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Expanding Access to Career and Technical Education Through Dual Enrollment

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Abstract

Despite major policy investments in Career and Technical Education (CTE) and dual enrollment (DuE), little is known about how, and if, dual enrollment expands access to CTE coursework. This study examines participation patterns in high school-based CTE (HS-CTE) and dual enrollment CTE (DuE-CTE) among California's 2022 public high school graduates, using linked administrative data from the California Department of Education and the California Community Colleges Chancellor's Office. We find that nearly one-quarter of students engaged in CTE: 15.5% completed a high school CTE pathway, 6.3% enrolled in DuE-CTE, and 2.9% participated in both. DuE-CTE substantially broadened access to industry sectors such as Business & Finance, Public Service, and Education & Child Development, which are less commonly available in high school based programs. However, participation was not equitably distributed. Asian American students were more likely, and Black students less likely, to participate compared to peers; female students had higher DuE-CTE rates than male students; and students with higher prior achievement were disproportionately represented. Using school fixed-effects models, we show that disparities reflect both differences across schools in CTE offerings and within-school sorting mechanisms. This is one of the first studies to document CTE participation through dual enrollment, highlighting both the promise of expanded coursework opportunities and the persistent inequities in who benefits.

Keywords: College and career readiness, career and technical education, dual enrollment, educational access and opportunity

Introduction

Career and Technical Education (CTE) is essential in aligning secondary education with the evolving world of a skilled workplace. Participation in CTE is associated with higher rates of high school completion, college enrollment, and earnings (Dougherty, 2018; Dougherty et al.,

2019; Gottfried & Plasman, 2018; Kemple & Willner, 2008; Kreisman & Stange, 2020). Despite these benefits, CTE has historically been viewed as distinct from college preparation. In more recent years, however, CTE has had a resurgence amidst a "college for all" culture, offering a balanced view of career preparation alongside college readiness and preparing students for an expansive set of postsecondary educational opportunities. At the same time, efforts to increase students' preparation for and access to higher education through college coursetaking in high school, an educational experience known as dual enrollment (DuE), have been on the rise. Dual enrollment provides a way for students to access CTE in the United States while increasing college *and* career readiness.

Approximately 77% of high school students take at least one CTE course (U.S. Department of Education, 2019), and 34% of students take at least one dual enrollment course (Shivji & Wilson, 2019). Yet, despite the prominence of both CTE and dual enrollment, neither are equitably accessed (Boochever et al., 2023; Dykeman et al., 2024; Friedmann et al., 2020; Friedmann et al., 2024; Reed et al., 2018; Wheelhouse et. al., 2020; Xu et al., 2021). Moreover, little is currently known about the overlap in these postsecondary preparation experiences. This paper addresses some of these gaps by exploring the increasing complexity of the secondary CTE landscape, focusing on California—one of the United States' largest and most diverse states.

Specifically, this study describes participation patterns across two avenues for CTE coursetaking, high school-based CTE (HS-CTE) and dual enrollment-CTE (DuE-CTE), addressing the following questions:

1. How does high school-CTE pathway completion compare to dual enrollment-CTE participation? Within each type, how does participation differ by student demographic subgroups (e.g., gender, race/ethnicity, socioeconomic status) and students' prior academic performance?
2. How does participation vary by industry sector within and across the two avenues through which students participate in CTE?
3. Are statewide differences in CTE participation due to differences across schools or the result of within-school factors?

In answering these questions, this study provides evidence about whether these different and intersecting avenues expand CTE opportunities and for whom.

This exploratory study makes an essential contribution to the literature in a few notable ways. First, this paper is one of the few to explore CTE coursetaking through dual enrollment. It provides a thorough description of students who participate in CTE, dual enrollment, or both, contributing to the larger conversation on the increasing complexity of coursetaking for postsecondary readiness. Second, this paper focuses on equity in CTE and dual enrollment, identifying which groups of students are underrepresented in DuE-CTE and whether differences in enrollment reflect *between*-school disparities (e.g., program availability or course offerings) or *within*-school sorting mechanisms, such as scheduling and/or advising, or how student preferences shape course-taking within a school. This is particularly important given the research on the impacts within-school differences have on student outcomes and inequality (Domina et al., 2019). As states invest heavily in both CTE and dual enrollment to bolster postsecondary participation and improve labor market outcomes, it is critical to more fully investigate these

pathways.

Conceptual Framing: Improving College *and* Career Readiness

Historically, preparation for college and preparation for a career have been viewed as two distinct paths for high school students, and the role of schools in providing either or both pathway(s) has been a topic of debate since the birth of public schools in the United States (Ogden, 1990). Through much of the 20th century, education was a siloed dual-purpose system, where some students were directed to academic courses that would prepare them for postsecondary education, and others were tracked toward industrial or vocational education (Ogden, 1990). This shifted in the late 1900s in response to *A Nation at Risk* (1983) and other reports suggesting that employers desired more academically prepared students (e.g., Gray et al., 1995). A "college-for-all" ethos began to shape America's education system (Rosenbaum, 2001). The college-for-all movement was bolstered by the standards movement, where states adopted curricular standards that would strengthen academic college readiness. The increased focus on college was accompanied by the diminishing importance of vocational education, leading to a significant decline in CTE coursetaking (Jacob, 2017).

Today, policymakers and educators across the country recognize that the skills necessary for success in postsecondary education and the workforce are overlapping. As such, many states emphasize college *and* career readiness as a single concept rather than two distinct pathways in educational goals for students and accountability systems for schools. In fact, the most recent iteration of the federal government's primary CTE funding program, *Perkins V*, makes this shift to career *and* college readiness explicit. Instead of funding programs that lead students directly to the workforce, it encourages CTE programs that promote students' preparation for careers *and* college. Moreover, the *Every Student Succeeds Act* (ESSA), signed into law in 2015 by President Obama, emphasized preparedness for college and career and set the stage for including career readiness in state accountability frameworks previously based primarily on standardized test scores (U.S. Department of Education, 2024). States' enthusiasm for the alignment of college and career readiness was reflected in ESSA State Plans; 49 states included strategies to expand career readiness, and 35 states incorporated a measure of career readiness in their high school accountability frameworks, with dual enrollment, completion of an industry-recognized credential, and work-based learning most frequently included (Education Strategy Group, 2017).

CTE and Dual Enrollment Participation in California

Typically, high school CTE in California is offered either on the high school campus (through individual courses or specialized programs aligned with California's 15 industry sectors) or off-site at Regional Occupational Centers and Programs (ROCPs). Each industry sector includes multiple pathways consisting of a sequence of courses with a minimum of 300 classroom hours and culminating in a capstone course. To be considered a high school CTE completer, a student must earn a grade of C– or better in the pathway's capstone course (see the Measures section for more information about the definition of high school CTE completers and dual enrollment CTE participants).

Among the California 2022 public high school graduating cohort, 18% of students completed a HS-CTE pathway (Boochever et al., 2023). Overall, there were no differences in HS-CTE pathway completion by gender and minimal differences by race/ethnicity (Boochever et al., 2023; Reed et al., 2018). However, within industries, large differences across demographic subgroups emerged, particularly by gender (Boochever et al., 2023; Reed et al., 2018).

Dual enrollment serves as another pathway for students to access CTE. Students may participate in dual enrollment independently (*Independent Dual Enrollment)* or through a formalized partnership between their high school/high school district and a local college/college district (*Structured Dual Enrollment*). Dual enrollment courses can also be academic or career-focused (i.e., DuE-CTE). DuE-CTE courses are directly aligned to career industries (e.g., *Agriculture Power Equipment Technology*, *Respiratory Therapy*, etc), whereas academic dual enrollment courses are intended as college-preparation. Despite these distinctions, DuE-CTE courses are also academically rigorous and often lead to further postsecondary study. Nevertheless, the identification and distinction of CTE courses exists in other studies (e.g., Hemelt & Swiderski, 2022; Ryu et al., 2024), as well as the California community college data that enables us to track this type of CTE participation among high school students.

Nearly one-quarter (22%) of students in the 2022 California high school graduation cohort took at least one dual enrollment course, including either (or both) academic and CTE dual enrollment (Dykeman et al., 2024). Participation rates varied substantially by race/ethnicity, with 31% of Asian American/Pacific Islander students enrolling in dual enrollment, compared to 26% of White students, 25% of multiracial students, 19% of Hispanic students, and 17% of Black students (Dykeman et al., 2024). Notably, over 20% of dual enrollment courses taken at California community colleges were CTE courses (Rodriguez & Gao, 2021; Friedmann et al., 2024).

