Dual Enrollment and Career and Technical Education in California: Participation, Access, and College and Career Readiness under Common Core and Multiple Measures Accountability

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Abstract

Postsecondary education and career training is increasingly important, with growing polarization of the labor market and forecasts for increasingly skilled workers to meet the needs of the US economy, particularly in California. Additionally, gaps between various student groups in educational access and attainment continue to persist despite policies to increase equity in education. This work examines two approaches to improving college and career readiness for high school students: dual enrollment and career and technical education (CTE).

There is growing interest in both dual enrollment and career and technical education as policy levers to improve education. CTE in California has been aligned to the Common Core curriculum, and career preparation is included in accountability under the Every Student Succeeds Act (ESSA). Preparation for the labor market is important for socioeconomic mobility, particularly for marginalized groups. However, there is concern about tracking students out of college preparation, especially given vocational education's historical legacy. Social priorities have shifted from "college for all" to "career *and* college readiness," though it is not clear if students are prepared for both trajectories. Recent statewide legislation has aimed to improve access to dual enrollment, especially for students that are not considered college-bound, but substantial gaps persist in dual enrollment access and participation, particularly by race. However, there is promising evidence that targeted dual enrollment programs are more equitable.

In *Career and Technical Education in California: Participation, Access, and College and Career Readiness under Common Core and Multiple Measures Accountability*, I utilize comprehensive student-level data on the population of California public school students to understand both the landscape of CTE enrollment and participation in California and access to CTE programs for various subgroups of students. I examine stratification across CTE industry groups, patterns of CTE participation across various school types, and access to schools with

varying levels of CTE participation. I find significant stratification across CTE industry groups that follows historical patterns of tracking, suggesting continued challenges to utilizing CTE as a policy tool in efforts to improve college and career readiness and provide equitable educational opportunities.

In *Dual Enrollment: How Opportunity and Participation is Distributed Across California's Schools,* I categorize schools by their level of dual enrollment participation and examine the distribution of students across schools with different levels of dual enrollment by student subgroup. I find stark disparities in access to high dual enrollment schools by race, for English Learners, and socioeconomically disadvantaged students. I also find that charter and alternative or continuation schools often have high dual enrollment participation.

In *A Foot in the Door: Growth in Participation and Equity in Dual Enrollment in California*, along with my co-authors, I present data about which students are participating in various types of dual enrollment in the California Community Colleges–the primary provider of dual enrollment statewide, for the population of California students in the 2018-2019 graduating cohort. We also document how participation differs across regions, high schools, and course subjects pursued. We find that high school students represent a growing share of community college students and that there are an increasing number of course sections that serve only high school students. Gaps in participation rates across racial. & ethnic groups are much smaller for classes with only high schools students in comparison to the overall gaps in dual enrollment participation.

Keywords: dual enrollment, career and technical education, college and career readiness

Table of Contents

I: Career and Technical Education in California: Participation, Access, and College and Career Readiness under Common Core and Multiple Measures Accountability

Introduction

There is growing interest in career and technical education (CTE) with the expansion of Common Core adoption and the inclusion of career preparation in accountability under the Every Student Succeeds Act (ESSA). Social priorities have shifted from "college for all" to "career *and* college readiness," though it is not clear if students are prepared for both trajectories. Preparation for the labor market is important for socioeconomic mobility, particularly for historically marginalized groups. However, there is concern about vocational education's historical legacy of tracking and social stratification. This research utilizes comprehensive data on the census of California students to understand the state of career and technical education in California, examine stratification within CTE programs, and explore access to CTE.

Contribution

This research contributes to the field with novel and comprehensive data from a large and relevant context. My analytical sample includes the entire population of California high school students across several recent years. I utilize data on the census of California high school students from 2014-2018 to analyze career and technical education pathway behavior, measures of college and career readiness, and school-level access to CTE. I assess career and college-readiness using California's novel Career/College Readiness Indicator and its component measures.

California is an ideal context to examine academic outcomes across different educational settings. California has the largest public K-12 school enrollment in the US and the California Community Colleges system is the largest higher education system in the US. California's public

education systems also serve a diverse population with significant numbers of low-income families, students of color, and English language learners, and California State Universities (CSUs) in particular have been recognized as one of the most effective systems in promoting social mobility for disadvantaged students (Chetty et. al, 2017). California is also a leading state in the development and implementation of CTE policies and has made substantial investments in career and technical education in recent years. This context is perfectly suited to address questions about access and equity in educational systems, and the role of diverse pathways to social mobility for marginalized students.

There is recent related work examining trends and patterns of enrollment using older but nationally-representative survey data (Malkus, 2019), and recent administrative data in several states (Texas, Michigan, Tennessee, Massachusetts) (Giani, 2019; Jacob & Guardiola, 2020; Carruthers, Kreisman, Dougherty, & Martin, 2020) and school districts (Atlanta) (Kreisman & Villero, 2021), as well as work comparing disparities in outcomes by CTE industry (Ecton, 2021; Giani, 2017). This study expands the literature by using new data on a substantial number of students and provides a deeper look at stratification across industry types.

Importantly, causal analysis of CTE education is also almost entirely driven by work on career academies (a school-within-a-school model) or specialized career high schools (Cellini, 2006; Dougherty, Brunner, & Ross, 2018; Dougherty, 2018; Hemelt, Lenard, & Paeplow, 2017; Kemple, 2008), though the vast majority of CTE education occurs in traditional high schools (Malkus, 2019; Reed et. al., 2018). Therefore, descriptive work remains relevant to informing the literature because it examines career and technical education participation and career and college readiness across a variety of school types and CTE programs relevant to the majority of the population.

I find that CTE students are stratified across CTE industry groups by race, gender, language status, disability, and other characteristics. These patterns follow historical trends of tracking historically marginalized groups of students into traditional vocational education pathways. The introduction of new STEM-focused CTE pathways has recruited new students into CTE and their presence masks stratification when CTE students are studied as a single group. This supports findings from Malkus (2019) and Giani (2019) with a larger and more recent data set. I also contribute to the literature by examining career and college readiness across CTE industry groups within California's accountability framework.

Background

Philosophical Perspectives on Education & the Role of Career and Technical Education

The Second Industrial Revolution, especially the 1890s and early 1900s, was a period of incredible technological, economic, and social change in the western world. Periods of rapid technological changes drove significant fluctuations in labor markets and the relative demand for skilled and unskilled labor as well as child labor. This prompted an increased social interest in utilizing public education to adjust to the new realities of social and economic life as well as philosophical debates over the purpose and goals of education (Kantor, 1986). The essence of the debate is characterized by the views of Charles Prosser and John Dewey. Dewey argued that democratizing accessible education for all students and producing well-rounded pupils that were prepared for life required learning traditional subjects via applied or vocational themed education (Martinez Jr., 2007), a sentiment uncannily familiar to current philosophy on 21st century skills and college and career readiness. In contrast, Prosser argued that vocational and academic education are fundamentally distinct pursuits, and that the public education system should separate and prepare students for their expected roles in the economy (Martinez Jr., 2007).

Historically, approaches to career and technical education have been dominated by Prosser's ideas, leading to a stark separation of career-focused education from traditional academic education, as well as the widespread practice of tracking, which exacerbated social stratification and inequality across vocational and other forms of education (Oakes, 1987; Ansalone, 2003; Domina, Penner, & Penner, 2017).

A tension between preparation for work via the development of marketable skills versus college-prep or classically academic (developing the intellect, or 'learning for its own sake') education have continued in present day debates over the purpose of education, and in policymaking decisions about education accountability. The academic versus vocational/technical schism has waned in recent decades, most clearly via the huge shift in ideology inherent in the change from the No Child Left Behind Act's intensely academic and narrow goal set, to the Every Student Succeeds Acts emphasis on a broad range of measures of success as well as a focus on preparation for both college *and* career with 21st century skills.

Trends in National CTE & Education Policy

Early federal education policy was primarily focused on vocational education. Specifically, the first federal legislation concerning education was entirely focused on developing, teaching, and applying knowledge in fields of practical importance, particularly agriculture. This began with the Morrill Act, which was passed during the Civil War to support the development of land-grant post-secondary institutions, and the second Morrill Act (1890), which extended support for separate land-grant institutions for black students in the South. Codifying the growing desire for work preparation in public secondary education, the third ever federal education bill, the Smith Hughes Act was passed in 1917 (initially known as the National Vocational Education Act), which provided support for vocational education in high schools.

Later, the George Barden Act of 1947 expanded the fields and topics for study and the Vocational Education Act (VEA) of 1963 and its subsequent amendments in 1968 expanded funding, supported research and work-study programs, and created a national advisory board on education. The VEA was renamed the Perkins Act in 1984 and has been reauthorized several times including as recently as 2018. It provides substantial funding (over a billion dollars annually as of 2018) and establishes requirements for career and technical education as we know it today (Dougherty & Lombardi, 2016).

Vocational education connotes tracking and separation of college and non-college bound and/or academically struggling students and has traditionally been viewed as an alternative to college-prep. Vocational education has a problematic history of tracking disadvantaged students into under-resourced educational programs and closing off pathways to traditional college education (Ainsworth & Roscigno, 2005; Domina et al., 2017; Gamoran & Mare, 1989; Oakes, 1983; Oakes & Guiton, 1995). In the 1990s trends began to shift towards rigorous academic standards in career-focused education, which began to be called career and technical education (EdSource, 2005). The 1994 School-to-Work Opportunities Act and 1998 Perkins reauthorization emphasized the integration of career and academic curricula and coincided with state-level development of school-to-work programs like career academies and tech prep programs (EdSource, 2005).

The No Child Left Behind Act of 2002 (NCLB) was a major shift in federal policy that introduced high stakes accountability systems narrowly focused on standardized test scores in English and mathematics with the goal of 'college for all', a focus that predictably resulted in a de-emphasis on career education (Fletcher, 2006; Wallace, 2012).

Obama's Every Student Succeeds Act of 2015 (ESSA), a response to the perceived failures and misaligned incentives of NCLB, constituted a major policy shift in the opposite direction. ESSA emphasizes a well-rounded education, college and career readiness and 21st Century skills, well-designed assessments, and multiple measures of accountability beyond test scores (English, Cushing, Therriault, & Rasmussen (n.d.)).

ESSA also tied federal funding to implementation of Common Core State Standards, which have since integrated CTE curriculum to ensure high-quality standards-aligned curricula for all students, college-bound or not. This new accountability framework has made CTE significantly more appealing as a policy tool in ensuring success for all students.

The inclusion of CTE as a measure of 'career and college readiness' in ESSA, incorporation into the widely-adopted Common Core standards, and mandated postsecondary articulation in Perkins Act reauthorizations in 2006 and 2018 (Perkins IV and Perkins V respectively) suggest a new perspective on the role of CTE, especially given mixed-success of 'college for all' approaches and continued disparities in attainment for disadvantaged groups (Giani, 2017; Stilwell & Sable, 2013).

National Trends in CTE Enrollment

At the national level, CTE course-taking has remained relatively high over time, with fluctuation in fields and credits. In 2005, 87% of high school graduates earned CTE credits, with an average of 2.6 credits (Hudson & Laird, 2009). From 1990 to 2009, the share of high school graduates earning any CTE credit fell slightly from 88% to 85%, and the average number of credits earned fell from 4.2 to 3.6 (Hudson, 2013; National Center for Education Statistics, n.d.). Among 2009 graduates, 76% of students had at least one CTE credit, 53% had at least two, and 36% had at least three, and the most popular fields of study were business and 'communications

and design' (National Center for Education Statistics, n.d.). The share of graduates earning credits in 'communications and design' and healthcare areas grew by 11 and seven percentage points respectively, while the share in business and manufacturing fell by 19 and 10 percentage points respectively (Hudson, 2013).

At the school-level, in 2008, 3.7% of public high schools were specialized career and technical schools, 83% offered CTE courses, 65% offered internships or work-based learning, 24% had a specialized career academy, and 66% had dual or concurrent enrollment programs for earning college credit (Chen & Wu, 2012). CTE specialty schools are relatively more common in suburban/town localities and less common in rural areas (Chen & Wu, 2012). In terms of the teaching workforce in CTE, 7.7% of teachers were assigned to occupational education compared to 67% in academic education (Chen & Wu, 2012).

CTE & Education Policy in California

California has approached CTE via legislative mandates with a variety of funding programs and delivery methods. Career and technical education occurs in traditional high schools (which offer stand-alone CTE classes and coordinated pathways), regional career education centers, career academies (school-within-a-school small learning communities), community colleges, and in linked learning school reform settings. These programs are generally funded both via state grants and appropriations as well as federally through Perkins grants. Additionally, some schools/programs collect tuition, receive private support, and/or federal small learning community (SLC) grants. For context, in 1992-93, 66% of California students were enrolled in at least one CTE course, falling to 50% in 1999-2000, and 30% in 2005-2006 (CDE, 2104). In 2016-17, 45% of all high school students were enrolled in a CTE course (Bohn, Gao, & McConville, 2018).

