are certified in several endorsement areas, with the plurality of individuals (36%) entering under the PTE area that has unique requirements under state law. Indeed, a large share (46%) of PTE-certified teachers enter with a high school diploma or associate's degree, and a large majority (85%) have a conditional license that implies an alternative avenue into the profession that bypasses traditional undergraduate teacher preparation. Because PTE is the most common certification endorsement area, it drives patterns across all CTE teachers. These patterns are fairly similar to those found by Theobald et al. (2024) in Washington state, whose Business and Industry pathway provides similar affordances as the PTE pathway in Maryland.

We also document that PTE endorsements are particularly common amongst Black (45%) and Hispanic (47%) CTE teachers, and high school diplomas or associate's degrees are a common entering degree for Black CTE teachers (21%). Again, Theobald et al. (2024) document similar patterns in their study, though the overall share of Black and other teachers of color is quite small in Washington state. Thus, our study provides a deeper dive into teacher licensure and degrees by race, relative to just a handful of other studies that examine the characteristics of CTE teachers. In national data, Nguyen et al. (2023) document a slight uptick over time in the share of CTE teachers who are Black, but do not probe potential mechanisms such as certification pathway, degree, license, or endorsement area.

Though the main focus of our analyses is on teachers, we document one important trend for students: Because of the larger share of Black teachers in CTE (23%) versus high school teachers more broadly (16%), Black students are substantially more likely to have a race-matched teacher in their CTE classes compared to other classes (15 percentage points). Future research may explore additional implications of these patterns for students, including race-matching effects on CTE outcomes, which is beyond the scope of this descriptive study. Together, these findings situate race as a central component to discussion on the characteristics of CTE teachers. Like Anglum et al. (2023), we argue that we need to know a lot more about the characteristics of CTE teachers, but we clarify this directive and urge other scholars to explore not just characteristics associated with certification and entry but also to consider the extent to which patterns differ by race.

Aligned with this perspective, we use our analyses and findings to make links between longstanding discussion on unique features of the CTE licensure process (Bonsu et al., 2013; Jacques & Potemski, 2014; Lynch, 1996; Miller, 1982; Zirkle et al., 2007) and parallel literature on the importance of decreasing barriers to entry for prospective teachers of color (Carver-Thomas, 2018; Dilworth & Coleman, 2014; Gist & Bristol, 2022). CTE scholars argue that substituting years of

professional experience for higher degrees is fundamental to the nature of teaching CTE courses, which requires direct application to real-world work. In this sense, state policies that provide these pathways—like PTE in Maryland, Business and Industry in Washington state, and others across the country—may not be “alternative” at all, even though scholars often use this language because of the ways in which these pathways bypass traditional undergraduate teacher education (Bonsu et al., 2013; Jacques & Potemski, 2014; Lynch, 1996; Zirkle et al., 2007). Either way, alternative pathways to become a CTE teacher that allow one to enter the profession without a bachelor’s degree, for example, generally are thought to afford novel recruitment opportunities (Jacques & Potemski, 2014). This is exactly the same argument for relying on alternative certification pathways—and other strategies that can decrease barriers to entry—when recruiting individuals of color into teaching and aiming to diversify the teacher workforce.

While our analyses are descriptive and not causal, patterns support the idea that decreased barriers to entry through alternative pathways—and their unique presence in the CTE licensure process—may be responsible for the larger share of Black teachers in CTE compared to high school courses more generally. We find that alternative certification rates are incredibly high amongst entering CTE teachers, driven primarily by PTE, and they are highest amongst Black CTE teachers. Future research should look for causal identification strategies to expand our findings, potentially exploiting differences in or changes to CTE certification laws and requirements across states and over time. This sort of work also would help consider whether or not Maryland is an outlier in the patterns we observe (and whether being an outlier in its certification requirements drive the results).

It also is important to explore and understand underlying mechanisms. We descriptively observe a higher proportion of Black teachers in CTE positions, but we do not know about their motivation to become a CTE educator, their perspectives on the licensure requirements, and if they viewed these requirements as a barrier to entering the teaching profession. For example, previous

literature has suggested that the use of high-stakes standardized testing for teachers adversely impacts teachers of color generally who are more likely to not retake a licensure test if they do not pass (Cowan et al., 2023) and the trajectory of Black teachers into the profession specifically (Petchauer & Baker-Doyle, 2019). In Maryland, individuals pursuing PTE certification who do not hold a bachelor's degree do not need to complete a basic skills assessment. Alternative certification and CTE certification also decrease barriers to entry along additional dimensions, including financial and opportunity costs. These dimensions may work in tandem, or one may be a key driver.