Prior Literature on the Benefits to Career and College Preparation

Students do not end up in particular course pathways in high school at random, rather by a set of real or perceived choices that are constrained by information barriers, availability, and of course, preference. Thus, it is difficult to determine the causal effect of CTE or dual enrollment participation on subsequent outcomes. Nevertheless, utilizing a variety of quasi-experimental approaches, researchers have found that CTE can improve student outcomes, including high school graduation, college enrollment (Brunner et al.,2023; Hemelt et al., 2019), and earnings (Kemple & Willner, 2008; Dougherty et al., 2019; Brunner et al., 2023). Moreover, the type of CTE pathway and level of CTE courses matter (Ecton & Dougherty, 2022). Dougherty et al. (2019) found that a policy shift in Arkansas requiring career-focused courses as part of high school graduation requirements led to an increase in the number of CTE courses students took. In turn, taking an additional CTE course increased the probability of high school graduation, enrollment in college, finding a job, and greater initial earnings (Dougherty et al., 2019). More recently, however, Ecton's (2023) study of four statewide graduation cohorts in Massachusetts found that concentrating in CTE had no significant impact on dropping out or completing high school, and reduced students' likelihood of attending college immediately after high school.

Investigating the impact of dual enrollment participation, both correlational and causal evidence suggests a positive association between dual enrollment and high school graduation (Karp et al., 2007; Lee et al., 2022); college enrollment (Henneberger et al., 2020; Lee et al., 2022); academic performance in college as measured by GPA (Kirby et al.,2023); degree attainment, especially for low-income students (An, 2013); and shorter time to degree completion through additional credit accumulation before and during college (Allen & Dadgar, 2012). Although dual enrollment is associated with higher college enrollment overall, the relationship between dual enrollment participation and two-year college versus four-year college enrollment appears to vary by study (Henneberger et al., 2020; Lee et al., 2022). Importantly, Lee et al. (2022) found that the positive impact of dual enrollment on high school graduation was greater for Black students compared to their Asian American and White peers and for Hispanic students compared to White students. Few studies show the effect of dual enrollment on workforce outcomes; however, Henneberger et al. (2020) found that dual enrollment participants had higher earnings six years following high school graduation when compared to those who did not participate.

A limited number of studies have explored CTE within dual enrollment frameworks (Phelps & Chan, 2016; Edmunds et al., 2024). In a study examining dual enrollment participation for students in CTE programs in Florida, Karp et al. (2007) found that dual enrollees were one percent more likely to graduate high school compared to students who did not take a dual enrollment course. In a three-year investigation of the Concurrent Courses Initiative in California, a program to develop CTE-focused dual enrollment opportunities, Hughes et al. (2012) found that students who participated in the program demonstrated a greater likelihood of high school graduation, a preference for four-year colleges over two-year colleges, elevated GPAs, and accumulation of more college credits compared to similar students in the same districts who did not participate in the Concurrent Courses Initiative. Additionally, these students were less prone to taking basic skills courses in college and were less likely to discontinue their college education (Hughes et al., 2012). DuE-CTE participants had a greater probability of high school graduation and college enrollment than students taking regular CTE coursework in high school, highlighting the potential boost of dual enrollment. In a study of CTE-dual enrollment in Wisconsin using a hierarchical linear modeling approach, Phelps and Chan (2016) found that CTE dual enrollment participants had higher college course completion rates, greater second-year persistence, higher graduation rates, and increased earnings compared to their peers who did not participate. Ryu et al. (2024), examining the association of dual enrollment course characteristics and post-secondary outcomes in Texas, found that passing an academic dual enrollment course was associated with an 11.9 percentage point increase in the likelihood of enrolling in any postsecondary institution and passing a CTE-dual enrollment course was associated with a 10 percentage point increase, suggesting that any dual enrollment participation led to greater likelihood of pursuing higher education, though academic dual enrollment had a slightly larger effect.

Factors Affecting Participation in CTE and Dual Enrollment

Students' participation in CTE and dual enrollment courses results from the interaction of individual preferences and school-level resources, policies, and practices (Carruthers et al., 2021; Dougherty, 2018; Jacob & Ricks, 2023; Kurlaender & Hibel, 2018). In selecting classes, students

may consider their subject matter interests and/or their postsecondary plans. In some cases, students may choose courses based on the academic or job skills they anticipate developing (Adelman, 1999) or because of the signal it may send to college admissions officers or potential employers (Spence, 1973). However, student choice is constrained by course offerings. Evidence suggests that school size (Monk & Haller, 1993; Reed et al., 2023), geographic location (Friedmann et al., 2024; Iatarola et al., 2011; Klopfenstein, 2004; Kurlaender et al., 2021), and demographic composition of students (Adelman, 1999; Conger et al., 2009) are associated with the degree to which college and career preparatory courses are available. In addition, the scheduling of courses, prerequisite requirements, and guidance counseling practices impact whether or not students enroll in particular classes among those that are offered (Mulhern, 2023).

Both student characteristics—such as gender, race/ethnicity, socioeconomic status, and disability (Carruthers et al., 2021; Dougherty, 2018)—and school factors (Carruthers et al., 2021; Jacob & Ricks, 2023) strongly predict CTE coursetaking. Examining two separate CTE programs in Massachusetts, Dougherty (2018) found that socioeconomically disadvantaged students (SED), students with lower prior test scores, male students, and Hispanic students were overrepresented in CTE. In a study of CTE participation that spanned four states, Carruthers et al. (2021) observed that differences in CTE participation across student demographic subgroups were largely driven by the schools that students attended. Jacob and Ricks (2023) found that "demand factors" (e.g., differences in student preferences) drove the gender participation gap, but that the SED gap was driven by "supply factors" (e.g., different levels of access to CTE programs). Jacob and Ricks (2023) also found that students of all races/ethnicities at schools with high proportions of Black students had a lower participation in CTE and that Black students were 20 percentage points less likely to have access to their top CTE program preference than White students.

School racial/ethnic composition is also associated with DuE participation (Xu et al., 2021; Spencer & Maldonado, 2021). This was reflected in a study of Tennessee's Statewide Dual-Credit program, where schools with higher proportions of White students were more likely to offer dual enrollment courses (Hemelt & Swiderski, 2022). Additionally, gaps in dual enrollment (and Advanced Placement [AP]) participation between White and Black students and White and Hispanic students were larger in districts with a higher proportion of Black students (Xu et al., 2021). Interestingly, no relationship between dual enrollment racial participation gaps and the proportion of students in the district who are Hispanic existed. Other correlates of racialized gaps in dual enrollment participation included average district achievement in grades three through eight and the White-"minority" achievement gap. This underscores racialized inequities in access to dual enrollment. Interestingly, Xu et al. (2021) found that districts where a greater proportion of adults in households with school-age children hold a bachelor's degree (a proxy for the educational background of the community served by the district) and districts with higher average student-teacher ratios had smaller White-Black and White-Hispanic gaps in dual enrollment participation.

Course characteristics and requirements also predict dual enrollment participation. For example, Hemelt and Swiderski (2022) found an increased proportion of students enrolling in a dual enrollment course across all academic achievement levels when districts adopted the Tennessee Statewide Dual-Credit program (SDC), which offered a set number of college-level courses

(Statistics, Precalculus, World History, Sociology, Psychology, Criminal Justice, Plant Science, and Agricultural Business) taught in high schools using centrally-created curricula that were free to students without GPA or course requirements. CTE-dual enrollment courses had the largest enrollments in the SDC program. Hemelt and Swiderski (2022) also found that school size was associated with two of the three DuE-CTE offerings (e.g., an increase of 100 juniors and seniors was associated with a 3% and 1.8% increase in the likelihood of a school offering a *Plant Sciences* and *Criminology* class, respectively). These increases were realized for academic-DuE courses too, but at lower statistical significance levels.

Course Tradeoffs

Given student preferences and school-level factors, participation in either CTE or dual enrollment, or both, likely necessitates some tradeoffs. High school graduation requirements play a key role. In some schools, high school graduation requirements align with college admissions requirements (Lee, 2023; Luu, 2024), but students may desire additional academic courses to strengthen their likelihood of admission to selective institutions. In this case, students may seek out AP or dual enrollment courses. According to Tulloch (2023), students prefer dual enrollment because it guarantees college credit, whereas with AP college credit is contingent on attaining a high score on the AP exam. High school graduation requirements also impact CTE participation; Kreisman and Stange (2020) found that among a nationally representative sample, the greater the number of high school requirements, the fewer CTE courses students took. Ecton (2023) also found that CTE concentrators (students who have completed two or more courses in a single career pathway) took fewer AP and International Baccalaureate classes, fewer study hall and test-prep courses, and fewer arts and world language courses.