In 1967 (around the time of the Vocational Education Act), California passed a bill establishing Regional Occupational Centers and Programs (ROP or ROCP), which were initially designed to pool resources for high-cost equipment. Over time they became more academically integrated. ROCPs are open to high school students (who typically spend part of their day at a ROCP and part at a traditional high school), as well as adult learners, and served 336,000 high school students in 2003-2004 (EdSource, 2005). Most counties in California have ROCPs (the exceptions being particularly rural counties with small populations); 42 ROCPs are operated by counties and 32 ROCPs are operated by school districts, either singly (6) or in partnership with other districts (26) (California Department of Education, 2008).

In the mid-eighties through the early nineties, California passed several pieces of legislation to support the development of career academies, called the California Partnership Academies (CPAs). CPAs utilize a career academy model with small school-within-a-school learning communities or small learning communities (SLCs) that integrate college-prep curriculum with defined career themes and *may* involve completing defined CTE pathways.

In 2002, California passed legislation to develop CTE standards and frameworks, resulting in the 2005 adoption of the California CTE Model Curriculum Standards and the CA CTE Framework (a guide for curriculum implementation) adopted in 2007 (CDE, 2013). The state developed the California State Plan for Career and Technical Education 2008-2012 in 2008, as a requirement of receiving funding through the 2006 Perkins reauthorization (CDE, 2008). In 2015 state course codes and names were remapped to encourage CTE pathway completion in conjunction with other state-wide initiatives. For example, in 2013-14 the pathway Agricultural Business consisted of 4 courses: Ag Economics, Ag Sales and Marketing, Ag Communications & Leadership, and Ag Computers & Technology (CDE, 2013). In 2016-17, the Agricultural

Business pathway consists of 3 courses: Intro to Agricultural Business, Intermediate Agricultural Business (Concentrator Level), and Advanced Agricultural Business (Capstone Level) (CDE, 2016). Students completing 50% or more credits in the same pathway (generally 2 courses) earn concentrator status and those who also complete a capstone course in the same pathway are considered CTE pathway completers. These clarified names are now typical for all pathway courses, and emphasize the trajectory for CTE pathway concentration and completion.

The past decade has been a period of radical reform in the California education system, with changes to standards, curriculum, assessment, funding models, and accountability systems, often preceding anticipated changes in federal policy. These changes have had a substantive impact on career and technical education in the state. California adopted the Common Core State Standards in 2010 (earlier than ESSA strongly incentivized its adoption in 2015). This prompted a series of changes in policy and the development of new curriculum to align with the new standards. The state adopted new CTE curriculum to align with the Common Core State Standards, Next Generation Science Core Ideas, and the History/Social Science Standards (CDE, 2019). Along with new standards came new assessment systems, the California Assessment(s) of Student Performance and Progress (CAASPP), which were implemented state-wide in 2015.

In 2013, the state implemented the Local Control Funding Formula (LCFF), which allows local education agencies (LEAs) a great deal of flexibility and discretion in allocating funding to programs that best suit their students. The LCFF ended the state's categorical block grant model of funding, a complex and bureaucratic system of highly specific grants that imposed state-level control and were criticized for their inefficiency and 'one-size-fits-all' approach to school-level operations. Funding to LEAs is now based on the number of students enrolled, with additional money allocated for high-needs students (Ortiz, 2018). It is unclear exactly how the LCFF has

impacted spending on CTE programs, but it was generally viewed as a positive opportunity to expand funding for successful programs (Ortiz, 2018).

The state also introduced a number of grant programs to support CTE, including the California Career Pathways Trust (CCPT) and the CTE Incentive Grant in 2014. The CCPT received $500 million and was designed to support the development or expansion of CTE programs "that integrate standards-based academics with a sequenced, career-relevant curriculum following industry-themed pathways that are aligned with high-need, high-growth, or emerging regional economic sectors" (CDE CCTD, 2017). The CTE Incentive Grant was intended to support CTE programs until the LCFF was fully funded and has distributed over $1 billion from 2015-2019. In 2016, the state committed to an annual investment of $248 million for the Strong Workforce Program, designed to support community colleges in coordinating with school districts and local industries to improve articulated career education across K12 and community college systems (collectively called K14). Between 2014 and 2020 these programs have provided $2.5 billion in investment from the state in career and technical education. In addition, many of these programs require matching investments from LEAs or industry groups, and the community college system also receives over $90 million annually in federal Perkins funding (Gonzalez & Lee, 2018).

Coupled with the new funding model is a new accountability model via the Local Control Accountability Plan and the CA School Dashboard, implemented in 2016. California's new accountability model considers multiple measures of student success over varied domains like attendance, discipline, and standardized assessment performance, while also emphasizing the success of vulnerable populations like homeless and foster youth, English learners, students with disabilities, and racial/ethnic minority groups. These metrics are aggregated at the school level

and published via the California School Dashboard, and schools receive performance color ratings (red, blue, green, etc.) in each category based on overall performance levels and improvement from prior years. Another important dimension of accountability at the high school level is the career/college readiness indicator (CCI), which acknowledges many paths to postsecondary success. Students' preparation for college or career is assessed as, not prepared, approaching prepared, or prepared based on one or more of these measures: standardized test performance, AP/IB exam performance, taking college courses, completing a college-prep curriculum (a-g requirements), completion of a CTE pathway, completing leadership or military science coursework, and/or receiving the State Seal of Biliteracy. Schools are evaluated based on the share of the four-year graduating cohort that meet prepared and approaching prepared categories.

Implications for Current Research

This context provides opportunities and challenges for research. Changes in CTE and broad education policy developments in California have been both rapid and drastic, completely revamping funding systems, accountability, curriculum, and assessment in less than a decade. The state has also extended significant financial and organizational support for both CTE broadly and specialized CTE programs and partnerships with the hope of complementing state-wide educational reforms.

The scale of changes and reforms are so great that there is a very reasonable expectation of measurable changes in the conditions of career and technical education and intermediary outcomes (i.e., increased local funding allocations for CTE programs that meet local needs). The emphasis on local decision-making and funding (especially after a long period of state-control) suggests increased regional variation in resource allocation for CTE (via LCFF) and style of CTE

programs and delivery (in accordance with local preferences and needs as well as industry conditions). Due to the recognition of CTE *pathway completion,* particular for accountability and grant requirements, we may see a shift in the distribution of CTE intensity from taking one course to concentrating in a particular CTE pathway. Higher standards for CTE pathway completion mandated by Perkins could also be improving program quality. The California School Dashboard accountability model coupled with funding formulas that allocate money to students with the greatest needs suggest a focus on serving vulnerable subgroups, for example via minimum enrollment shares of socioeconomically disadvantaged students or those with low credit accumulation, poor attendance, or low test-scores. Introducing Common Core curriculum that is better aligned to higher quality state-wide assessments and integrating Common Core standards into CTE curriculum may improve student performance. The challenge in this context is that so much is going on in such a limited time that it is difficult to know which policies or components of career and technical education are driving changes in student outcomes.

Review of the Research

Overview

Prior research on vocational and career education has shown mixed and somewhat contradictory impacts on secondary and postsecondary outcomes, sometimes improving college attendance and sometimes at the cost of baccalaureate-level work, while other research has found no difference in postsecondary outcomes between CTE students and non-CTE. Making inferences about the impacts of CTE is complicated due to selection bias and unobservable differences between CTE and non-CTE students. From a theoretical perspective, students making educational investments under either human capital or signaling models are considering their abilities and preferences within their choice set (Becker 1962, 2009; Spence, 1973).

Controlling for important observables like academic ability via standardized test performance, school quality, only partially addresses the selection issues at hand. The use of synthetic controls, along with variation in CTE policy across time, may also partially address concerns about unobservable aspects of selection bias in estimates examining the effect of participating in CTE.

To address these potential biases, researchers have been able to leverage quasi-experimental techniques and variation in policies to yield causal conclusions (Dougherty, 2016). Importantly, the most compelling causal work in this field is limited to experimental evidence from specialty career academies (Hemelt, 2017; Kemple, 2008; Dougherty, 2018), rather than CTE programs more broadly. Therefore, many questions about CTE participation and impacts remain unanswered due to the lack of generalizability of these studies.

Descriptive Studies of CTE Students

To examine CTE more broadly, there are a number of recent descriptive studies of CTE students across various settings and utilizing different sources of data. Malkus (2020), Giani (2019), Jacob & Guardiola (2020), Carruthers, Kreisman, Dougherty, and Martin (2020), and Kreisman & Villero (2021) all find stratification in CTE by race, gender, socioeconomic status, and other identities. Giani (2019) and Malkus (2020) both find limited evidence of tracking into CTE (i.e. stratification between CTE and non-CTE students), but evidence of stratification within CTE via CTE industry groups.

Malkus (2020) uses nationally representative data from 1983 to 2013 to examine trends in CTE over time and stratification across industry groups that he categorizes as *traditional vocational education* and *new era CTE*. Malkus (2020) distinguishes CTE industry groups into *traditional vocational education* (manufacturing, public services, agriculture, construction, human services, and transportation) and *new era CTE* (computer science, communications,

healthcare, engineering, and hospitality). He finds that over time, the composition of CTE students has changed by attracting students who typically would not have taken CTE in the past but are interested in new era CTE, particularly in STEM fields. This compositional change has shifted demographic characteristics for CTE students such that on average they are very similar or appear better performing than non-CTE students, while also disguising the fact that the population of students in traditional vocational education pathways is unchanged, and these students' academic achievement is stagnant.

Malkus finds that over time, test scores in new era CTE have risen and closed the gap with non-CTE students, while students in traditional vocational education have low and stagnant test scores (2020). Students in traditional vocational education have lower GPAs, take longer to pass algebra I, are twice as likely to end the educational careers at the high school level, are much less likely to have parents with college educations or parents that expect them to get college educations, and less likely to prioritize good grades, while students in new era CTE are typically statistically indistinguishable from non-CTE students (Malkus, 2020). Students in traditional vocational education industries also are less likely to have a positive sense of belonging or positive school engagement compared to students in new era CTE, two mechanisms that are touted to yield improved academic outcomes for CTE students (Malkus, 2020).

Giani (2019) finds that the population of CTE students is generally similar to non-CTE but substantial racial and socioeconomic stratification occurs by industry group and CTE intensity (participation vs concentration). Giani (2019) uses longitudinal data for the population of Texas high school students graduating in 2016. Texas offers a range of high school diplomas (IEP, minimum requirements, recommended, and distinguished). Those completing a distinguished diploma have the highest rates of CTE completion and are the most likely to

concentrate in new era fields (health, IT, STEM) as well as business; whereas minimum and IEP diploma holders are most likely to do traditional vocational education fields (construction, manufacturing, transportation) as well has hospitality (Giani, 2019).

Several other studies find similar evidence of stratification across CTE industries in various contexts. Jacob & Guardiola (2020) use state-wide data from Michigan on 9 cohorts of students expected to graduate from 2010-2018, Kreisman & Villero (2021) use cohorts of 9th graders in Atlanta from 2010-2014, and Carruthers, Kreisman, Dougherty, and Martin (2020) pool data across Massachusetts, Tennessee, and Michigan. Both Malkus (2020) and Giani (2019) use data sets that are limited to students who *graduate* from high school, which may bias findings about subpopulations more likely to drop out of high school. In contrast, Kreisman & Villero (2021) and Jacob & Guardiola (2020) use cohorts based on *expected* graduation year, which is more inclusive of students at risk for droping out. Additionally, Jacob & Guardiola (2020) find evidence that racial and socioeconomic gaps in CTE participation are driven by differences in access to CTE programs at the school level, while gender stratification occurs within schools.

General CTE and Academic Outcomes in Traditional High Schools

The majority of students taking any career and technical education classes do so while in a traditional high school, with some students spending instructional time off-campus at specialized schools or training centers, or on campus but in structured small learning communities. Research in these school contexts generally finds positive post-secondary outcomes associated with CTE, with mixed findings on stratification. Dougherty Gottfried, & Sublett (2019) follow roughly 100,000 students in 3 cohorts in Arkansas (90% of whom take CTE courses at a traditional high school) after a policy change requiring students to take 6

career-readiness aligned courses in high school drove changes in CTE course offerings. They utilize high school and cohort fixed effects as well as quasi-experimental variation in CTE policy and find that CTE improves graduation rates, employment and wages, and enrollment in community college; and that CTE students are as likely as their peers to pursue baccalaureate degrees. They also find greater effects of CTE for low-income students and men. Importantly, this work emphasizes the number of courses taken in CTE and finds a dose-dependent relationship between CTE intensity and educational outcomes that does not necessarily require sequencing of courses within a coordinated pathway.

In related work, Giani (2017) utilizes temporal policy variation and high-quality data from Texas and finds limited evidence of stratification between CTE students and non-CTE, and higher rates of college-going for CTE students in more recent years. Castellano, Sundell, & Overman et al., (2014) conducted a mixed-methods study of 'career pathway programs of study' (POS), defined as "an organized approach to college and career readiness that offer an aligned sequence of courses spanning secondary and postsecondary education, blending standards-based academic and technical content, allowing students to earn postsecondary credit while in high school, and leading to an industry-recognized credential or certificate at the postsecondary level or an associate or baccalaureate degree" (pg. 1, 2014). The study included three large urban school districts, across three different states from 2008-2012 and has a sample size of 6,638. Schools include specialty and magnet schools, traditional high schools, and career academies. They find positive effects of POS on credit accumulation and graduation in one district but are unable to draw causal conclusions in the other two (Castellano, Sundell, & Overman et al., 2014). The authors also found a positive association between POS and STEM and AP course-taking, while plans to attend 4-year colleges were similar across POS and non-POS students.