We also recognize the cautions of some Black scholars that decreasing barriers to entry may not always be a good idea, if these programs provide less rigorous or comprehensive training (White et al., 2020). CTE scholars raise similar concerns, noting that CTE often has a stigma of decreased rigor compared to core academic courses (Jackson & Hasak, 2014; Stephens, 2015; Stone, 2017). Additional lines of inquiry may explore the specific programmatic features and rigor of alternative route CTE teacher credentialing processes and programs, as well as the perceptions of CTE teacher training and quality. That said, at least in Maryland, the primary ways that CTE programs—particularly in PTE—decrease barriers to entry are by eliminating testing and allowing candidates to substitute work experience for degrees. In most instances, candidates still need to complete professional education courses to learn the skills needed to translate industry work experience to the K12 classroom.

Finally, we situate our findings within broader policy conversations about teacher diversity and teacher shortages. While there is greater representation of Black teachers in CTE, we also know that there is a shortage of CTE teachers in the profession overall (Sims, 2010; Zirkle et al., 2019). In fact, PTE, Business Education, and Family and Consumer Sciences—all within CTE—are high-needs subject areas for Maryland, along with Special Education, STEM (science, technology, engineering, and mathematics), and English. Also drawing on Maryland data, Gottfried et al. (2022) point out that

many teachers who teach CTE also teach in non-CTE areas too, potentially reflecting teacher shortages across content areas and, thus, teachers wearing several different hats. As such, we cannot argue that expanding CTE certification pathways—potentially with the simultaneous goal of increasing diversity—is necessarily easy or straightforward. Decreasing barriers to entry appears to be a good idea with respect to increasing participation in the teaching profession for Black individuals. Policy efforts also need to consider multiple recruitment pools of prospective teachers, including industry and potentially also from current CTE students.