These tradeoffs assume the historical silos of CTE and college preparatory coursework previously described. Yet, with the recognition that the knowledge, skills, and dispositions necessary for success in both postsecondary education and the workplace are the same, educational opportunities may not require such tradeoffs. Dual enrollment may be key to the convergence of college and career readiness, offering students the opportunity to take college-level classes with a career focus. This paper investigates whether and how dual enrollment expands and diversifies high school CTE pathways in California and how the demography of participants differs between CTE, academic-DuE, and CTE-DuE.

Methods

Data and Sample

This study used student-level data for the census of all California public high school students in the graduating class of 2022, the most recent cohort data available from the California Department of Education (CDE) at the time of analysis. The analytic sample included 463,891 students across 2,844 high schools, with an average of 163 students in the cohort per school.

These student-level data included demographic information (race/ethnicity, gender, socioeconomic status), 8th grade standardized assessments, graduating high school information,

and information on HS-CTE pathway completion. Student-level data from the CDE was merged with administrative data from the California Community Colleges Chancellor's Office (CCCCO), which contained detailed information on students' college coursetaking, including enrollment and grades received, as well as an indicator of whether or not the course was a CTE course.

Because no unique statewide student identifier exists to connect high school and community college data, students were matched across the two systems (CDE and CCCCO) using last name, first name, date of birth, high school, and gender in an iterative process that uses both deterministic matching techniques (98.8% of matches) and fuzzy matching techniques (1.2% of matches) to account for differences in how names were reported between data sets, the same process used by Dykeman et al. (2024). For a detailed description of each step of the matching process is available from the authors upon request. The overall match rate was 81.7% of students flagged in the CCCCO data as high school students matched to CDE records. We do not rely on the CCCCO or the CDE flag as the primary identifier of dual enrollment students, as both have been found to substantially underreport the true number of dually enrolled students. Thus, the iterative matching process described here identifies a substantially larger population of dual enrollment students than either flag alone. An exact match rate of 100% would not be achievable given that approximately 10% of school-age students in CCCCO were likely private school or homeschooled students whose records were not included in the CDE data (Legislative Analyst's Office, 2025), placing the theoretical ceiling of the match rate at approximately 90%. The achieved match rate of 81.7% thus represents approximately 90% of the maximum possible matches. Match rates varied minimally by student demographic characteristics (table comparing match rates across student demographic characteristics is available from authors upon request).

While the 2022 cohort experienced significant disruptions due to the COVID-19 pandemic, including widespread remote learning, we measure CTE participation cumulatively across grades 9–12, which helps smooth year-to-year fluctuations in course-taking. Neither HS-CTE nor dual enrollment participation declined during the pandemic years in California. Boochever et al. (2023) found that HS-CTE pathway completion remained steady across pandemic cohorts, and Dykeman et al. (2024) found that dual enrollment participation flattened relative to a prior upward trend but did not decline, suggesting participation levels may have been somewhat higher absent the pandemic. Additionally, 12th grade, when most CTE completions occur, corresponds to 2021-22, the year after the most acute COVID-19 disruptions. One caveat is that Dykeman et al. (2024) found that racial and ethnic disparities in dual enrollment participation were exacerbated during the pandemic, suggesting that subgroup differences in DuE-CTE documented in this study may be somewhat larger than they would have been absent COVID-19 disruptions.

CCCCO and CDE use different taxonomies to categorize CTE courses. CDE organizes CTE into 15 industries (disciplines) that include 58 pathways (subdisciplines); for instance, *Biotechnology*, *Patient Care*, and *Healthcare Administrative Services* are pathways within the *Health Science & Medical Technology* industry. A few pathways also have subpathways, for instance, the pathway *Agriscience* (in the *Agriculture & Natural Resources* industry) has a subpathway of *Sustainable Agriculture*. In contrast, CCCCO identifies 18 disciplines (industries) encompassing 178

subdisciplines (pathways); for instance, the *Biotechnology & Biomedical Technology* subdiscipline falls under the *Biological Sciences* discipline.

To compare HS-CTE and DuE-CTE course-taking patterns, different classification systems were reconciled using ChatGPT, which generated initial matches based on keywords in each subdiscipline title, and reviewed by a CTE expert from the CCCCO system. The expert manually adjusted 10 of the 116 subdiscipline–to–industry matches (e.g., reclassifying *Diesel Technology* from *Engineering & Architecture* to the *Transportation* industry). The final crosswalk is available upon request and includes each CCCCO code and subdiscipline title, the ChatGPT-assigned industry, and the final industry assignment (including revisions made by the CTE expert).

Measures

In this study, CTE participation was measured in the two distinct avenues in which CTE can occur: high school-based CTE (HS-CTE) and dual enrollment-CTE (DuE-CTE). The study also explored observations of students participating in both HS-CTE and DuE-CTE during their high school tenure, resulting in three mutually exclusive groups of CTE students: HS-CTE, DuE-CTE, and Both. The measure of students participating in HS-CTE aligns with CDE's measure of *CTE Completers*. Students were considered CTE pathway completers if they completed a pathway sequence of 300 hours and passed the two- or three- course sequence's capstone course associated with their particular CTE pathway. CTE Completers were chosen instead of CTE Participants for HS-CTE for three reasons. First, this is what the CDE reports for federal and state reporting requirements. Second, relatedly, CDE no longer identifies which students are simply CTE participants (rather than completers) in the datasets available to us. Third, the research shows that the benefits of CTE accrue to students who completed a CTE pathway, rather than dabbling in a course or two across industries (Ecton & Dougherty, 2022). Prior years of data, which identified completers and participants, indicated that CTE participants (completers plus non-completers) were roughly double the number of completers.

No similar definition of "CTE completers" in the community college dual enrollment data exists, further highlighting the lack of alignment between the secondary and postsecondary systems in California with regard to Career and Technical Education. As a result, DuE-CTE participation was defined as students who took at least one California community college course designated as a CTE course for credit at some point during their four years of high school. Available data does not allow for the inclusion of students taking DuE-CTE courses at four-year colleges; however, four-year college dual enrollment programs are a very small proportion of dual enrollment nationally (Fink et al., 2017), and likely in California as well; and are less likely to offer CTE-oriented courses.

In short, results for HS-CTE included CTE completers, whereas results for DuE-CTE included CTE participants (any student who took at least one dual enrollment course in a CTE subject area); as such, the two avenues reflect different levels of CTE engagement and comparisons across them should be interpreted with this in mind. The Both category is composed of students who completed a HS-CTE pathway and took at least one DuE-CTE course. One data limitation is

that we were unable to observe whether a DuE-CTE course also counted toward a student's HS-CTE pathway requirements. In cases where we observed both pathway completion and DuE-CTE enrollment, we assigned the student to the Both category, though in some high schools the DuE-CTE course may have contributed to pathway completion.

Analysis of CTE participation across academic performance levels used California's 8th grade English Language Arts standardized assessment (ELA SBAC), the last year of standardized testing before students could begin enrolling in HS-CTE or DuE-CTE courses. The use of prior achievement rather than current high school achievement ensures that performance on standardized assessments was not influenced by CTE participation. Student performance on this assessment was categorized across four performance levels*: Not Met Standards, Nearly Met Standards, Met Standards,* and *Exceeded Standards*.

The industry analysis included the 2022 graduates who took at least one DuE-CTE course or completed one HS-CTE pathway in any of the 15 CTE industries. Student counts reflected unique students per industry. For example, if a student completed two HS-CTE pathways within the *Information & Communication Technologies* (*ICT*) industry, they were counted once in that industry. However, if a student participated in CTE across multiple industries (e.g., completing a HS-CTE pathway in *ICT* and taking a DuE-CTE course in *Public Service*) they were counted once in each industry. In this way, students may have been represented in multiple industries, but only once per industry. This approach ensured that the analysis reflected the number of students who accessed each industry, rather than the total number of enrollments.

Analytic Approach

This study investigated participation patterns across CTE avenues by student subgroups and industry, comparing the proportion of all 2022 graduates who participated in HS-CTE, DuE-CTE, or Both. CTE participation rates were also calculated for race/ethnicity, socioeconomic status, gender, and academic achievement subgroups, as well as by the demographic composition of participants in each CTE type. Lastly, participation in specific CTE industries and across CTE types were explored.