Notably, this work also adds qualitative interviews and exit surveys for a closer look at student experiences in CTE.

Career Academy Models, California Partnership Academies & Linked Learning

Nearly all experimental evidence of the impact of CTE is driven by research on career academies and there is a substantial body of evidence from the California Partnership Academies on the effects of career academies in California specifically. The available evidence suggests that career education improves economic and high school and post-secondary outcomes without tracking students out of higher education pathways. There are three defining characteristics of career academies: small learning communities (SLCs), career themed college preparatory curriculum, and coordination with local industry and postsecondary institutions (Stern, Dayton, & Raby, 2010). SLCs are a school-within-a-school model often utilized in school reform to increase engagement by providing a stronger sense of community among smaller groups of students who select into programs based on their interests. Typically, cohorts of students share a common class schedule and team of teachers working across disciplines to provide more personalized curriculum and instruction around a central theme, such as healthcare, arts, or technology. Career academies were the most common type of SLC funded by the federal Smaller Learning Communities Grant program in recent years, representing 60 percent of schools receiving grants and serving an estimated 10 percent of 10^{th} to 12^{th} graders nationally (Stern, Dayton, and Raby, 2010).

Linked learning programs are a new take on career academies in California that place greater emphasis on school reform, identifying themselves as a movement rather than representing one model of schooling, which also utilizes extensive public-private partnerships. The James Irvine Foundation partnered with ConnectEd to roll out a linked learning initiative,

which was later expanded and supported with state funds via the Furitani CA Assembly Bill 790 in 2011 (The Linked Learning Alliance, 2011). Linked Learning is a variant of the career academy approach, involving college-prep curriculum with CTE pathways and work-based learning, which occur in both schools-within-a-school or a stand-alone schools (Warner, Caspary, et al., 2016). Linked learning also focuses more on school reform by emphasizing extensive support in advising and supplemental instruction to ensure all students are meeting academic standards.

Available evidence supports career academies as effective models for improving student outcomes, particularly earnings and employment, while at least not having any negative effect on post-secondary trajectories, though some evidence supports an increase in college-going for academy students. A long-term randomized controlled study by MDRC, provides the highest quality causal evidence on any CTE and career academies in particular (Kemple, 2008). Researchers in this study randomly assigned 1,400 students to career academies or a control group in 9 high schools across the US beginning in 1993 and following them 8 years after expected graduation. Results show that career academy students have significant gains in earnings and employment, especially for men, but similar postsecondary educational trajectories to a relevant control group of students. In North Carolina, Hemelt, Lenard, and Paeplow (2017) descriptively find that students entering career academies are generally higher performing, less likely to be Hispanic, and less likely to have limited English proficiency. To estimate causal effects, the authors utilize a lottery-based admission system in one career academy and find that enrollment increases the probability of both graduation and college enrollment by 8 percentage points, and that 20 percent of this effect is mediated via improved school engagement. They find no impact on academic performance.

Turning to California, since the early 1980's, program evaluations and correlational studies on California Partnership Academies have generally shown positive impacts on a range of outcomes including attendance, credit accumulation, graduation, a-g completion, performance on standardized assessments, postsecondary enrollment, school climate, lower remediation rates in college, earnings, and employment (Bradby, Malloy et al, 2007; Dayton, Hamilton Hester, et al, 2011; Kemple, 2008; Stern, Dayton, & Raby, 2010). Linked learning programs in particular are associated with positive impacts on credit accumulation, graduation, performance on the English language arts standardized test; and linked learning students have similar post-secondary enrollment and persistence trajectories (Warner & Caspary, 2016).

Technical High Schools & CTE/Vocational Schools

Specialty technical high schools are typically high schools that offer extensive CTE curriculum with traditional high school curriculum. Some require students to take at least some career-focused classes, while others require all students to be in a defined CTE pathway. This differs from career academies that may be SLCs in a larger high school with some students that are not taking any CTE, or that require career-focused education without requiring students to complete a CTE pathway i.e., students research different career paths, learn about an industry like health or technology, or participate in an internship. California does not have specialty tech high schools that are not CA Partnership Academies, it does however have specialty vocational schools: 74 Regional Occupational Centers & Programs (often referred to as ROP or ROCP). These programs are open to both high school students and adults, in California students must be at least 16 years old to attend. Secondary students typically attend ROCPs for part of the school day or are taught by ROCP instructors on their high school campus.

Evidence on either the educational impact of CTE in technical schools, or for K12 students in particular, is generally restricted to specialty high schools that have a school-wide tech focus (as opposed to a SLC) and are generally not open to adults. Dougherty (2018) applies a regression discontinuity design with data from three oversubscribed Massachusetts career high schools, called regional vocational and technical high schools (RVTS), and finds a large increase in on-time graduation for students in those schools. Brunner, Dougherty, & Ross (2019) utilize a quasi-experimental regression discontinuity design on score-based admissions to 16 specialty CTE high schools in Connecticut for three cohorts of students graduating in 2012, 2013, and 2014. They find significant stratification across fields of study by gender, which drives a number of their results. Specifically, results show little evidence that demographic or socioeconomic characteristics matter, and strikingly, no impact of CTE on women. Overall, they find that students in tech high schools are 6 percentage points more likely to graduate and 4.5 percentage points less likely to go to college. In one high school, male students were 10 percentage points more likely to graduate and 8 percentage points less likely to go to college. This suggests that school-level factors may matter a great deal in outcomes for CTE students and that stratification across fields, particularly by gender, may drive heterogeneous outcomes.

Theory of Action

Career and technical education may act through several different channels to improve student outcomes, in particular, school engagement as well as via school or academy-level program design or interventions i.e., cohort models, themed course sequences, more coordinated school services, advising & counseling, tutoring, support (Dayton, Hamilton Hester, et al, 2011; Kemple, 2008; Stern, Dayton, & Raby, 2010). Engagement may be improved via novel

approaches instructional delivery and curricular design in specialized schools or focused coursetaking (Castellano, Sundell, & Overman et al., 2014).

Students in CTE may be more engaged in what they are learning in school in a CTE environment. It may be more interesting, applied to real world situations, and easier for students to understand how what they are learning is useful to their future (Castellano, Sundell, & Overman et al., 2014; Dayton, Hamilton Hester, et al, 2011;). In this sense, CTE is similar to other instructional approaches like active learning, project-based learning, and culturally relevant pedagogy. This is particularly relevant for disengaged students at risk of dropping out, as "many students feel that their particular strengths are valued and developed through career education experiences" (Cashdollar, 2021). Not only is CTE education likely to be more engaging, students may be more motivated to learn in a career focused context (Castellano, Sundell, & Overman et al., 2014; Kemple, 2008; Stern, Dayton, & Raby, 2010).

Implications for Current Research

If policy changes are improving program quality and extending access to coordinated programs like career academies or even simply incentivizing students to complete more CTE courses, we would expect to see positive impacts on academic achievement in high school, including credit accumulation, attendance, engagement, graduation, etc. Research on college trajectories is less clear. It could be that CTE students have similar post-secondary trajectories, are more likely to go to college but to community colleges rather than 4-year institutions or have higher college-going rates for both 2- and 4-year institutions when compared to non-CTE peers.

The findings in the literature strongly suggest the need to examine heterogeneous effects across subgroups, particularly by gender, and especially if there is stratification across industries. The best evidence comes from career academies, which tend to have differences in outcomes by

gender. Thus, a priori, I expect to gender stratification in CTE. Based on existing literature, I also speculate that academic settings matter. CTE students across many different contexts tend to show positive effects on educational and employment outcomes and positive or null effects on postsecondary trajectories, but in some cases there are negative impacts, which may be concentrated in specific schools.

There is strong prior evidence that CA partnership academies are effective, so it is important to be attentive to which students are in CPAs and how they compare to other CTE students to understand the policy implications of general CTE programs, and particular impacts of CTE in small learning communities. There is also evidence of an increasing dose-dependent relationship between intensity of participation and positive outcomes even if students are taking courses that do not lead to pathway concentration or completion.

To provide a comprehensive and up-to-date examination of the CTE landscape in California, I examine the following research questions:

Research Questions

1. What are the characteristics of California CTE students overall and by industry group? Is there evidence of stratification in CTE?
2. How is CTE associated with other college and career readiness measures?
3. How is CTE distributed across schools?

Data

Population & Sample

The data include cohorts of the population of California high school students expected to graduate in 2015-16, 2016-17, and 2017-18. I construct the cohorts using California Department of Education (CDE) business rules for 1-year and 4-year cohorts, which include 5th year and

beyond seniors and students in alternative schools (See table 1 for detailed cohort sizes; for business rules see data guide from California Department of Education, 2018). [1]

Sample sizes

Table 1a

Cohort Size by Type & Graduation by Cohort

Graduation by Cohort	2015-16 Cohort	2016-17 Cohort	2017-18 Cohort
Total Students in Cohort	481,551	499,457	517,917
Students in 4-Year Cohort	-	420,102	426,948
Students in 1-Year Cohort	-	79,344	90,959
Graduates in 4-Year Cohort	-	380,556	389,198
Graduates in 1-Year Cohort	-	41,581	43,740
Total Graduates	410,058	422,137	432,938
Overall Graduation Rate	85%	85%	84%
Graduation Rate for 4-Year Cohort	-	91%	91%
Graduation Rate for 1-Year Cohort	-	52%	48%
Share of students in 4-Year Cohort	-	84%	82%
Share of students in 1-Year Cohort	-	16%	18%

Data Source

The data used in this paper is from the California Longitudinal Pupil Achievement Data System (CALPADS) from the California Department of Education (CDE)[2]. The CDE data includes data files on CTE pathways, CCI components, performance on 11th grade standardized tests (SBAC), and student- and school-level demographic data. I also utilize publicly available data from the CDE on public schools and districts and their characteristics.

[1] A small number of students are included in multiple cohorts, likely by closely missing expected graduation and those students are only kept in the final cohort they appear in. Cohorts in my sample range from 475,000-525,000 students (See Table 1a). In other work using CDE data and cohorts in these years, researchers utilizing only the 4-year cohort typically have much smaller samples of 350,000-400,000 students due to the exclusion of students in the 1-year cohort or students in schools with Dashboard Alternative School Status (DASS). The full sample across all three cohorts includes 1,498,925 unique students. The 2015-16 cohort does not have data on which students are in the 4 or 1-year cohort but appears to include both based on graduation rates.

[2] Detailed summary statistics for these data sources are available in the appendix.

Table 1b

Data by Source

Data Sources	Variables
CTE File	CTE Pathway, Completion Date, Associated CDS Code
Testing File	SBAC Scores, Gender, Race/Ethnicity, Disability, Socioeconomic Disadvantage, English Learners, CDS code
CCI File	Approaching Prepared or Prepared status, CTE pathway completion, 11th grade SBAC assessment performance, Advanced Placement (AP) exams, International Baccalaureate (IB) exams, college credits, a-g (coursework for in-state college eligibility) completion, achievement in a foreign language (State Seal of Biliteracy (SSB)), and leadership/military science
Public Schools Data	Education options codes, School ownership codes, Instructional levels, Latitude and Longitudes, Charter, Magnet and Year-Round

Data Limitations

The sample is limited in time and changes in reporting policies and data requirements occurred in 2016. Anecdotally, our partners at the CDE consider 2015-16 data to be poorly reported in some variables, and local education agencies (LEAs) were adjusting to new accountability programs and reporting processes. The most recent year of data (2017-18) is the most reliable cross-section of the state of career and technical education in California, and for this reason I will primarily emphasize findings in that year. Readers are cautioned from drawing strong conclusions on CTE trends or changes over time in these data. Time trends in CTE demographics and participation may be biased by improved reporting. I will discuss suggestive evidence of trends, but due to data limitations it is likely that conclusions about trends are not especially reliable.

Data Assembly

CTE Pathways

CTE "concentrators and completers" are distinguished in CALPADS data via the availability of CTE concentration status and CTE pathway completion year(s). Students are marked as concentrators typically after completing 2 courses in a defined pathway and completers after completing 3 courses. CTE pathway data in CALPADS is often reported in several years for accountability and funding purposes, especially under Perkins. For example, a student that starts a pathway in 2015-16 and completes it in 2016-17 may be reported as a concentrator in 2015-16, and then reported as completing the pathway in both 2016-17 and 2017-18, so that the school gets credit for the total number of pathway concentrators and completers every year. To address this issue, I consider pathways to be completed in the first year that they are marked as completed. To identify concentrators that never complete their pathways I drop concentration data for students that ultimately complete their pathway within at the K-12 level within the years of data available. This approach identifies true concentration for students that are graduating in their 4-year or 1-year cohort expected graduation year but miss completion for students that do not graduate on-time but complete their pathways outside the data range.