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Figures and Tables

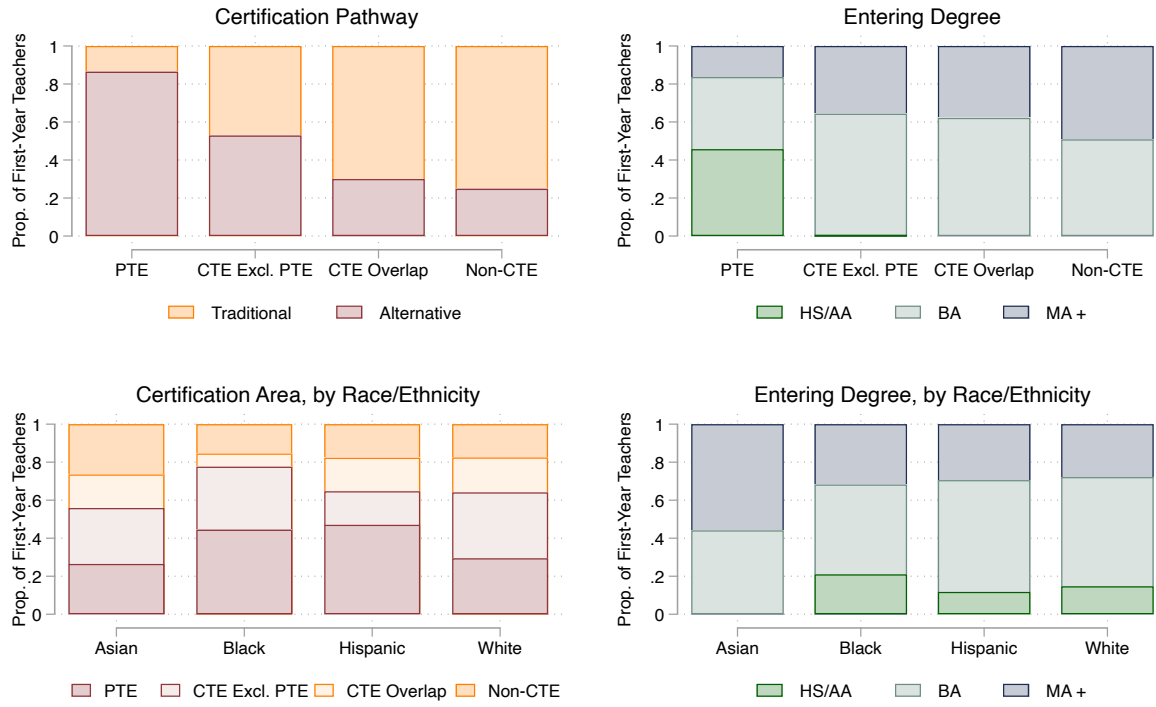


Figure 1. Characteristics of CTE Teachers.

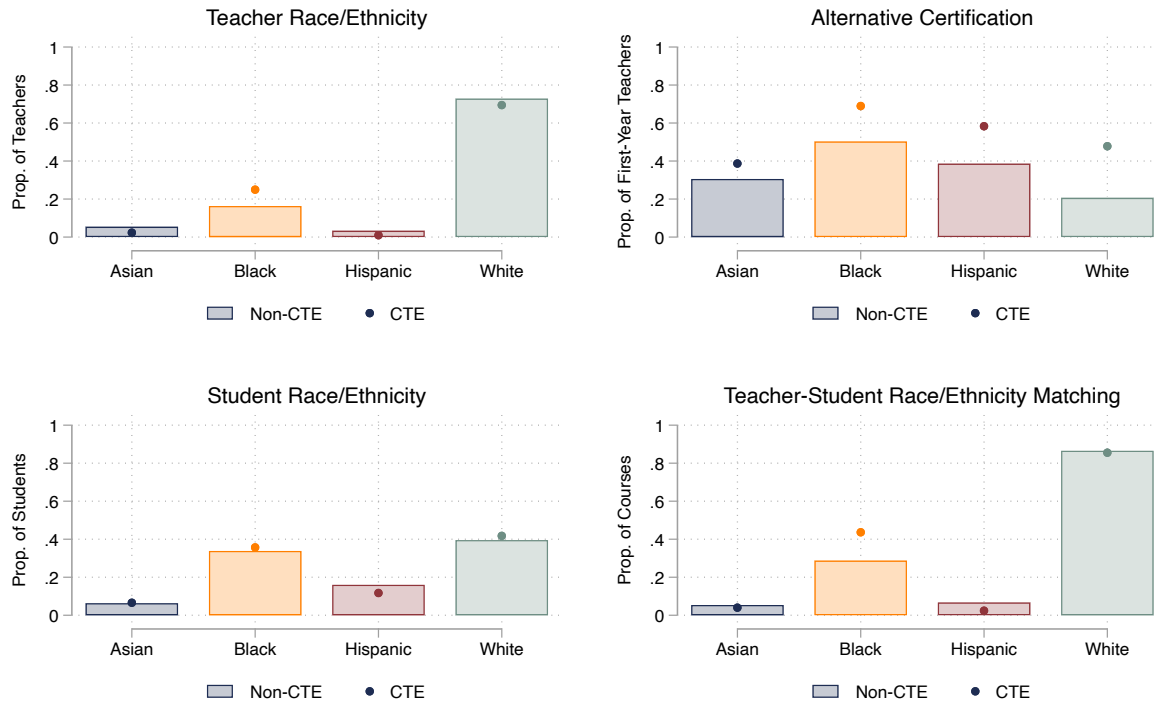


Figure 2. Comparisons between Teacher and Student Characteristics between CTE and non-CTE.