To understand whether the observed differences in participation were due to differences between schools or within school, two linear probability models were estimated. The first (or base) model (1) took the form:

$$Y_{is} = \beta_0 + \beta_1 RaceEth_i + \beta_2 Gender_i + \beta_3 SED_i + \beta_4 Achieve_i + \varepsilon_{is} \quad (1)$$

Where $Y_{is}$was a dichotomous variable for each of our three separately estimated outcomes: whether or not student *i* at school *s* participated in HS-CTE, DuE-CTE, or both. $RaceEth_i$ included seven dichotomous variables representing racial/ethnic groups defined by CDE (Asian American, Black, Filipino, Hispanic, Multiracial, Pacific Islander, Native), with White as the omitted group. $Gender_i$ consisted of a variable for whether or not student *i* was female (male was the omitted group). The CDE and the CCCCO have recently started to include a nonbinary category for gender. Just 414 students in the 2021–22 cohort identify as non-binary, accounting for just 0.09% of the population; this non-binary group was excluded from the analysis due to the

tiny population size, which likely underreported the actual proportions of students who identify as non-binary.

SED_i indicated whether the student is socioeconomically disadvantaged, compared to non-SED. $Achieve_i$ included three variables for performance groupings on the 8th grade ELA assessment: *Met*, *Nearly Met*, or *Not Met*, with *Exceeded* as the reference group. We use ELA instead of Math SBAC since there was a more even distribution of students across the four performance levels (California School Dashboard, 2022). Findings based on 8th grade Math SBAC are available upon request.

The parameters β_1 , β_2 , β_3, and β_4 represented differences in the average likelihood of participating in each CTE type associated with each racial/ethnic group (compared to White), gender identity (compared to male), socioeconomic status (compared to non-SED), and ELA performance (compared to *Exceeded*) on the 8th-grade ELA EOYA, respectively. Standard errors were clustered at the school level.

Model (2) added school fixed effects δ_s to the base model to control for school differences and allow for comparison of participation rates within schools:

$$Y_{is} = \beta_0 + \beta_1 RaceEth_i + \beta_2 Gender_i + \beta_3 SED_i + \beta_4 Achieve_i + \delta_s + \varepsilon_{is} \quad (2)$$

Findings

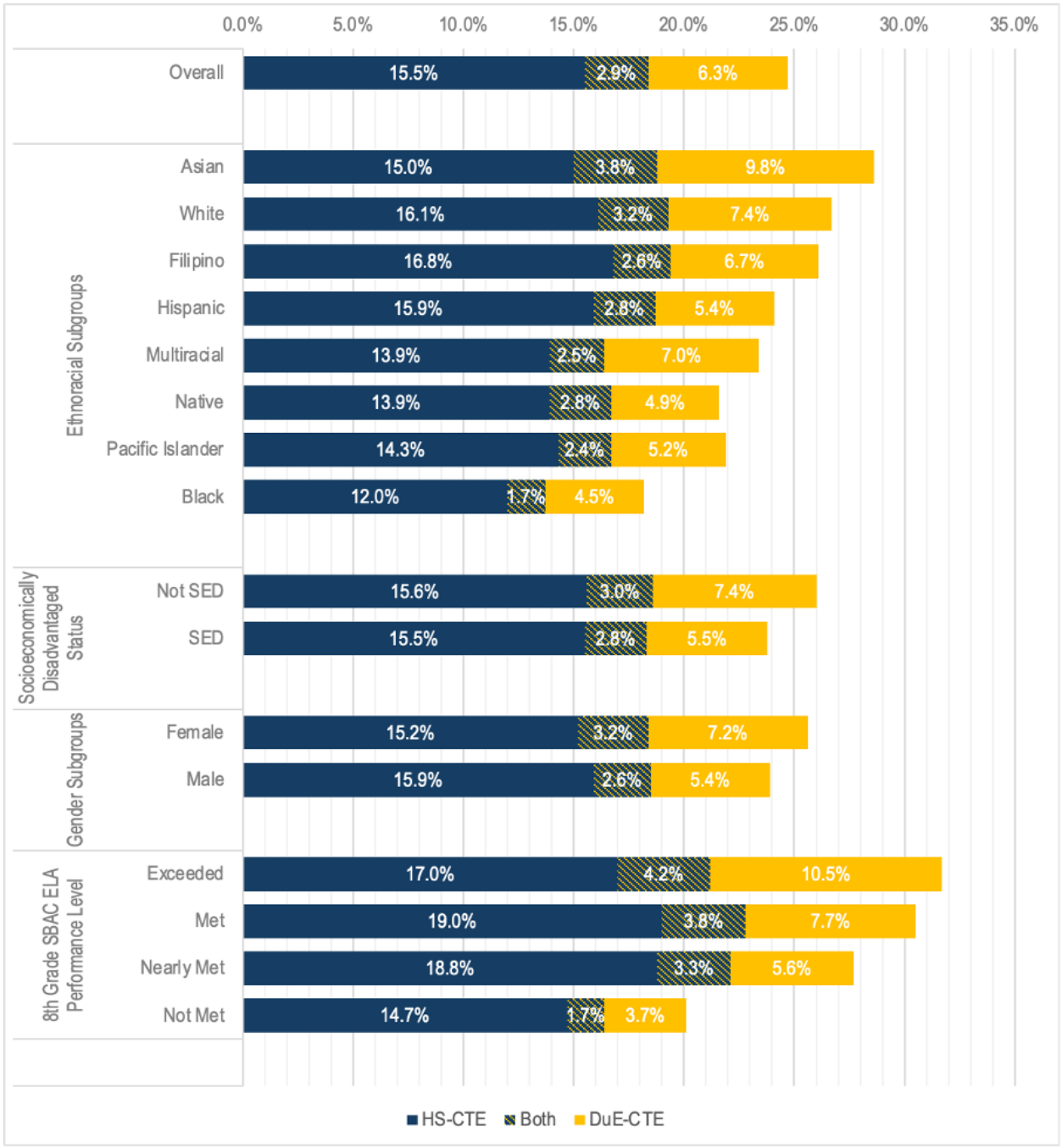
Participation Overall and by Subgroup

Among the class of 2022, 24.7% of students participated in CTE, either by completing a high school CTE pathway, taking a dual enrollment CTE course, or both. Although high school-based CTE remained the most common form of participation—18.4% of students completed a HS-CTE pathway (including those who also took DuE-CTE)—dual enrollment CTE was also a prevalent route. In total, 9.2% of students participated in CTE through dual enrollment, either exclusively through DuE-CTE or by combining it with HS-CTE. Notably, 2.9% of students engaged in both HS-CTE and DuE-CTE.

When examining CTE participation by subgroups (Figure 1), some key differences across CTE avenues emerged. Across all avenues of CTE participation, Asian American students had the highest total rate (28.6%) of all racial/ethnic subgroups, driven largely by their higher participation in DuE-CTE. This differs from North Carolina, where Asian American students were least likely to participate in DuE-CTE compared to their peers from other racial/ethnic subgroups (Edmunds et al., 2024), possibly driven by the different composition of Asian American groups in North Carolina and California (AAPI Data, 2022; UNC Asian American Center & Carolina Demography, 2022). Asian American students in this California sample were 5.4 percentage points more likely to participate in DuE-CTE and 1 percentage point more likely to take both HS-CTE and DuE-CTE courses compared to Hispanic students. Black students had the lowest overall CTE participation rates at 18.2%. They were 5.0 percentage points less likely to take HS-CTE and 2.0 percentage points less likely to take DuE-CTE than their Hispanic counterparts.

Figure 1

CTE participation across student characteristics by CTE type, 2021-22



Note. As with all other analyses in this paper, HS-CTE includes only students who completed a pathway in that industry. For both HS-CTE and DuE-CTE, students are counted once per industry per avenue. A student who participated in the same industry through both HS-CTE and DuE-CTE would be counted once in each. Students who participated in multiple industries are counted once in each applicable industry.

CTE participation rates were relatively similar across socioeconomic groups, although SED students participated at slightly lower rates than their non-SED peers. Among SED students, 23.8% participated in any form of CTE, compared to 26.0% of non-SED students. SED students were also slightly less likely to complete a HS-CTE pathway (18.3% versus 18.6%) and less likely to participate in DuE-CTE, with 8.3% participating compared to 10.4% of non-SED students.