Students are considered CTE completers if they ever complete any pathway, such that a student that completes one pathway and concentrates in another will only be considered a completer, not a concentrator. A small number of students are considered CTE completers in the CCI but missing pathway completion data, so that we can observe what paths they at least concentrated in, but not which were completed. These students are considered completers in analyses that compare completers and concentrators, but all of their pathways are considered incomplete/concentrated pathways in industry-level analyses.

CTE Industries

CALPADS CTE data includes CTE pathway names and codes and I merge on the corresponding industry categories identified in the California Department of Education's CTE Framework. For each student I identify completed, concentrated, and participated paths separately from identifying the student as a completer or concentrator. Recall that students are identified as completer if they ever complete any pathway, and a concentrator if they do not have any completion data in the CTE file or CCI file. Since each completed pathway has a completion year, I can distinguish between completed and concentrated paths at the student-path level, rather than at the student-level. I generate separate indicator variables for completed pathways and industries that a student has a completed path in, concentrated pathways and industries that a student concentrated path in, as well as a 'participation' indicator for concentration or completion in a path/industry. This allows me to consider for example, additional pathways that CTE completers may concentrate in without completing.

School Data

For school-level data I utilize publicly available data including education options codes, school ownership codes, instructional levels, latitude and longitudes, and indicators for charter, magnet and year-round schools. I also incorporate data on grants and California Partnership Academies.

In the 2017-18 cohort, a vast majority of students are enrolled in traditional high schools (about 85%). K12 schools account for 6% of cohort enrollment, and Alternative/Continuation schools account for 7% of cohort enrollment. About 8% of students are in year-round schools, and charter and magnet schools each enroll 11% of the cohort. About a quarter of students attend

a school that has a CA Partnership academy and 2% attend CTE Grant Schools. (See Appendix B Table 3 for summary statistics).

School Identifiers

California utilizes nested county-district-school (CDS) codes to identify the county, district, and school via one code that is unique at the school level. Students may have several school codes associated with their academic records. Standardized testing data includes the CDS code of the school where 11th grade standardized testing occurred and some CDS codes in this data are missing, but there are more unique schools represented in this data than in the CCI data. CTE data includes a CDS code for each pathway associated with a student, so some students have multiple codes from participating in pathways at more than one school. Importantly, note that CDS codes from CTE data are based on a student's home high school, even if courses in the CTE pathway are taken at a regional occupational center or community college, and small learning communities / schools-within-a-school do not have separate CDS codes.

The CDE collects data at the student-course-year level on which courses are funded within California Partnership Academies (CPAs) and publishes a public list of CPAs, which I use to identify schools with CPAs (i.e., I can identify students that attend schools that have CPAs, but not which students are actually in the CPA). CCI data also includes a CDS code associated with the school a student attends in the year CCI data are collected (typically the 12th grade or year they are considered in the graduation cohort.

To assign students to a particular school I start with the CDS codes associated with CTE pathway completion to prioritize accurate identification of CTE schools (See Table 2 for unique CTE CDS codes). A small share of students have different CDS codes across data sources. Due to data constraints a very small number of CTE schools (7 total) are unable to be assigned to

students who participate in pathways at multiple schools, but these students are identified via an indicator in the data for robustness checks of their impact. For non-CTE students, I first assign them to their CDS code in the standardized testing data. For students missing the CDS code here, I assign the CDS code in the CCI data. This approach yields the highest number of unique CDS codes in the cohort.

Table 2

CDS Code Availability & Match

CDS Codes	2015-16	2016-17	2017-18
In CTE Data			
Unique codes	1,281	1,408	1,437
Unique recoverable codes	1,281	1,406	1,432
CTE students with mulitple codes	525	1,991	2,883
Unique Codes Across Data Sources			
CCI Data	2,832	2,841	2,842
CCI & CTE	2,976	3,021	3,032
SBAC Data	3,094	3,048	4,632
SBAC & CTE	3,124	3,088	4,542
SBAC & CTE & CCI	3,537	3,582	5,014
Students: Code Consistency by Data Source			
CTE matches CCI	104,665	134,641	144,342
CTE does not match CCI	12,355	26,075	36,285
CTE matches SBAC	106,901	146,538	159,252
CTE does not match SBAC	7,958	9,997	16,891

School Types

The CDE makes extensive school data available to the public, including unique state and federal identifiers, school administrators, opening and closing dates, location, education and school type, grades offered/served, and indicators of charter, magnet, virtual, and year-round schools (CDE, 2019, See Appendix A for specific category definitions).

Data on education and school types and instruction levels is included in school ownership codes (SOC), education option codes (EdOps), and educational instruction-level code (EIL). School ownership codes contain essentially the same information as education options codes, especially in this context, but also categorize traditional schools into instruction levels (elementary, high school, etc). For clarity I collapse similar categories, (i.e., youth authority and juvenile court schools). (See Appendix B Table 3 for summary statistics)

CTE Grant Schools

I identify CTE Grant as schools receiving CTE grants under the California Career Pathways Trust (CCPT) or the CTE Incentive Grant. Both are listed in publicly available documents on the CDE website with CDS codes (CDE, 2019). Similarly, California Partnership Academies are listed on the CDE website but without CDS codes, so they are matched to codes on school names, districts, and counties. (See Appendix B Table 3 for summary statistics).

Defining Measures

Student Characteristics

I utilize student characteristics from the SBAC standardized testing data, which most closely align with CDE reports of student characteristics[3]. SBAC characteristics are collected at a single point in time: when students take the exam in the 11th grade. Student characteristics from SBAC include gender, race/ethnicity, students with disabilities, socioeconomic disadvantage, and English learners. For race/ethnicity, I categorize students into African American/Black, Asian, Latino/Hispanic, White, and Other (which includes Native Hawaiian, Pacific Islanders, Native American/Alaskan). Students are socioeconomically disadvantaged if they are eligible for the National School Lunch Program (i.e., free or reduced-price lunch) or if available data on parent education level indicates parent(s)' education is below high school graduate[4]. English learners are students currently classified as English learners and does not include reclassified students or multilingual students determined to be initially fluent English proficient. Students are considered 'students with disabilities' if they had a disability code reported at any time during a

[3] Student characteristics are available across several CDE data files, but since data are collected at different times (Fall census and end-of-year (EOY) annually, during standardized testing), for different purposes (program eligibility vs enrollment, for accountability, etc.), and sometimes updated they do not consistently agree. For example, the CCI data file reports a share of socioeconomically disadvantaged (SED) students much higher than statewide reports, perhaps because it is reported if a student is ever SED in high school vs SED at a particular point in time.

[4] Legislation requires this definition for SED in California public education data

school year or took the California Alternative Assessment. I utilize standardized test scores from the Smarter Balanced (SBAC) summative assessment scores from 11th grade testing, a component of California's standardized testing system, the California Assessment of Student Performance and Progress (CAASPP)[5].

The students in population of CA graduation cohorts are slightly more male than female and the largest racial/ethnic group is Latino/Hispanic students (52%) followed by white students (25%). A majority of students are socioeconomically disadvantaged (55%). Students with disabilities are about 9% of each cohort while about 10% are English learners. In 11th grade standardized testing, about half of students in the 2015-16 to 2017-18 cohorts are considered proficient in ELA and 27% are proficient in math. (See Appendix B Table 1 for summary statistics).

College/Career Readiness Indicator

The CDE determines career/college readiness via a combination of achievements in several domains: CTE pathway completion, 11th grade SBAC assessment performance, Advanced Placement (AP) exams, International Baccalaureate (IB) exams, college credits, a-g (coursework for in-state college eligibility) completion, achievement in a foreign language (State Seal of Biliteracy (SSB)), and leadership/military science. Meeting the standard on the SBAC assessment is enough for a student to be considered prepared, but in some cases, students are considered prepared if they meet some criteria AND reach a level 3 on either the English language arts (ELA) or math portion of the assessment and level 2 (standard nearly met) on the

[5] The SBAC assessments are computer-based tests that are partially adaptive and partially performance-based tasks aligned to Common Core State Standards (CCSS) in for mathematics and English language arts. They occur in grades three through eight, and eleventh grade and performance is measured on a continuous scale across grades, with cut scores for proficiency and performance level increased in higher grades.

other, I will refer to this as achieving SBAC 3/2 levels. There are 5 paths to 'approaching prepared' and 8 paths to 'prepared,' with most of the prepared paths adding SBAC performance requirements to 'approaching prepared' level requirements.

Students most commonly achieve prepared status via the a-g completion pathway (35%) and/or SBAC performance (26-39%). A meaningful share (7-9%) of students are considered prepared via the CTE pathway, the fourth most common path after AP. (See Appendix B Table 2 for summary statistics).

Students are considered prepared if they:

1. Meet the standard on SBAC (level 3+) in both ELA and math (abbreviated: prepared via SBAC, or SBAC)
2. Pass 2 AP exams (score 3+) (abbreviated: prepared via AP, or AP)
3. Pass 2 IB exams (score 4+) (abbreviated: prepared via IB, or IB)
4. Earn 2 semester classes or 3 quarters/trimester classes worth of college credit (abbreviated: prepared via college credit, or college credit)
5. Earn the SSB AND meet the ELA SBAC standard (abbreviated: prepared via SSB, or SSB)
6. Complete 2 years of leadership/military science AND achieve SBAC 3/2 levels (abbreviated: prepared via military, or military)
7. Complete a CTE pathway AND either SBAC 3/2 levels OR earn 1 semester/2 quarter-length classes worth of college credit OR complete a-g requirements (abbreviated: prepared via CTE, or CTE)

8. Complete the a-g requirements AND SBAC 3/2 levels OR pass an AP or IB exam OR complete a CTE pathway OR earn 1 semester/2 quarter-length classes worth of college credit (abbreviated: prepared via a-g, or a-g)

Students are considered 'approaching prepared' if they:

1. Nearly meet the standard on SBAC (level 2) in both ELA and math (approaching via SBAC)
2. Earn 1 semester or 2 quarter-length classes worth of college credit (approaching via college credit)
3. Complete 2 years of leadership/military science (approaching via military)
4. Complete a CTE pathway (approaching via CTE)
5. Complete the a-g requirements (approaching via a-g)

CTE Participation Intensity

This work focuses on CTE pathways via concentrators, completers and completers+ only. For convenience, I will refer to CTE completers and concentrators jointly as 'participators', meaning participating in a pathway, while generally in the literature and state terminology CTE participators are simply students that take any CTE class. The category 'All CTE' refers to all CTE pathway concentrators and completers. (See Appendix Table X for summary statistics) The CALPADS Data Guide defines CTE participants, concentrators, and completers as follows:

- *CTE Participant:* A CTE participant is a student who has completed the equivalent of a conventional 50-minute class taken five times per week for 180 school days, or approximately 150 hours of instruction in a state-recognized CTE pathway. The CDE counts as a participant, any student who has completed a CTE course.

- *CTE Concentrator:* A CTE concentrator is […] a student who has completed 50 percent of a planned program sequence (in hours or credits) in a state-approved CTE pathway and is enrolled in the next course in that sequence, or has completed 50 percent of a single state-recognized multi-hour course and is enrolled in the second half of that course.
- *CTE Completer***:** A CTE completer […] is a student who has completed a minimum of 300 hours in a state-approved CTE pathway and has successfully passed the capstone course in that sequence with a grade of C- or better (2020).

The CDE has also recently identified a fourth category of interest, *CTE Completer Plus* (completers +). These students are CTE completers that have also earned the 'prepared' designation on the CCI.

Pathways & Industries

The California CTE Curriculum Pathway Standards identifies 58 unique pathways organized into 15 industry sectors (Table 3).

Table 3

CTE Pathway and Industry Groupings

Agriculture and Natural Resources		**Fashion and Interior Design**
Agricultural Business		Fashion and Merchandising
Agricultural Mechanics		Interior Design
Agriscience		Personal Services
Animal Science		**Health Science and Medical Technology**
Forestry and Natural Resources		Biotechnology
Ornamental Horticulture		Healthcare Administrative Services
Plant and Soil Science		Healthcare Operational Support
Arts, Media, and Entertainment		Mental and Behavioral Health
Design Visual and Media Arts		Patient Care
Game Design and Integration		Public and Community Health
Performing Arts		**Hospitality, Tourism, and Recreation**
Production and Managerial Arts		Food Science Dietetics and Nutrition
Building and Construction Trades		Food Service and Hospitality
Cabinetmaking Millwork and Woodworking		Hospitality Tourism and Recreation
Engineering Design		**Information and Communication Technologies**
Mechanical Systems Installation and Repair		Games and Simulations
Residential and Commercial Construction		Information Support and Services
Business and Finance		Networking
Business Management		Software and Systems Development
Financial Services		**Manufacturing and Product Development**
International Business		Graphic Production Technologies
Education, Child Development, and Family Services		Machining and Forming Technologies
Child Development		Product Innovation and Design
Consumer Services		Welding and Materials Joining
Education		**Marketing, Sales, and Services**
Family and Human Services		Entrepreneurship/Self-Employment
Energy, Environment, and Utilities		Marketing
Energy and Power Technology		Professional Sales
Environmental Resources		**Public Services**
Telecommunications		Emergency Response
Engineering and Architecture		Legal Practices
Architectural Design		Public Safety
Engineering Technology		**Transportation**
Engineering and Heavy Construction		Operations
Environmental Engineering		Structural Repair and Refinishing
		Systems Diagnostics Services and Repair

Results

To understand the landscape of career and technical education in California, I start by considering the characteristics of the student population broadly and how they compare across levels of CTE intensity. I investigate several dimensions including gender, race/ethnicity, socioeconomic status, disability status, English learner status, homelessness, foster youth, and standardized test performance. I then consider variation in these dimensions across industry participation. The literature suggests that while career and technical education (CTE) students, as a whole, may differ only slightly from non-CTE students (Giani, 2017), significant stratification occurs within CTE pathways.