Table 1. Certification Area, Certification Pathway, and Highest Degree of Non-Censored/Entering CTE Teachers

Certification/Endorsement Areas (Sorted within Panel by Share)	Column Proportion	Row Proportion					
		Certificate Type (Row Prop.)			Highest Degree (Row Prop.)		
		Traditional	Conditional	Resident	HS or AA	BA	MA +
<u>Panel A: CTE-Specific Certification Areas</u>							
Professional and Technical Education	0.359	0.136	0.864	0.000	0.457	0.380	0.163
Business Education and Marketing [^]	0.124	0.440	0.552	0.008	0.008	0.544	0.448
Technology Education	0.072	0.528	0.444	0.028	0.000	0.681	0.319
Family and Consumer Sciences	0.064	0.438	0.516	0.047	0.000	0.734	0.266
Computer Science	0.040	0.300	0.675	0.025	0.000	0.625	0.375
Agriculture and Environmental Science [^]	0.030	0.767	0.233	0.000	0.000	0.767	0.233
<u>Panel B: Certification Areas Overlapping between CTE and non-CTE</u>							
Biology and Chemistry [^]	0.043	0.744	0.186	0.070	0.000	0.442	0.558
Mathematics	0.042	0.643	0.333	0.024	0.000	0.643	0.357
Health and Physical Education	0.037	0.676	0.324	0.000	0.000	0.757	0.243
Art [^]	0.018	0.778	0.222	0.000	0.000	0.722	0.278
<u>Panel C: Other Certifications</u>							
Special Education	0.045	0.644	0.356	0.000	0.000	0.400	0.600
Social Studies	0.040	0.675	0.300	0.025	0.000	0.525	0.475
Missing	0.033	0.970	0.030	0.000	0.000	0.667	0.333
Other [^]	0.023	0.783	0.217	0.000	0.000	0.304	0.696
Elementary Education	0.017	0.824	0.176	0.000	0.000	0.706	0.294
English, Reading, and ESOL [^]	0.015	0.667	0.200	0.133	0.000	0.533	0.467
Teachers				1,005			

Notes: Non-censored CTE teachers as those whom we can observe their certification area, pathway, and highest degree at time of entry. [^] indicates that certification areas are combined to avoid small cell sizes of fewer than 10 teachers.

Table 2. Differences in Teacher Race/Ethnicity in and out of CTE

	Teacher- Years	Non-CTE Mean	Difference for CTE			
			(1)	(2)	(3)	(4)
Asian	6,201	0.054	-0.031*** (0.003)	-0.033*** (0.003)	-0.027*** (0.003)	-0.026*** (0.003)
Black	20,917	0.163	0.086*** (0.008)	0.070*** (0.008)	0.088*** (0.007)	0.080*** (0.007)
Hispanic	3,723	0.033	-0.023*** (0.002)	-0.024*** (0.002)	-0.020*** (0.002)	-0.020*** (0.002)
White	87,988	0.728	-0.034*** (0.009)	-0.014 (0.009)	-0.043*** (0.007)	-0.036*** (0.007)
Other Race/Missing	2,552	0.021	0.002 (0.003)	0.001 (0.003)	0.002 (0.003)	0.002 (0.003)
Teacher Background				X	X	X
Year Fixed Effects				X	X	X
District Fixed Effects					X	
School Fixed Effects						X

Notes: The sample includes all high school teachers. Teacher background characteristics include: years of teaching experience, age, and sex. Robust standard errors clustered at the teacher level in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, ~ $p < 0.1$

Table 3. Rates of Alternative Certification of Non-Censored/Entering Teachers by Race/Ethnicity, in CTE and non-CTE

	Teachers	Non-CTE Mean	Difference for CTE			
			(1)	(2)	(3)	(4)
Asian	466	0.306	0.081 (0.090)	0.069 (0.092)	0.133 (0.094)	0.156 (0.113)
Black	2,113	0.503	0.187*** (0.028)	0.210*** (0.028)	0.206*** (0.028)	0.168*** (0.032)
Hispanic	574	0.386	0.197 (0.144)	0.175 (0.136)	0.153 (0.140)	0.214 (0.168)
White	6,311	0.206	0.272*** (0.024)	0.251*** (0.024)	0.271*** (0.024)	0.235*** (0.025)
Other Race	795	0.410	0.296*** (0.053)	0.297*** (0.053)	0.298*** (0.055)	0.270*** (0.073)
Teacher Background				X	X	X
Year Fixed Effects				X	X	X
District Fixed Effects					X	
School Fixed Effects						X

Notes: The sample includes all high school teachers for whom we can observe their certification area, pathway, and highest degree at time of entry. Teacher background characteristics include: age (at time of entry) and sex. Robust standard errors clustered at the teacher level in parentheses. *** p<0.001, ** p<0.01, * p<0.05, ~ p<0.1