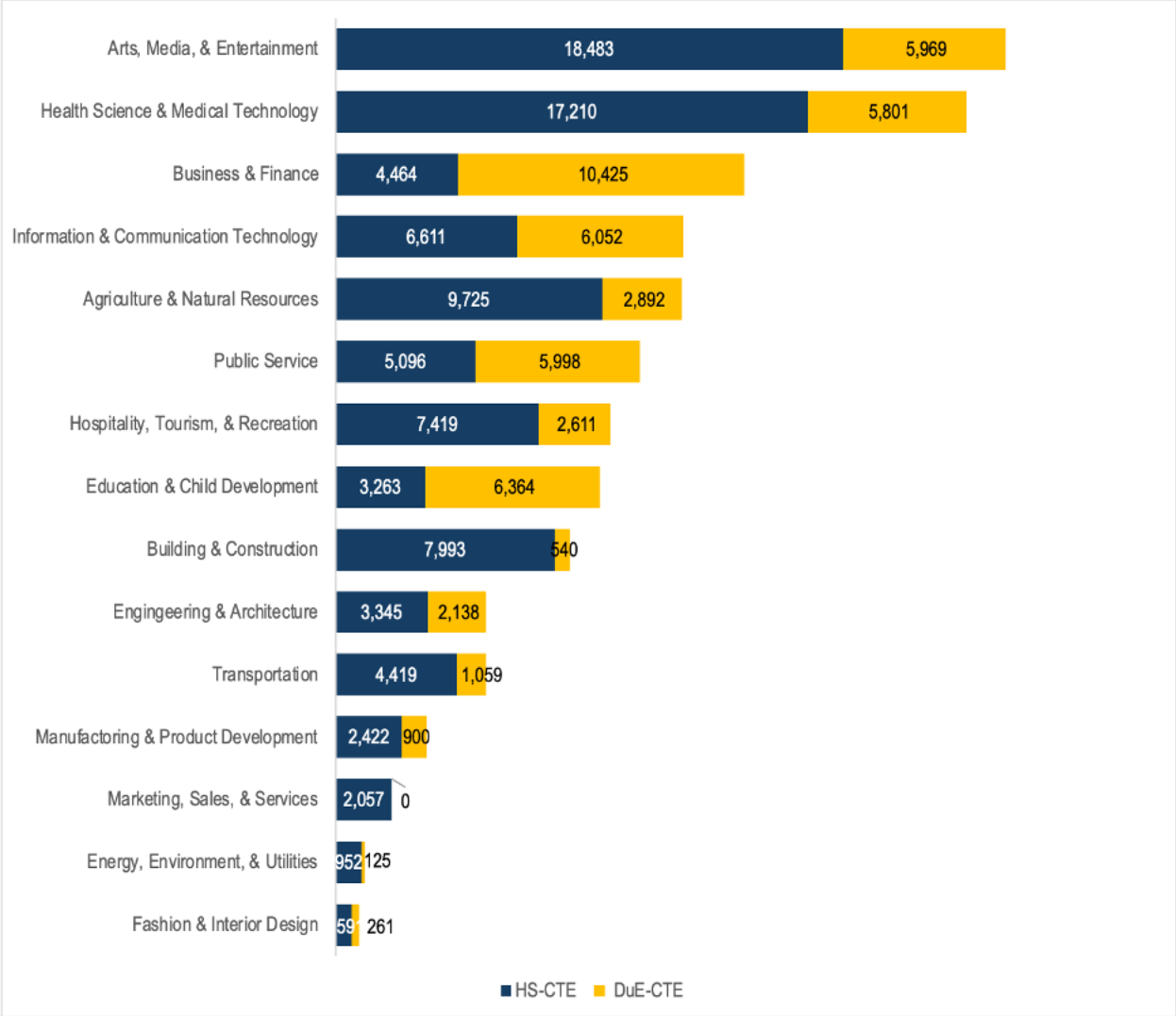
A relatively similar proportion of female and male students participated in CTE (25.6% compared to 23.9%), with nearly identical rates of HS-CTE pathway completion (18.5% for male students vs. 18.4% for female students). However, female students were more likely to participate in DuE-CTE, with 10.4% participating compared to 8.0% of male students. This pattern in California mirrors findings from North Carolina, where Edmunds et al. (2024) observed higher DuE-CTE participation among female students, but contradicts findings from Texas, where Ryu et al. (2024) found higher DuE-CTE participation rates among male students.

Interesting patterns emerged when considering the relationship between CTE and prior achievement. In general, prior achievement was positively associated with CTE participation. Among students in the *Exceeded*, *Met,* and *Nearly Met* performance levels on the 8th grade ELA SBAC, 31.7%, 30.5%, and 27.7% of students, respectively, completed a HS-CTE pathway, took a DuE-CTE course, or did both. In contrast, just 20.1% of students who scored *Not Met* on the 8th-grade assessment participated in CTE, regardless of avenue. The differences in participation rates, especially for the top three performance groups, were primarily driven by differences in DuE-CTE. Findings were similar when using math SBAC performance levels (table with math SBAC performance levels available from authors upon request).

Industry Sectors

The patterns of CTE participation varied across industry sectors. Figure 2 shows the number of 2022 graduates who participated in each of the 15 CTE industries, either by completing a high school CTE pathway or by taking at least one dual enrollment CTE course. The industries with the greatest participation were *Arts, Media, & Entertainment*, followed by *Health Science & Medical Technology*. However, more students engaged in *Business & Finance, Public Service,* and *Education & Child Development* through college courses than by completing a HS-CTE pathway. This suggests that without dual enrollment, students had fewer opportunities to participate in these industries during high school. Given that exposure to these fields is linked to greater postsecondary and/or employment outcomes (Ecton & Dougherty, 2022), the increased access to these fields through dual enrollment is noteworthy. In addition to the industries where dual enrollment participation exceeds HS-CTE, there was also substantial DuE-CTE participation in fields like *Health & Medical Technology* (5,801 students) and *Information & Communication Technologies* (6,052 students). These patterns were particularly important given the priority areas of California's Golden State Pathway Program, which aims to align high school pathways with high-wage, high-growth fields and explicitly names technology, health care, and education.

Figure 2
CTE industry sector participation across CTE types, 2021-22



Note. As with all other analyses in this paper, HS-CTE includes only students who completed a pathway in that industry. For both HS-CTE and DuE-CTE, students are counted once per industry per avenue. A student who participated in the same industry through both HS-CTE and DuE-CTE would be counted once in each. Students who participated in multiple industries are counted once in each applicable industry.

Within-School Versus Between-School Factors in CTE Participation

Prior research indicates that students' participation in CTE and DuE, and the differences across subgroups, are at least partly driven by the schools students attend (Carruthers et al., 2021; Jacob & Ricks, 2023). Using a regression analysis with school fixed effects provided a clearer picture of the role schools play in participation disparities by accounting for unobservable differences across schools. Table 1 presents the estimates for both the base (Columns 1 and 3)

Table 1

Base and School Fixed Effects Models across HS- and DuE- CTE Types

	HS-CTE		DuE-CTE	
	Base (1)	Fixed Effects (2)	Base (3)	Fixed Effects (4)
Asian American	-0.002	-0.009**	0.026***	0.027***
	(0.006)	(0.004)	(0.005)	(0.003)
Black	-0.038***	-0.043***	-0.019***	-0.003*
	(0.005)	(0.003)	(0.004)	(0.002)
Filipino	0.009	-0.008*	-0.006	-0.002
	(0.007)	(0.004)	(0.005)	(0.003)
Multiracial	-0.019***	-0.019***	-0.002	0.002
	(0.004)	(0.003)	(0.003)	(0.003)
Pacific Islander	-0.019**	-0.033***	-0.014**	-0.001
	(0.009)	(0.007)	(0.006)	(0.005)
Native	-0.021**	-0.024***	-0.016***	-0.013**
	(0.010)	(0.008)	(0.006)	(0.005)
Hispanic	-0.005	-0.021***	-0.010***	-0.004***
	(0.004)	(0.002)	(0.003)	(0.001)
SED	-0.007**	-0.019***	-0.008***	-0.006***
	(0.003)	(0.002)	(0.002)	(0.001)
Female	-0.007***	-0.012***	0.015***	0.013***
	(0.002)	(0.002)	(0.001)	(0.001)
Met Standards	0.083***	0.054***	0.009***	0.004***
	(0.003)	(0.003)	(0.002)	(0.001)
Nearly Met	0.083***	0.054***	-0.006***	-0.009***
	(0.004)	(0.003)	(0.002)	(0.001)
Not Met	0.043***	0.021***	-0.022***	-0.022***
	(0.004)	(0.003)	(0.002)	(0.001)
Constant	0.120***	0.157***	0.068***	0.065***
	(0.005)	(0.002)	(0.003)	(0.001)
Observations	463891	463777	463891	463777
R^2	0.011	0.138	0.007	0.138

Note. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table presents the outcomes for HS-CTE and DuE-CTE. The "both" outcome is available from the authors upon request. The R^2 for each of the base models shows the variance in CTE participation that is explained by student demographic characteristics and prior achievement. The low values across outcomes suggest that while these characteristics are associated with participation, many additional factors that are associated with CTE participation are not included in the model. The higher R^2 values for each of the school-level fixed effects models reflect the additional variance absorbed by school fixed effects.

and fixed-effects (Columns 2 and 4) models for the HS-CTE participation and DuE-CTE participation outcomes.

School differences for HS-CTE participation.