I then examine the relationship between CTE pathways and career and college readiness measures. CTE students, on average, perform well on the Career/College Readiness indicator, including on academic measures, but these averages mask significant heterogeneity across different industry groups and the intensity of CTE participation (concentration or completion). I also examine variation across industry groups in the specific pathways via which CTE students achieve prepared status (or not).

Our current understanding of the school context of career and technical education in the literature is driven by work on specialized technical schools. The vast majority of CTE both generally and in California occurs in traditional comprehensive high school settings in conjunction with a variety of programmatic approaches, including school-within-a-school models like partnership academies or linked learning. To understand CTE within the landscape of schools in California, I examine access to CTE opportunities via the proxy of school-level CTE participation rate, and consider how this rate varies by the characteristics of students (including race/ethnicity, standardized test proficiency, socioeconomic status, disability status,

English learner status, homelessness and for foster youth) and by their school program or type (traditional high school, CA Partnership Academy, CTE grant school, charter or magnet schools, and alternative or continuation schools).

CTE Intensity

About a third of students are at least CTE concentrators, and about half of those students (15% of the total cohort) complete a CTE pathway. Interestingly, most completers also fall into the completer+ category, with only about a third of completers finishing a pathway but not achieving *prepared* on the CCI. It appears that the rate of concentration in CTE pathways is increasing across the sample while completion rates are falling, though this could be driven by the previously discussed changes in data quality over time.

Table 4

CTE Intensity by Cohort

	Full Sample	**2015-16**	**2016-17**	**2017-18**
N	1,498,895	481,541	499,447	517,907
CTE Participator	33%	29%	34%	35%
CTE Completer	16%	18%	15%	14%
CTE Concentrator	17%	11%	18%	21%
CTE Completer+	10%	11%	9%	9%
CTE Completers only NOT plus	6%	7%	6%	5%

Note. Changes in reporting policies or data quality limit confidence in conclusions about trends over time.

CTE students, as a whole, appear fairly similar to non-CTE students, but there is typically greater representation of marginalized or vulnerable groups among CTE concentrators relative to CTE completers (Table 5). The greatest differences between CTE students and others are by gender and standardized test performance. CTE students are 6 percentage points more likely to be male and 6 percentage points more likely to be proficient in ELA on standardized tests in the 11th grade. CTE students are 3 percentage points more likely to be Latino/Hispanic and socioeconomically disadvantaged (SED), and gaps are even larger among concentrators.

Gaps in test performance are especially stark among CTE completers, who are 11 percentage points more likely to be proficient in ELA and 4 percentage points more likely to be proficient in math compared to non-CTE students. CTE students, notably both completers and concentrators, are 2 percentage points less likely to be African American. CTE completers are as likely as non-CTE students to be Asian, but Asian students are underrepresented among concentrators. Students with disabilities and English learners are underrepresented among CTE students, especially among completers.

CTE students tend to perform very similarly to non-CTE students on the Smarter Balanced Assessment Consortium (SBAC) standardized test measured by average scale scores (not shown), but CTE completers are much more likely to be proficient on both math and ELA. Concentrators do slightly worse on math but outperform non-CTE in ELA. Patterns in demographics and standardized test performance appear to be relatively stable across cohorts and there are limited differences across non-CTE and CTE groups, though data quality in earlier years limits confidence in this conclusion (see appendix for additional years).

Table 5

Student Characteristics & Test Scores by CTE Intensity 2017-2018

Student Characteristics 2017-2018	Full Cohort	Non CTE Students	CTE Participators	CTE Completers	CTE Concentrators
n =	517,907	334,060	183,847	73,628	110,219
Male	51%	49%	55%	54%	55%
African American/Black	5.5%	5.8%	5.0%	4.6%	5.2%
Asian	8.8%	8.9%	8.6%	9.5%	8.1%
Hispanic or Latino	48%	45%	53%	52%	54%
White	22%	22%	24%	25%	23%
Filipino	2.6%	2.5%	2.7%	3.0%	2.6%
Native American or Alaskan	0.54%	0.53%	0.54%	0.52%	0.55%
Native Hawaiian or Pacific Islander	0.47%	0.46%	0.49%	0.46%	0.51%
Two+ Races	2.6%	2.7%	2.3%	2.3%	2.4%
SED	56%	55%	58%	56%	59%
Students with Disabilities	9.3%	9.5%	9.0%	7.9%	9.7%
English Learners	10%	11%	8.9%	7.1%	10%
Foster Care	1.3%	1.5%	0.9%	0.7%	1.1%
Homeless	5.8%	5.9%	5.8%	5.3%	6.0%
Proficient- SBAC ELA	51%	49%	55%	60%	52%
Proficient- SBAC Math	28%	27%	28%	31%	26%

Industry Participation

The most common industry groups for CTE participators are Arts, Media, and Entertainment (31%) and Health Science and Medical Technology (15%). Agriculture and Natural Resources, Building and Construction Trades, Hospitality Tourism and Recreation, and Information and Communication Technologies are moderately popular, each with 10-12% of participators.

Participation in Arts, Media, and Entertainment grew 4% from 2015-16 to 2017-18. Health Science and Medical Technology pathway participation grew from 2015-16 to 2016-17 and then appears to stabilize. Business and Finance and Marketing, Sales, and Services have the greatest declines in participation (from 11% to 8% and 6% to 4% respectively). Growing

industries include Building and Construction Trades and Arts, Media, and Entertainment (about 2 and 4 percentage points respectively).

Table 6

Industry Participation by Cohort

Industry Participation	Full Sample	2015-16	2016-17	2017-18
N	363,414	118,225	120,167	125,022
Arts Media and Entertainment	29%	27%	29%	31%
Health Science and Medical Technology	14%	13%	15%	15%
Hospitality Tourism and Recreation	12%	12%	13%	12%
Information and Communication Technologies	11%	10%	12%	11%
Agriculture and Natural Resources	11%	10%	10%	12%
Business and Finance	9.2%	11%	9.5%	8.1%
Building and Construction Trades	9.2%	7.7%	9.3%	10%
Public Services	6.1%	6.1%	6.5%	5.6%
Education Child Development and Family Services	6.0%	6.2%	6.3%	5.5%
Transportation	5.7%	5.5%	5.9%	5.7%
Marketing Sales and Services	4.9%	6.1%	5.1%	3.9%
Manufacturing and Product Development	4.7%	5.1%	4.8%	4.4%
Engineering and Architecture	4.3%	3.8%	4.4%	4.6%
Fashion and Interior Design	1.2%	1.4%	1.2%	1.1%
Energy Environment and Utilities	0.90%	0.83%	0.94%	0.90%

*Changes in reporting policies or data quality limit confidence in conclusions about trends over time.

Participation, Concentration, & Completion by Industry

The most popular CTE industries are Arts, Media, and Entertainment; Health Science and Medical Technology; and Hospitality, Tourism, and Recreation. The least popular are Energy, Environment, and Utilities; and Fashion and Interior Design, with a 1% share of pathways each.

By far the largest industry group for pathway participators is Arts, Media, and Entertainment, with a 30% share of pathways in 2017-18. Arts, Media, and Entertainment is much more popular with concentrators than completers (33% vs 18% of pathways respectively),

which may suggest that more students are taking electives in this field without the intention of completing a pathway, though this field still has the largest number of pathway completers.

The next largest industry group is Health Science and Medical Technology with a 14.5% share of pathways. Health Science and Medical Technology has more completers than concentrators (17% vs 12%), which suggests students may be more focused on completing pathways in this field. The third largest industry group is Hospitality, Tourism, and Recreation, which has a 12.5% average share of pathways, with a slightly more concentrators than completers (13% vs 9% in later years).

Building and Construction, Information Technology, and Agriculture and Natural Resources, and Business and Finance industries each account for about 10% of CTE participation. About 5% of pathways are in Marketing, Sales, and Service; Manufacturing and Product Development; Education, Child Development, and Family Services; Public Services; Transportation; and Engineering and Architecture.

Table 7

Participation, Concentration, and Completion by Industry 2017-2018

	Industry Participation for All CTE Students	Industry Concentrations by CTE Concentrators	Industry Completion by CTE Completers
N =	**180,627**	**111,955**	**70,408**
Agriculture and Natural Resources	11.6%	10.7%	10.5%
Arts, Media, and Entertainment	30.9%	33.5%	19.8%
Building and Construction Trades	10.1%	9.2%	8.9%
Business and Finance	8.1%	8.7%	4.9%
Education, Child Development, and Family Services	5.5%	5.2%	4.4%
Energy, Environment, and Utilities	0.9%	0.8%	0.9%
Engineering and Architecture	4.6%	3.6%	4.1%
Fashion and Interior Design	1.1%	1.1%	1.0%
Health Science and Medical Technology	14.5%	11.7%	16.7%
Hospitality, Tourism, and Recreation	12.2%	12.7%	8.1%
Information and Communication Technology	11.5%	10.8%	8.9%
Manufacturing and Product Development	4.4%	4.1%	3.1%
Marketing, Sales, and Services	3.9%	3.6%	3.2%
Public Services	5.6%	4.4%	6.4%
Transportation	5.7%	5.2%	5.1%

Stratification Across Industry Groups

Gender

The greatest disparities in CTE industry participation exist across gender. Females are most overrepresented in Fashion and Interior Design (87% female); Education, Child Development, and Family Services (79%); and Health Science and Medical Technology (67%). However, trends in these fields appear to be reversing, the share of females dropped by 4 to 5 percentage points in each group from 2015-16 to 2017-18.

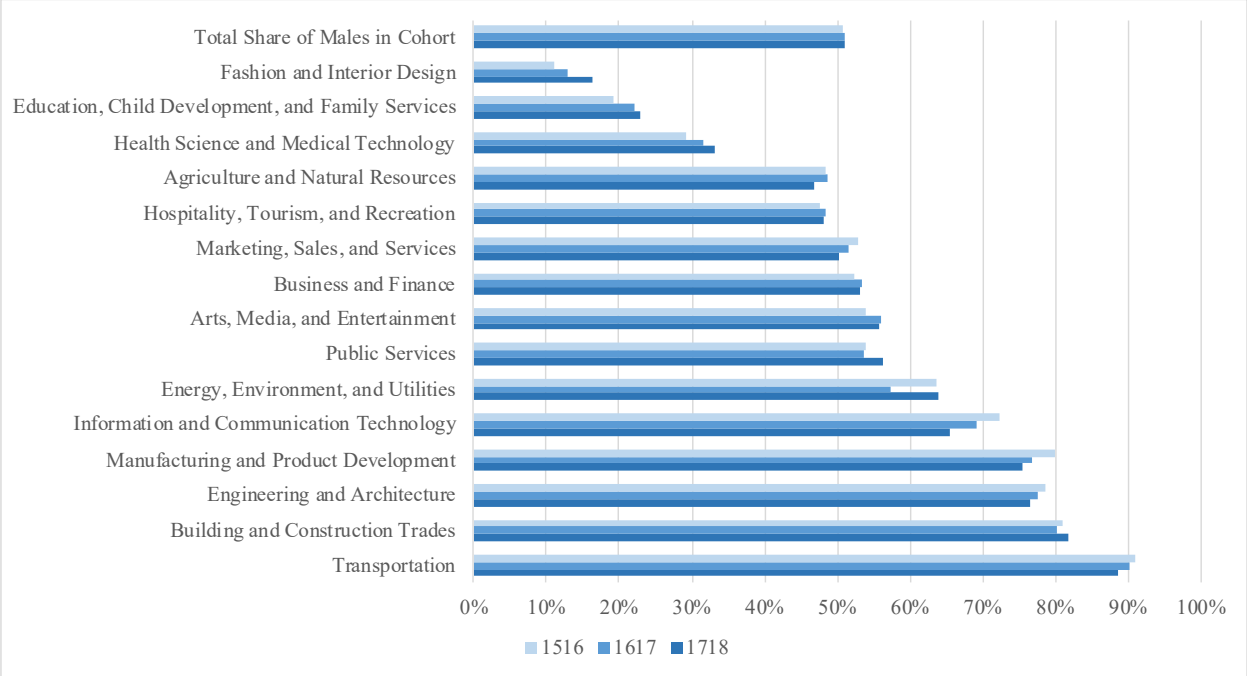
Males are most overrepresented in Transportation (90%); Building and Construction Trades (81%); Engineering and Architecture (78%); Manufacturing and Product Development (77%); Information and Communication Technology (69%); and Energy, Environment, and Utilities (62%). Information and Technology has increased female representation by nearly 7

percentage points from 2015-16 to 2017-18. Building and Construction Trades have remained stagnant, but the remaining fields have increased female representation by 2-3 percentage points over the sample.