Table 4. Teacher/Student Race Matching in CTE and non-CTE Courses

	Student- Course-Years	Non-CTE Mean	Difference for CTE		
			(1)	(2)	(3)
Asian	961,457	0.054	-0.014*** (0.001)	-0.012*** (0.001)	-0.011*** (0.001)
Black	4,776,674	0.287	0.149*** (0.001)	0.154*** (0.001)	0.142*** (0.001)
Hispanic	2,062,088	0.067	-0.043*** (0.001)	-0.040*** (0.001)	-0.038*** (0.001)
White	5,697,499	0.867	-0.010*** (0.001)	-0.024*** (0.001)	-0.025*** (0.001)
Year Fixed Effects				X	X
District Fixed Effects				X	
School Fixed Effects					X

Notes: The sample includes all high school students and teachers. Standard errors clustered at the school level. We exclude the “other race/missing” category because race/ethnicity-matching for this group does not have a substantive interpretation. Robust standard errors clustered at the student level in parentheses. *** p<0.001, ** p<0.01, * p<0.05, ~ p<0.1

Appendix

Appendix Table 1. Entering Certification Area and Degree of Non-Censored/Entering CTE Teachers by Race/Ethnicity

Certification/Endorsement Areas and Degree	Column Proportion					Row Proportion				
	Asian	Black	Hispanic	White	Other	Asian	Black	Hispanic	White	Other
<u>Panel A: CTE-Specific Certification Areas</u>										
Professional and Technical Education	0.265	0.445	0.471	0.294	0.385	0.025	0.446	0.022	0.404	0.102
Business Education and Marketing [^]	0.088	0.163	0.118	0.105	0.094	0.024	0.472	0.016	0.416	0.072
Technology Education	0.029	0.044	0.000	0.101	0.052	0.014	0.222	0.000	0.694	0.069
Family and Consumer Sciences	0.029	0.086	0.000	0.050	0.073	0.016	0.484	0.000	0.391	0.109
Computer Science	0.147	0.039	0.059	0.032	0.042	0.125	0.350	0.025	0.400	0.100
Agriculture and Environmental Science [^]	0.000	0.000	0.000	0.058	0.010	0.000	0.000	0.000	0.967	0.033
<u>Panel B: Certification Areas Overlapping between CTE and non-CTE</u>										
Biology and Chemistry [^]	0.029	0.017	0.059	0.063	0.042	0.023	0.140	0.023	0.721	0.093
Mathematics	0.118	0.022	0.059	0.048	0.052	0.095	0.190	0.024	0.571	0.119
Health and Physical Education	0.029	0.028	0.000	0.040	0.063	0.027	0.270	0.000	0.541	0.162
Art [^]	0.000	0.003	0.059	0.032	0.000	0.000	0.056	0.056	0.889	0.000
<u>Panel C: Other Certifications</u>										
Special Education	0.088	0.039	0.059	0.046	0.042	0.067	0.311	0.022	0.511	0.089
Social Studies	0.000	0.022	0.000	0.056	0.042	0.000	0.200	0.000	0.700	0.100
Missing	0.059	0.055	0.059	0.014	0.031	0.061	0.606	0.030	0.212	0.091
Other [^]	0.059	0.019	0.000	0.022	0.031	0.087	0.304	0.000	0.478	0.130
Elementary Education	0.059	0.006	0.059	0.018	0.031	0.118	0.118	0.059	0.529	0.176
English, Reading, and ESOL [^]	0.000	0.014	0.000	0.018	0.010	0.000	0.333	0.000	0.600	0.067
<u>Panel D: Degree</u>										
High School or AA	0.000	0.210	0.118	0.147	0.156	0.000	0.458	0.012	0.440	0.090
BA	0.441	0.472	0.588	0.575	0.448	0.029	0.326	0.019	0.544	0.082

MA or Higher	0.559	0.318	0.294	0.278	0.396	0.060	0.365	0.016	0.438	0.121
Teachers	1,005									

Notes: Non-censored CTE teachers as those whom we can observe their certification area, pathway, and highest degree at time of entry. ^ indicates that certification areas are combined to avoid small cell sizes of fewer than 10 teachers. Column proportions sum to 1 across panels A, B, and C, and, separately, sum to 1 in panel D on its own.