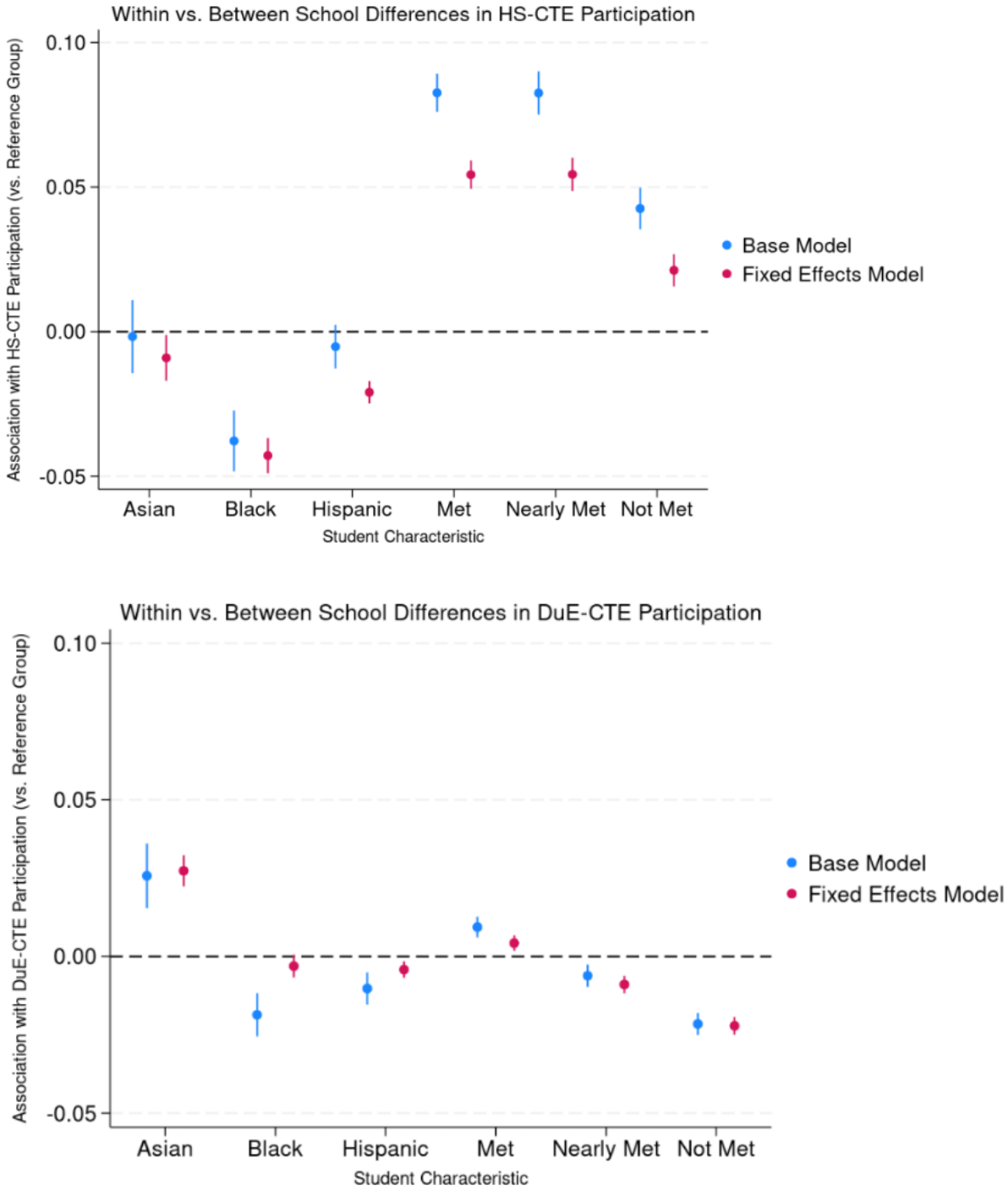
Aligned with the subgroup findings previously discussed, the regression analysis for HS-CTE participation revealed significant disparities in participation rates across various student subgroups, though differences were somewhat attenuated due to the inclusion of control variables. The overall patterns remained consistent when comparing the base model (Column 1) to the fixed-effects model (Column 2) for HS-CTE. If between-school differences alone explained the disparities in CTE participation, the fixed-effects estimates would approach zero. However, the persistence of disparities across models suggests that both between-school factors (e.g., CTE program availability and funding) and within-school mechanisms (e.g., how advising or scheduling practices differentially direct students toward certain pathways) contributed to these differences.

Figure 3 illustrates differences between the base and fixed-effects models for HS-CTE and DuE-CTE outcomes, focusing on key racial/ethnic subgroups (Black, Hispanic, Asian American; White as the omitted group) and academic achievement categories (*Met*, *Nearly Met*, *Not Met*; *Exceeded* as the omitted group). The blue dots represent coefficients from the base model (Columns 1 and 3 in Table 1), while the red dots show fixed-effects model estimates (Columns 2 and 4). Error bars denote 95% confidence intervals.

Notable deviations between the base and fixed-effects models emerged for Hispanic students and for academic achievement subgroups. For Hispanic students, the base model showed no statistically significant difference in participation relative to White students (0.5 percentage points higher, not significant). However, in the fixed-effects model, Hispanic students were 2.1 percentage points less likely to participate in CTE compared to White students within the same school. This is reflected by a large gap between the red and blue dots for the Hispanic variable in Figure 3. This evidence suggests that within-school reasons (e.g., advising or self-sorting) were contributing to disparities in Hispanic student participation.

Figure 3

Differences in base model estimates and school fixed effects model estimates



Note. The blue dots represent the coefficients for each variable in the base model without fixed effects, while the red dots represent the corresponding estimates from the school-level fixed-effects model. The blue and red lines

extending from each dot indicate the 95% confidence intervals for these estimates, reflecting a significance level of $p = 0.05$.

In terms of student achievement, the inclusion of fixed effects reduced the magnitude of the participation differences observed in the base model for the HS-CTE outcome. While the base model showed that students in the *Met*, *Nearly Met*, and *Not Met* categories were more likely to participate in CTE compared to students who *Exceeded*, the fixed-effects model revealed smaller gaps. This indicates that schools with higher-achieving students were less likely to offer HS-CTE opportunities, reflecting a between-school difference in CTE participation.

Regression results for DuE-CTE participation revealed similar patterns of disparity across student subgroups, albeit the magnitude of the differences was different. In the base model (Column 3), Asian students were 2.6 percentage points more likely to participate in DuE-CTE than their White peers, while Black, Pacific Islander, Native, and Hispanic students were less likely. Socioeconomically disadvantaged students were also less likely to participate (0.8 percentage points) compared to non-SED students, whereas female students were 1.3 percentage points more likely compared to male students. These results also align with the descriptive analysis.

School differences for DuE-CTE participation.

Comparing the base model (Column 3) to the fixed-effects model (Column 4) for DuE-CTE revealed that most subgroup disparities persisted, again suggesting that both differences between schools and within-school factors drive differences in participation. Notably, there were virtually no differences between the base and fixed-effects models in the likelihood of DuE-CTE participation across the various levels of academic achievement. This indicates that while schools with higher-achieving students were more likely to offer DuE-CTE, or enroll students who take DuE-CTE, within-school differences remained. Specifically, this means that higher-achieving students, those in the *Met* and *Exceeded* standards categories, were more likely to take DuE-CTE than lower-achieving students statewide and within the same school. The base model also showed that Black and Pacific Islander students were less likely to participate in DuE-CTE compared to White students; however, in the fixed-effects model, the difference was not statistically significant. This suggests that between-school factors (e.g., school-level availability of DuE-CTE programs) were more influential than within-school factors for Black and Pacific Islander students.

Given that CTE and dual enrollment policies often operate at the district level, for instance through partnerships between community college districts and high school districts known as College and Career Access Pathway partnerships, we replicated the models with district fixed effects and clustering at the district level as a specification check to further examine whether participation patterns reflect differences at this level. Disparities persisted across both school and district fixed effects specifications for most subgroups, suggesting that the inequities observed were not primarily driven by between-district differences in program access. One exception is that, for DuE-CTE, the advantage for Asian American students was somewhat larger under district fixed effects than school fixed effects. The source of this difference is an opportunity for further study, as it could reflect district-level variation in program access, between-school

differences within the same district, or other factors. More detailed results for the district-level analysis are available from the authors upon request.

Overall, the persistence of participation disparities across base and fixed-effects models indicates that both between-school and within-school factors influence CTE participation. In other words, differences in HS-CTE and DuE-CTE participation reflected the combined effects of school-level characteristics (such as program availability) and within-school factors (like advising, scheduling, and self-sorting).