The remaining industries (Agriculture and Natural Resources; Hospitality, Tourism and Recreation; Marketing, Sales, and Services; Business and Finance; Arts, Media and Entertainment; and Public Services are more balanced in gender composition, ranging from 48% to 55% male. Trends in this group are mostly flat, though Public Services and Arts, Media, and Entertainment (which are already more male) have lost about 2 percentage points in female participation, while the Business and Finance field has gained 2 percentage points.

Figure 1

Share of Males by Industry Participation 2017-18



*Changes in reporting policies or data quality limit confidence in conclusions about trends over time.

Race & Ethnicity

At the industry level, racial representation is far more unbalanced for some industries than others. Figure 2 focuses on the 4 largest racial or ethnic groups, while smaller groups in the 'other' category will be discussed in the next section. Information and Communication Technology is heavily dominated by White and Asian students. This is especially driven by overrepresentation of Asian students and the most significant underrepresentation of Hispanic/Latino students. Engineering and Architecture is also dominated by White and Asian students, but this is driven more by overrepresentation of White students than Asian students, while underrepresentation of Hispanic/Latino students is not as severe. Both Transportation and Agriculture and Natural Resources are dominated by White and Hispanic/Latino students. Differences in the racial composition of Agriculture and Natural Resources students are driven by the largest overrepresentation of White students (in any one industry) and greatest underrepresentation of both Asian and Black students (in any one industry).

Several industries are aligned closely to the racial/ethnic composition of the overall population: Hospitality, Tourism, and Recreation; and Marketing, Sales, and Services. Fashion and Interior Design is fairly representative, except for the overrepresentation of African American students. Building and Construction Trades is somewhat representative with a relatively small overrepresentation of White and Asian students. Health Science and Medical Technology is also fairly representative but with some overrepresentation of Asian and Hispanic/Latino students.

Hispanic/Latino students comprise 52% of the population, are generally overrepresented in CTE, and experience significant stratification across industries. They are most overrepresented in Public Services (67%, which is 28% higher than their baseline share of the population),

Transportation; Business and Finance; and Education, Child Development, and Family Services (62% in each industry). Hispanic/Latino students are most underrepresented in Information and Communication Technology (38%, which is 27% lower than their baseline share of the population); Energy Environment, and Utilities (40%); and Engineering and Architecture (47%).

African American/Black students constitute 5% of the population and generally underrepresented in CTE. The stratification across industries appears small in absolute terms (typically 2-3% differences), but due to the small size of the population these are very large. African American students are most overrepresented in Fashion and Interior Design (7%) but this is a 40% increase from the baseline share of Black students in the population. African American/Black students are most underrepresented in Transportation (2%); and Agriculture and Natural Resources (2%), which is 40% lower than their share of the population.

Asian students comprise 11% of the population and are generally underrepresented in CTE. Asian students are most overrepresented in Information and Communication Technologies (23%, a 109% increase from their baseline share of the population); Engineering and Architecture (17%); and Energy, Environment and Utilities (17%). Asian students are most underrepresented in Agriculture and Natural Resources (4%).

White students are 22% of the population and are proportionally represented in CTE. They are most overrepresented in Agriculture and Natural Resources (37%, which is a 68% increase from their baseline share of the population); Manufacturing and Product Development (36%); and Energy, Environment, and Utilities (33%). White students are most underrepresented in Business and Finance (17%); and Public Services (20%, which is 23% lower than their share of the overall population).

Figure 2

Industry Participation by Race & Ethnicity 2017-18

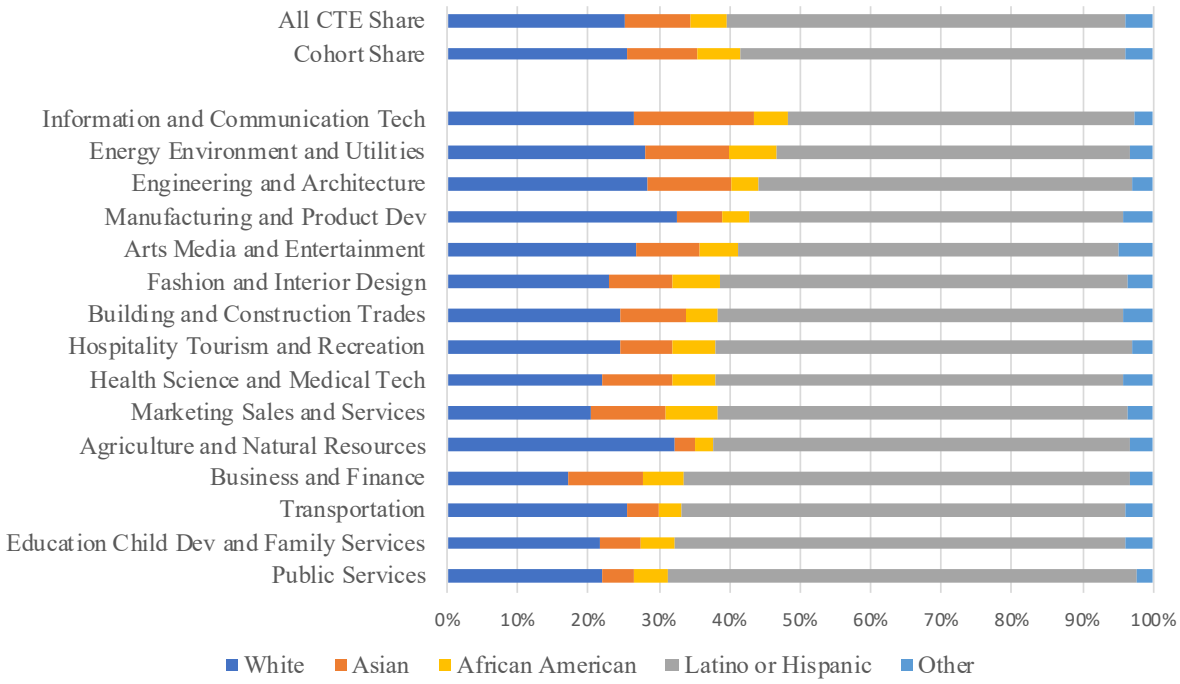
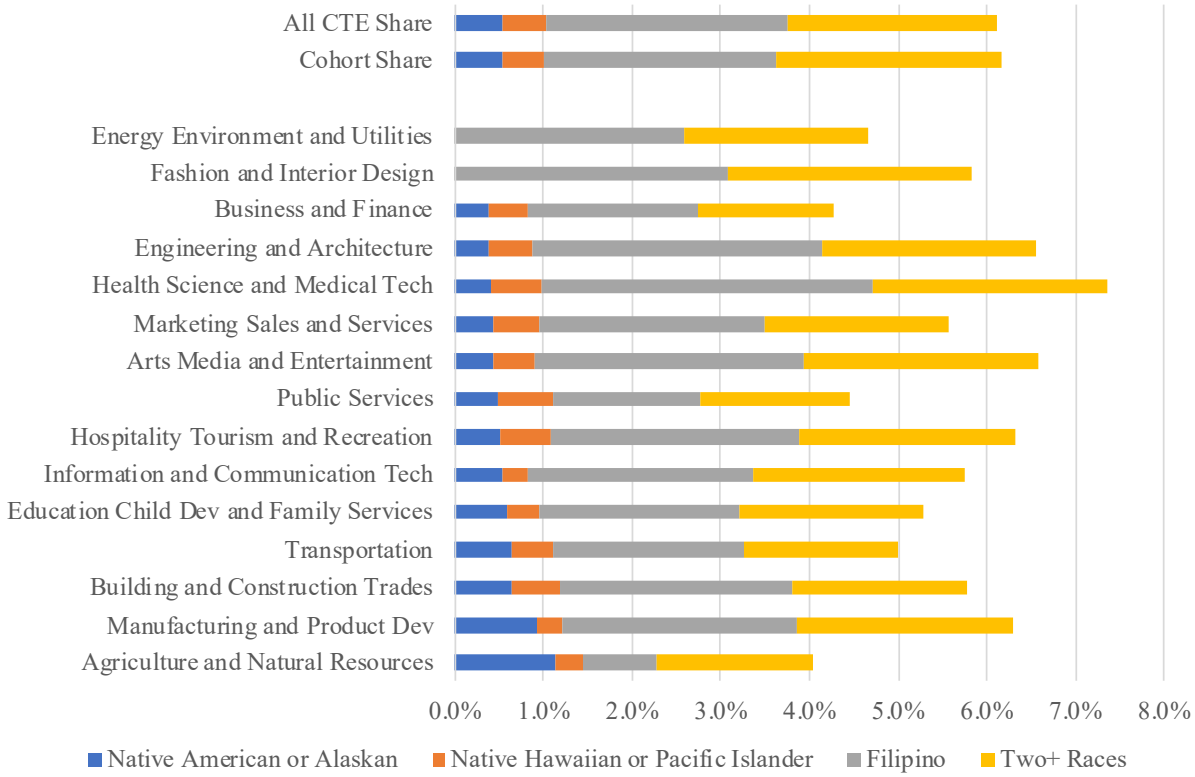


Figure 3

Industry Participation by Race & Ethnicity: 'Other' Category 2017-18



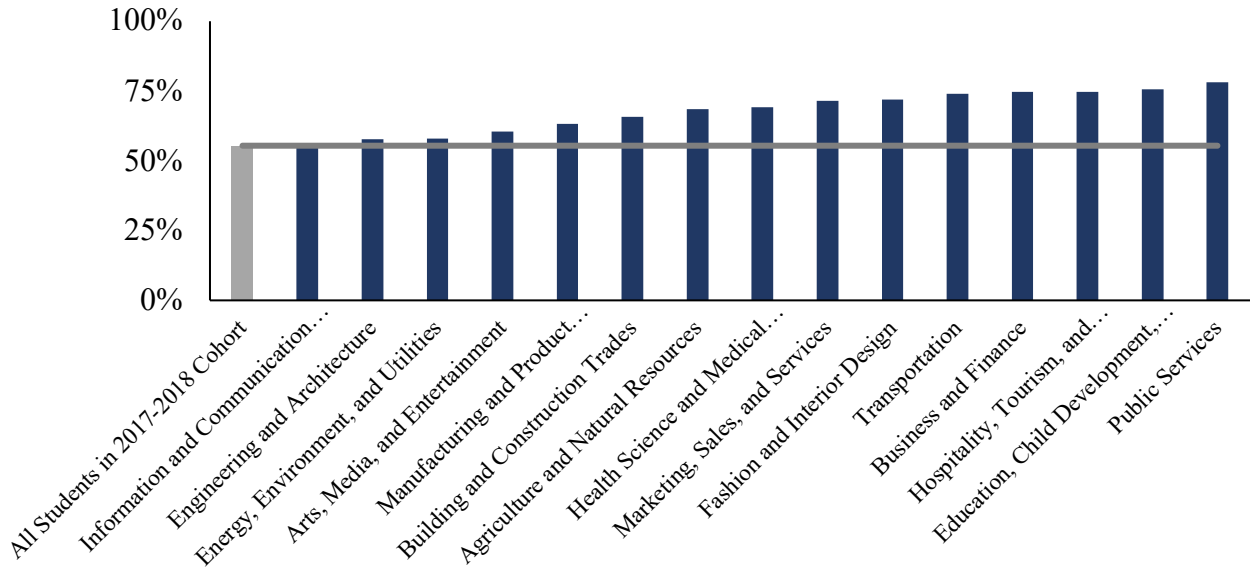
* Data for Native American or Alaskan and Native Hawaiian or Pacific Islander students in Energy Environment and Utilities and Fashion and Interior Design are omitted due to insufficient sample size.

Socioeconomically Disadvantaged Students

CTE students are only 3 percentage points more likely to be socioeconomically disadvantaged (SED), but there is a great deal of variation across industries. Students in Information and Communication Technologies (IT) are the only group where SED students are proportionally represented. Engineering and Architecture and Energy, Environment, and Utilities have the least overrepresentation, with a 58% share of SED students each. SED students are most overrepresented in Public Services (78%); Education, Child Development, and Family Services (76%); Hospitality, Tourism, and Recreation (75%); and Business and Finance (75%). There is a 23 percentage point gap in the share of SED students between the industries with the least and most overrepresentation.

Figure 4

Stratification in Socioeconomic Disadvantage by Industry

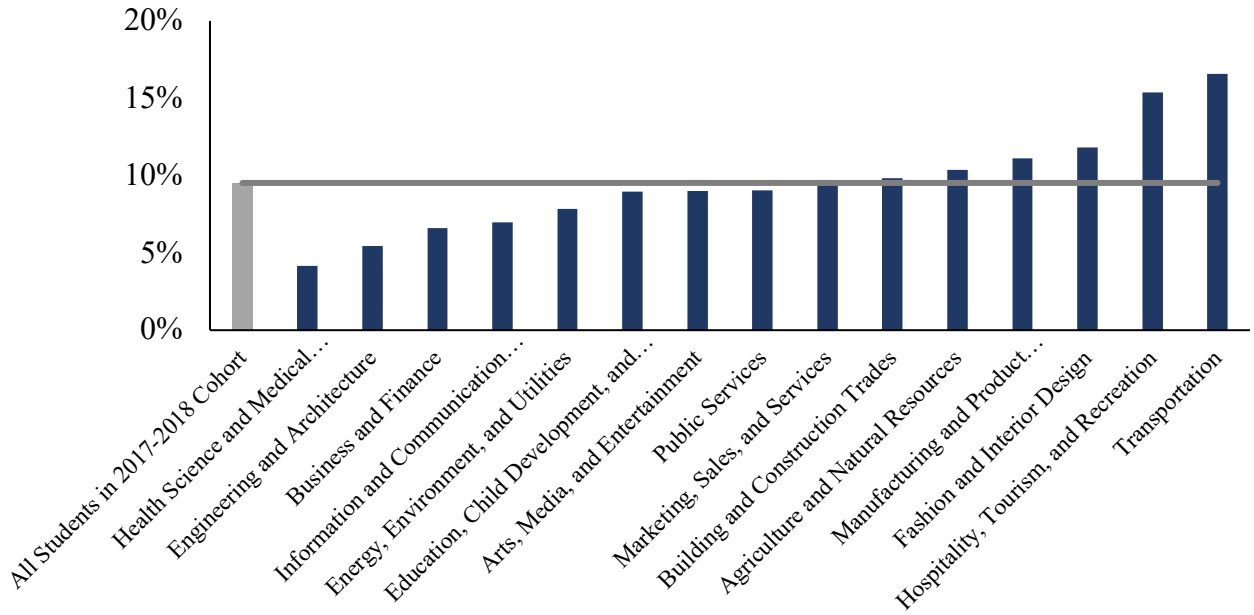


Students with Disabilities

CTE students are only half of a percentage point less likely to be students with disabilities, who make up a 10% share of the cohort population, but there is a great deal of variation across industries. Health Science and Medical Technology and Engineering and Architecture have a 4% and 5% share of students with disabilities (60% and 50% lower than the cohort share, respectively). While 17% of Transportation students and 15% of Hospitality, Tourism, and Recreation students have disabilities (70% and 50% higher than the cohort share, respectively). There is a 13 percentage point gap in the share of students with disabilities between the industries with the highest and lowest representation.

Figure 5

Stratification of Students with Disabilities by Industry

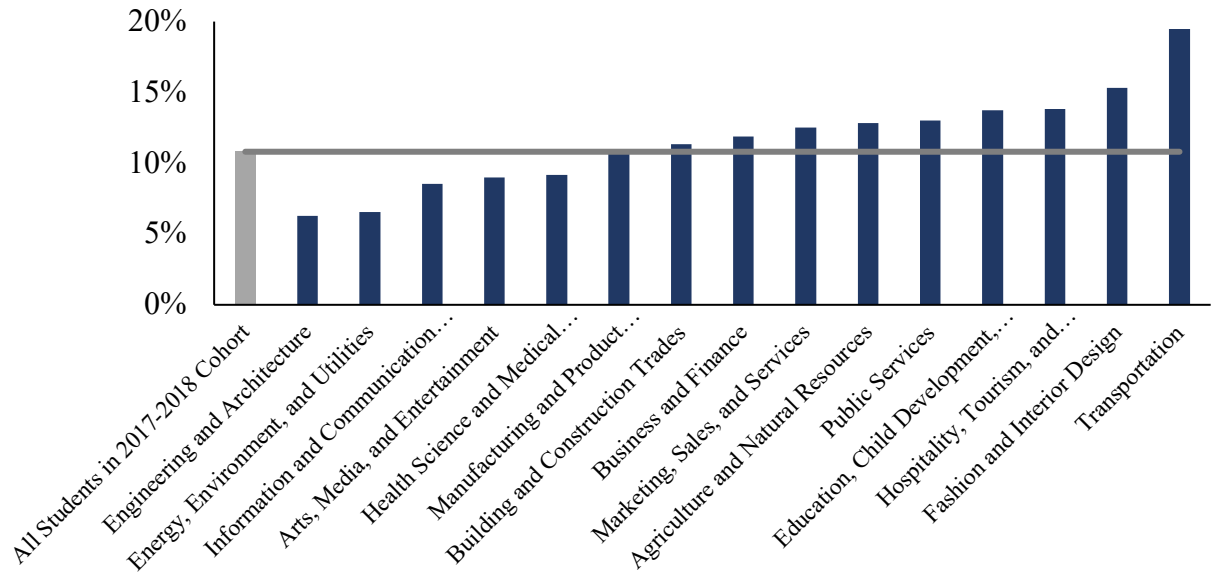


English Learners

CTE students are 1.2 percentage points more likely to be English learners, who make up an 11% share of the cohort population, and there is a great deal of variation across industries. Only 6% & 7% of Engineering and Architecture and Energy, Environment, and Utilities students are English learners (45% & 36% lower than the cohort share, respectively), while 19% of Transportation students and 15% of Fashion and Interior Design students are English learners (72% and 36% higher than the cohort share, respectively). There is a 13 percentage point gap in the share of students that are English learners between the industries with the highest and lowest representation.

Figure 6

Stratification of English Learners by Industry

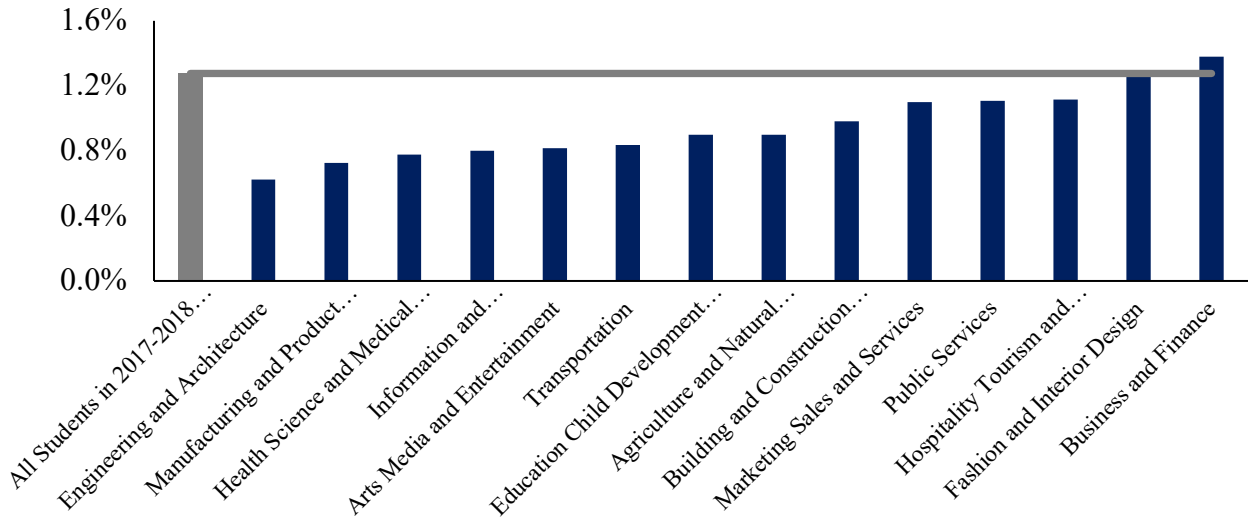


Foster Youth

CTE students are half a percentage point less likely to be children in foster care, who make up a 1.3% share of the cohort population. Foster children are very slightly overrepresented in Business and Finance, and underrepresented in every other industry. Underrepresentation is most severe in Engineering and Architecture and Manufacturing and Product Development, with a 0.63% and 0.72% share of foster students, respectively. Engineering and Architecture in particular has 51% fewer children in foster care than the population.

Figure 7

Stratification of Foster Youth by Industry



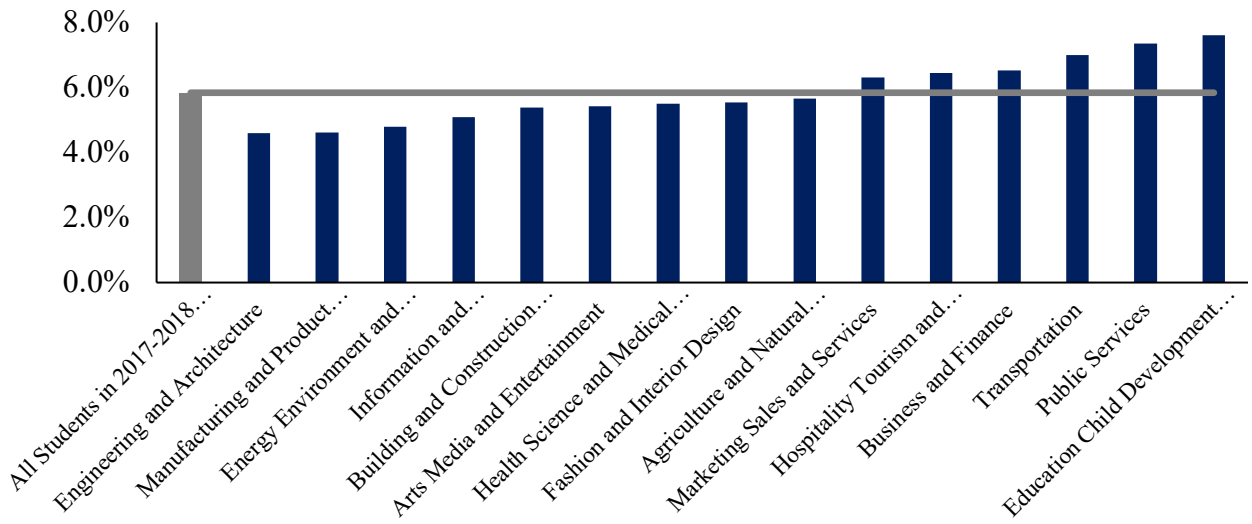
*Energy, Environment, and Utilities omitted due to insufficient cell size

Homeless students

Homeless students are very close to proportionally represented in CTE and they are only underrepresented by 0.1 percentage points, though there is significant variation across industries. Students that are homeless are most overrepresented in Education, Child Development, & Family Services (4.6%); Manufacturing and Product Development (4.6%); and Energy, Environment, and Utilities (4.8%); these represent shares 21% to18% higher than the population share. Students who are homeless are most underrepresented in Engineering and Architecture (7.6%) and Public Services (7.4%); these represent shares 30% to 26% lower than the population share.

Figure 8

Stratification of Homeless Students by Industry



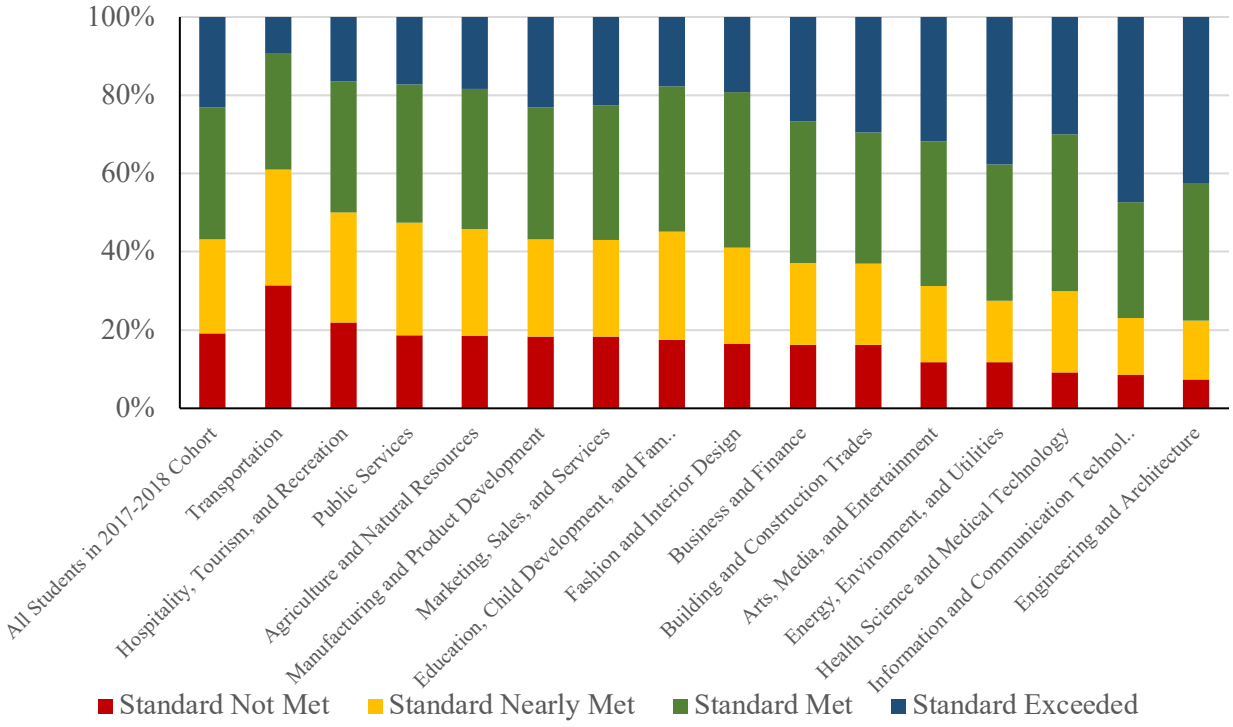
Standardized Test Performance

Comparing scores on the 11th grade Smarter Balanced Assessment Consortium exam reveals substantial variation in performance across industries, particularly in mathematics. Red and yellow respectively represent ‘Standard Not Met’ and “Standard Nearly Met’ performance levels, these are considered ‘not proficient.’ Blue and green categories represent ‘Standard Met’ and ‘Standard Exceeded’ respectively and are considered ‘proficient’ performance. A much

larger share of the total student population (57%) is proficient in English language arts (ELA) than mathematics (30%), and CTE students outperform non-CTE students by a larger gap in ELA (55% proficient vs 49%) than math (28% proficient vs 27%). There are similar trends in performance across ELA and mathematics by industry, students in Engineering and Architecture; Information and Communication Technology; and Energy, Environment, and Utilities are the highest performing (by proficiency rate) students in both ELA and mathematics, and students in Transportation; Hospitality, Tourism, and Recreation; and Public Services are the lowest performing in both ELA and mathematics. Comparing proficiency rates between students in the highest and lowest industry groups there is a 20 percentage point gap in ELA and a 28 percentage point gap in mathematics.