Discussion

These findings shed light on the intersection of college and career readiness opportunities through CTE and dual enrollment, offering key insights for shaping program implementation, student recruitment, and the removal of barriers to access. Results provide clear evidence that participation in CTE among California secondary school students was higher than previously reported. Aligning with prior research on CTE pathway completion rates in California (Boochever et al., 2023; Reed et al., 2018), evidence indicates 18.4% of 2022 high school graduates completed a high school CTE pathway. Additionally, 9.2% of graduates enrolled in dual enrollment courses in CTE fields and some students participated in both. Together, the total percentage of students engaged in CTE was nearly a quarter of all high school graduates. Dual enrollment thus plays a significant role in increasing access to and student participation in CTE.

The increased CTE participation driven by dual enrollment suggests that certain aspects of community college courses—whether specific fields of study, timing, schedule, or location — may appeal to or meet the needs of high school students. Importantly, dual enrollment expanded the range of courses and industries available to students. *Health Science & Medical Technology* and *Arts, Media & Entertainment* were the most popular CTE fields, with 35,384 students completing a high school CTE pathway in these industries. An additional 18,869 students participated in these fields through CTE dual enrollment. In *Business & Finance*, *Public Service*, and *Education & Child Development*, students were more likely to take CTE through college courses than complete a high school pathway.

Despite the fact that nearly one-quarter of California public school students engaged in CTE during high school, and dual enrollment expanded access and participation to CTE coursework further, opportunities were not equitably distributed. Our analysis showed moderate differences in HS-CTE participation across racial/ethnic subgroups, with virtually no differences by gender or socioeconomic status. However, disparities became more pronounced when considering CTE dual enrollment. Asian American, White, Filipino, and Hispanic students had similar rates of HS-CTE participation. Still, Asian American students were significantly more likely to participate in dual enrollment CTE, widening the gap in overall CTE participation between Asian American and Hispanic students by 4.6 percentage points. Black students had the lowest participation rates in CTE overall, with a 5.1 percentage point gap between Asian American and Black students in high school CTE pathway completion and 7.4 percentage point gap in dual enrollment CTE.

The most striking disparities emerged when considering students' prior academic achievement. Contrary to the historical notion of CTE as a pathway for non-college-bound students, those who performed well on standardized tests in 8th grade were more likely to engage in CTE opportunities during high school. Notably, students who *Exceeded* or *Met* performance benchmarks were more likely to participate in CTE, particularly through dual enrollment programs. This contrasts starkly with Dougherty's (2018) findings from Massachusetts, where students who performed lower academically were overrepresented in CTE. These findings raise concerns about access and equity for lower-achieving students, who may benefit most from CTE coursetaking. Further research is needed to understand the relationship between academic achievement and CTE participation, particularly to identify barriers that prevent lower-performing students from accessing both high school and community college-based CTE programs.

Our analysis demonstrated that differences in CTE participation across most demographic subgroups were influenced by both within-school and between-school factors. However, the difference in participation between Hispanic and White students in HS-CTE pathways was primarily driven by within-school dynamics. More research is needed to explore the nuances of these within-school factors, particularly to understand how they influence participation across different CTE industries.

Conclusion

CTE pathways and dual enrollment are increasingly important college and career preparation opportunities for secondary students in the U.S. While dual enrollment significantly expands access to CTE opportunities, it also exacerbates existing disparities in participation, particularly for students of color and those with lower academic achievement. These disparities are concerning because dual enrollment CTE, if primarily available to or accessed by students who are likely to attend college irrespective of dual enrollment opportunities and if these opportunities are limited, may crowd out students who stand to benefit most, historically underserved students, from these programs. With California and other states investing in CTE and dual enrollment opportunities, the persistence of a siloed structure within CTE raises challenges for equitable access. The disparities documented in this study highlight the importance of examining how CTE can more effectively serve as a pathway to college and career success for historically marginalized students.

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Competing Interests

The authors have no competing interests to declare.

References

AAPI Data. (2022). *State of Asian Americans, Native Hawaiians, and Pacific Islanders in California*. https://aapidata.com/wp-content/uploads/2024/02/CA_State_of_AANHPIs_Report_2022.pdf

Adelman, C. (1999). *Answers in the tool box: Academic intensity, attendance patterns and bachelor's degree attainment.* U.S. Department of Education.

Allen, D., & Dadgar, M. (2012). Does dual enrollment increase students' success in college? Evidence from a quasi-experimental analysis of dual enrollment in New York City. *New Directions for Higher Education*, *2012*(158), 11–19. https://doi.org/10.1002/he.20010

An, B. P. (2013). The impact of dual enrollment on college degree attainment: Do low-SES students benefit? *Educational Evaluation and Policy Analysis*, *35*(1), 57–75.

Boochever, A., Reed, S., & Kurlaender, M. (2023). *Career technical education among California high school graduates*. Policy Analysis for California Education. https://edpolicyinca.org/sites/default/files/2023-11/ig_boochever-nov2023.pdf

Brunner, E. J., Dougherty, S. M., & Ross, S. L. (2023). The effects of Career and Technical Education: Evidence from the Connecticut technical high school system. *The Review of Economics and Statistics*, *105*(4), 867–882. https://doi.org/10.1162/rest_a_01098

Carruthers, C. K., Dougherty, S., Kreisman, D., & Theobald, R. (2021). *A multi-state study of equity in Career and Technical Education*. Georgia Policy Labs. https://gpl.gsu.edu/download/multi-state-study-of-equity-in-cte-report/?wpdmdl=2325&refresh=665f60f8414c41717526776

Conger, D., Long, M. C., & Iatarola, P. (2009). Explaining race, poverty, and gender disparities in advanced course-taking. *Journal of Policy Analysis and Management*, *28*(4), 555–576. https://doi.org/10.1002/pam.20455

Domina, T., McEachin, A., Hanselman, P., Agarwal, P., Hwang, N., & Lewis, R. W. (2019). Beyond tracking and detracking: The dimensions of organizational differentiation in schools. *Sociology of Education*, *92*(3), 293–322. https://doi.org/10.1177/0038040719851879

Dougherty, S. M. (2018). The effect of Career and Technical Education on human capital accumulation: Causal evidence from Massachusetts. *Education Finance and Policy*, *13*(2), 119–148. https://doi.org/10.1162/edfp_a_00224

Dougherty, S. M., Gottfried, M. A., & Sublett, C. (2019). Does increasing Career and Technical Education coursework in high school boost educational attainment and labor market outcomes? *Journal of Education Finance*, *44*(4), 423–447.

Dykeman, K., Reed, S., Friedmann, E, & Kurlaender, M. (2024, September). *Growth interrupted: An update on dual enrollment participation among public high school graduates*. Policy Analysis for California Education & Wheelhouse: The Center for Community College Leadership and Research. https://education.ucdavis.edu/sites/main/files/file-attachments/wheelhouse_infographic_dual_enrollment_09-2024_final.pdf

Ecton, W. G. (2023). *The opportunity costs of Career and Technical Education: Coursetaking tradeoffs for high school CTE students (EdWorkingPaper: 23-870).* https://doi.org/10.26300/jehn-h591

Ecton, W. G., & Dougherty, S. M. (2022). Heterogeneity in high school Career and Technical Education outcomes. *Educational Evaluation and Policy Analysis*, 01623737221103842. https://doi.org/10.3102/01623737221103842

Edmunds, J. A., Unlu, F., Phillips, B., Mulhern, C., & Hutchins, B. C. (2024). CTE-focused dual enrollment: Participation and outcomes. *Education Finance and Policy*, *19*(4), 612–633. https://doi.org/10.1162/edfp_a_00414

Education Strategy Group. (2017). *Career readiness & The Every Student Succeeds Act*. Education Strategy Group. https://edstrategy.org/resource/career-readiness-the-every-student-succeeds-act/

Fink, J., Jenkins, D., & Yanagiura, T. (2017). *What happens to students who take community college "dual enrollment" courses in high school?*. Community College Research Center, Teachers College, Columbia University. https://files.eric.ed.gov/fulltext/ED578185.pdf

Friedmann, E., Kurlaender, M., Li, A., & Rumberger, R. (2020). *A leg up on college: The scale and distribution of community college participation among California high school students*. Wheelhouse: The Center for Community College Leadership and Research. https://education.ucdavis.edu/sites/main/files/ucdavis_wheelhouse_research_brief_vol5no1_online.pdf

Friedmann, E., Reed, S., Kurlaender, M. & Dykeman, K. (2024, February). *A strong start for college and career: Dual enrollment participation from 9th to 12th grade.* Policy Analysis for California Education & Wheelhouse: The Center for Community College Leadership and Research, Davis. California. https://education.ucdavis.edu/sites/main/files/file-attachments/wheelhouse_infographic_dual_enrollment_02-2024_final_1.pdf

Gillborn, D., Warmington, P., & Demack, S. (2018). QuantCrit: Education, policy, 'Big Data' and principles for a critical race theory of statistics. *Race Ethnicity and Education*, *21*(2), 158–179. https://doi.org/10.1080/13613324.2017.1377417

Gottfried, M. A., & Plasman, J. S. (2018). Linking the timing of Career and Technical Education coursetaking with high school dropout and college-going behavior. *American Educational Research Journal*, *55*(2), 325–361. https://doi.org/10.3102/0002831217734805

Gray, K., Wang, W.-J., & Malizia, S. (1995). Is vocational education still necessary? Investigating the educational effectiveness of the college prep curriculum. *Journal of Industrial Teacher Education*, *32*(2).

Hemelt, S. W., Lenard, M. A., & Paeplow, C. G. (2019). Building bridges to life after high school: Contemporary career academies and student outcomes. *Economics of Education Review*, *68*, 161–178. https://doi.org/10.1016/j.econedurev.2018.08.005

Hemelt, S. W., & Swiderski, T. (2022). College comes to high school: Participation and performance in Tennessee's innovative wave of dual-credit courses. *Educational Evaluation and Policy Analysis*, *44*(2), 313–341. https://doi.org/10.3102/01623737211052310

Henneberger, A. K., Witzen, H., & Preston, A. M. (2020). A longitudinal study examining dual enrollment as a strategy for easing the transition to college and career for emerging adults. *Emerging Adulthood*, *10*(1), 225–236. https://doi.org/10.1177/2167696820922052

Hughes, K. L., Rodríguez, O., Edwards, L., & Belfield, C. (2012). *Broadening the benefits of dual enrollment: Reaching underachieving and underrepresented students with career-focused programs*. https://ccrc.tc.columbia.edu/publications/broadening-benefits-dual-enrollment.html

Iatarola, P., Conger, D., & Long, M. C. (2011). Determinants of high schools' advanced course offerings. *Educational Evaluation and Policy Analysis*, *33*(3), 340–359. https://doi.org/10.3102/0162373711398124

Jacob, B. (2017). *What we know about Career and Technical Education in high school*. Brookings. https://www.brookings.edu/articles/what-we-know-about-career-and-technical-education-in-high-school/

Jacob, B., & Ricks, M. (2023). *Why choose career technical education? Disentangling student preferences from program availability. NBER Working Paper, 31756*. https://www.nber.org/papers/w31756

Karp, M. M., Calcagno, J. C., Hughes, K. L., Jeong, D. W., & Bailey, T. R. (2007). *The postsecondary achievement of participants in dual enrollment: An analysis of student outcomes in two states*. Community College Research Center, Teachers College, Columbia University. https://ccrc.tc.columbia.edu/publications/dual-enrollment-student-outcomes.html

Kemple, J., & Willner, C. (2008). *Career academies: Long-term impacts on labor-market outcomes, educational attainment, and transitions to adulthood*. MDRC.

Kirby, C., Misra, K., Bagchi Misra, A., & Cox, S. P. (2023). The effects of dual-enrollment programs on students' post-secondary academic performance. *CESifo Economic Studies*, ifad004. https://doi.org/10.1093/cesifo/ifad004

Klopfenstein, K. (2004). The Advanced Placement expansion of the 1990s: How did traditionally underserved students fare? *Education Policy Analysis Archives*, *12*. https://doi.org/10.14507/epaa.v12n68.2004

Kreisman, D., & Stange, K. (2020). Vocational and career tech education in American high schools: The value of depth over breadth. *Education Finance and Policy*, *15*(1), 11–44. https://doi.org/10.1162/edfp_a_00266

Kurlaender, M., & Hibel, J. (2018). Students' educational pathways: Aspirations, decisions, and constrained choices along the education lifecourse. In B. Schneider (Ed.), *Handbook of the Sociology of Education in the 21st Century* (pp. 361–384). Springer International Publishing. https://doi.org/10.1007/978-3-319-76694-2_16

Kurlaender, M., Reed, S., Grosz, M., Mathias, J., & Hughes, K. (2021). *A foot in the door: Growth in participation and equity in dual enrollment in California.* Wheelhouse: The Center for Community College Leadership and Research. https://files.eric.ed.gov/fulltext/ED624034.pdf

Lee, J., Fernandez, F., Ro, H. K., & Suh, H. (2022). Does dual enrollment influence high school graduation, college enrollment, choice, and persistence? *Research in Higher Education*, *63*(5), 825–848. https://doi.org/10.1007/s11162-021-09667-3

Lee, P. (2023). *A–G resource guide: Insights and strategies from exemplar school districts*. Policy Analysis for California Education. https://edpolicyinca.org/publications/a-g-resource-guide

Legislative Analyst's Office (2025, October 7). *A.G. File No. 2025-014.* Retrieved from

https://lao.ca.gov/BallotAnalysis/Initiative/2025-014

Luu, J. (2024). *Requiring A-to-G: Examining the effect of aligning high school graduation requirements with California's public university admissions course requirement [Unpublished doctoral dissertation]*. University of California, Davis.

Monk, D. H., & Haller, E. J. (1993). Predictors of high school academic course offerings: The role of school size. *American Educational Research Journal*, *30*(1), 3–21. https://doi.org/10.3102/00028312030001003

Mulhern, C. (2023). Beyond teachers: Estimating individual school counselors' effects on educational attainment. *American Economic Review*, *113*(11), 2846–2893. https://doi.org/10.1257/aer.20200847

Ogden, W. R. (1990). Vocational education: A historical perspective. *The High School Journal*, *73*(4), 245–251.

Phelps, L. A., & Chan, H.-Y. (2016). Optimizing technical education pathways: Does dual-credit course completion predict students' college and labor market success? *Journal of Career and Technical Education*, *31*(1). https://doi.org/10.21061/jcte.v31i1.1496

Rodriguez, O., & Gao, N. (2021). *Dual enrollment in California*. Public Policy Institute of California. https://www.ppic.org/publication/dual-enrollment-in-california/

Reed, S., Dougherty, S. M., Kurlaender, M., & Mathias, J. (2018). *A portrait of California Career Technical Education pathway completers* (Getting Down to Facts II). PACE: Policy Analysis for California Education.

Rosenbaum, J. E. (2001). *Beyond college for all: Career paths for the forgotten half*. Russell Sage Foundation. https://www.jstor.org/stable/10.7758/9781610444767

Ryu, W., Schudde, L., & Pack-Cosme, K. (2024). Dually noted: Examining the implications of dual enrollment course structure for students' course and college enrollment outcomes. *American Educational Research Journal*, 00028312241257453. https://doi.org/10.3102/00028312241257453

Shivji, A., & Wilson, S. (2019). *Dual enrollment: Participation and characteristics* (NCES 2019-176, Data Point). National Center for Education Statistics. https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2019176

Spence, M. (1973). Job market signaling. *The Quarterly Journal of Economics*, *87*(3), 355–374. https://doi.org/10.2307/1882010

Spencer, G., & Maldonado, M. (2021). Determinants of dual enrollment access: A national examination of institutional context and state policies. *AERA Open*, *7*, 23328584211041628. https://doi.org/10.1177/23328584211041628

Tulloch, A. G. (2023). *Stealth transfer: How former dual-enrollment students are disrupting postsecondary education for the better.* Inside Higher Ed. Retrieved December 7, 2023, from https://www.insidehighered.com/opinion/blogs/beyond-transfer/2023/06/01/stealth-transfer-disruption-dual-enrollment-students

UNC Asian American Center & Carolina Demography. (2022). *Southeastern United States Asian American profiles*. University of North Carolina at Chapel Hill. https://aac.unc.edu/data-demography/

U.S Department of Education. (1983). *A nation at risk: The imperative for educational reform*.

U.S. Department of Education. (2019, September). *Bridging the Skills Gap: Career and Technical Education in High School*. https://www2.ed.gov/datastory/cte/index.html

U.S. Department of Education. (2024, March). *Every Student Succeeds Act (ESSA)*. http://www.ed.gov/laws-and-policy/laws-preschool-grade-12-education/every-student-succeeds-act-essa

Wheelhouse, California Education Lab, & Policy Analysis for California Education. (2020). *A rising tide: Dual enrollment is growing among California high school students*. https://edpolicyinca.org/sites/default/files/2020-12/ig_wheelhousedec2020.pdf

Xu, D., Solanki, S., & Fink, J. (2021). College acceleration for all? Mapping racial gaps in advanced placement and dual enrollment participation. *American Educational Research Journal*, *58*(5), 954–992. https://doi.org/10.3102/000283122199113

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