Figure 9

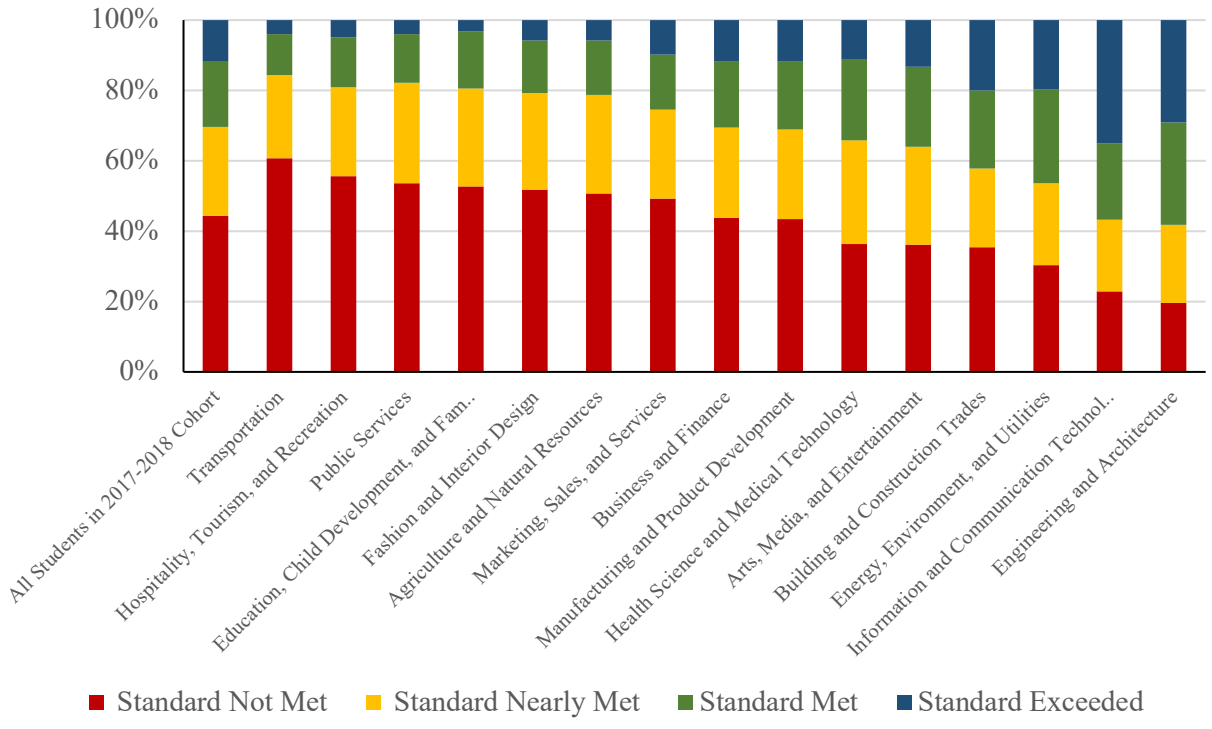
English Language Arts Performance by Industry



ELA performance is highest in Engineering and Architecture and Information and Communication Technology (IT) industries, each with 77% of students proficient in ELA. IT had by far the largest share of students (47%) exceeding the standard on ELA, while Engineering and Architecture had 42%. In contrast, only 39% of transportation students are proficient in ELA, and only 9% exceeded the standard, and Transportation has the largest share (31%) of students in the lowest performance group. Students in Hospitality, Tourism, and Recreation (49%); Public Services (52%); Agriculture and Natural Resources (54%); and Education, Child Development, and Family Services (54%) also had below average proficiency in ELA. The remaining industries had higher than average rates of proficiency in ELA.

Figure 10

Math Performance by Industry



Mathematics performance is also highest in Engineering and Architecture and IT industry groups, with 58% and 56% of students respectively considered proficient, and 29% and 35% of

students respectively in the highest performance group, exceeding the standard. Comparatively, only 16% of Transportation students are proficient, with 4% in the highest performing group and 60% (the highest share of any industry) in the lowest performing group. More than half of students in 6 lowest performing industries are in the lowest performance category for math. The next lowest performing industries are Public Services; Hospitality, Tourism, and Recreation; and Education, Child Development, and Family Services with 81%, 80%, and 79% of students not proficient in math. CTE students are fairly close to non-CTE students in math performance, with 7 industry groups below the cohort-wide average and 7 above the cohort-wide average in math performance.

Career & College Readiness

In the following sections I examine college and career readiness across dimensions of CTE participation intensity and by industry participation, concentration, and completion. Career and college readiness is measured by the California College/Career Readiness Indicators (see discussion in the data section).

Career/College Readiness by CTE Intensity

Table 8

College/Career Readiness by CTE Intensity 2017-2018

Career/College Readiness 2017-2018	Full Cohort	Non CTE Students	CTE Participators	CTE Completers	CTE Concentrators
n =	517,907	334,060	183,847	73,628	110,219
CCI Approaching Prepared	18%	15%	25%	35%	19%
CCI Prepared	43%	39%	50%	65%	40%
CCI Prepared via CTE	7.7%	0%	22%	54%	0%
CCI Prepared via SBAC	26%	26%	26%	29%	24%
CCI Prepared via College Credit	3.7%	2.1%	6.6%	7.4%	6.0%
CCI Prepared via AP	14%	15%	13%	14%	12%
CCI Prepared via IB	0.76%	0.96%	0.41%	0.48%	0.37%
CCI Prepared via a-g	34%	33%	38%	46%	32%
CCI Prepared via Military	0.46%	0.44%	0.50%	0.55%	0.46%
CCI Prepared via SSB	8.9%	9.3%	8.1%	9.0%	7.6%

There is substantial variation in career and college readiness (as measured by the CCI) across CTE intensities. Both CTE concentrators and completers are more likely than non-CTE students to be considered *prepared* or *approaching prepared*. For completers this may be driven by the fact that more than half of completers achieve *prepared* via CTE and just under half achieve *prepared* via a-g completion (students can be prepared via multiple categories of the CCI). CTE completers are slightly more likely than non-CTE students to achieve prepared via standardized test performance (SBAC), though concentrators are less likely. Non-CTE students are slightly more likely to achieve *prepared* via AP, IB, or SSB. Interestingly, both CTE

completers and concentrators are much more likely to achieve *prepared* via college credit, perhaps via CTE articulation agreements with community colleges.

CTE is the most common route to *prepared* status on the CCI for CTE completers, followed by a-g completion, SBAC performance, AP performance, and State Seal of Biliteracy (SSB). Overall, 54% of CTE completers achieve *prepared* via CTE and 46% achieve *prepared* via a-g completion, which is much higher than rates for CTE concentrators and non-CTE students, 32% and 33% of whom are *prepared* via a-g respectively (no non-CTE students or concentrators achieve *prepared* through CTE by definition). CTE completers, concentrators and non-CTE students are more similar in SBAC and AP routes to preparation: 29% of CTE completers are considered *prepared* via SBAC performance (vs 24% of concentrators and 26% of non-CTE students), and 14% via AP (vs 15% of concentrators and 15% of non-CTE students).

College credit, IB, and military routes to preparation are the least common for students and this pattern holds across CTE categories except where groups cannot technically be prepared via CTE because they are not CTE completers. CTE completers are overrepresented in the military path to *prepared* (they are the only disparate group), and both CTE completers and concentrators are underrepresented in IB, while non-CTE students are overrepresented. Both CTE completers and concentrators are more likely than non-CTE students to achieve *prepared* via college credit (7.4% and 6% respectively vs 3.7% of non-CTE students), with completers being twice as likely than non-CTE students to be *prepared* via college credit.

Career/College Readiness by Industry Participation

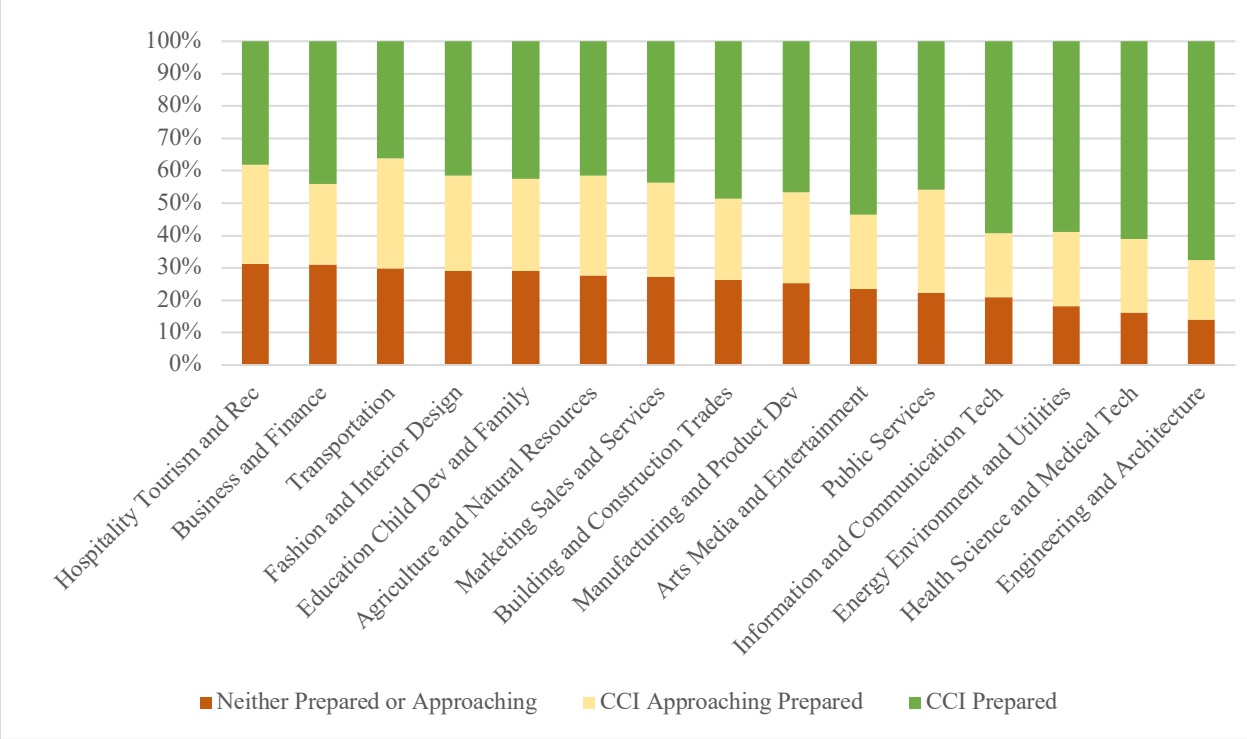
There are stark disparities in career and college readiness level by industry group (Figure 11 shows all CTE participators i.e., both concentrators and completers in each respective industry), as measured by the college/career readiness indicator. The share of unprepared

students in each industry group ranges from 14% to 38%, and the share of prepared students ranges from 38% to 68%.

Hospitality, Tourism, and Recreation and Business and Finance fields have nearly a third (31%) of students that are neither prepared, nor approaching prepared. This is twice the share of unprepared students than in the highest industry. Hospitality and Business both have low shares of prepared students (38% and 44%), but Transportation has the lowest share at 36%. Health Science and Engineering have the lowest shares of unprepared students, 16% and 14% respectively, and the highest share of prepared students, 61% and 68% respectively.

Figure 11

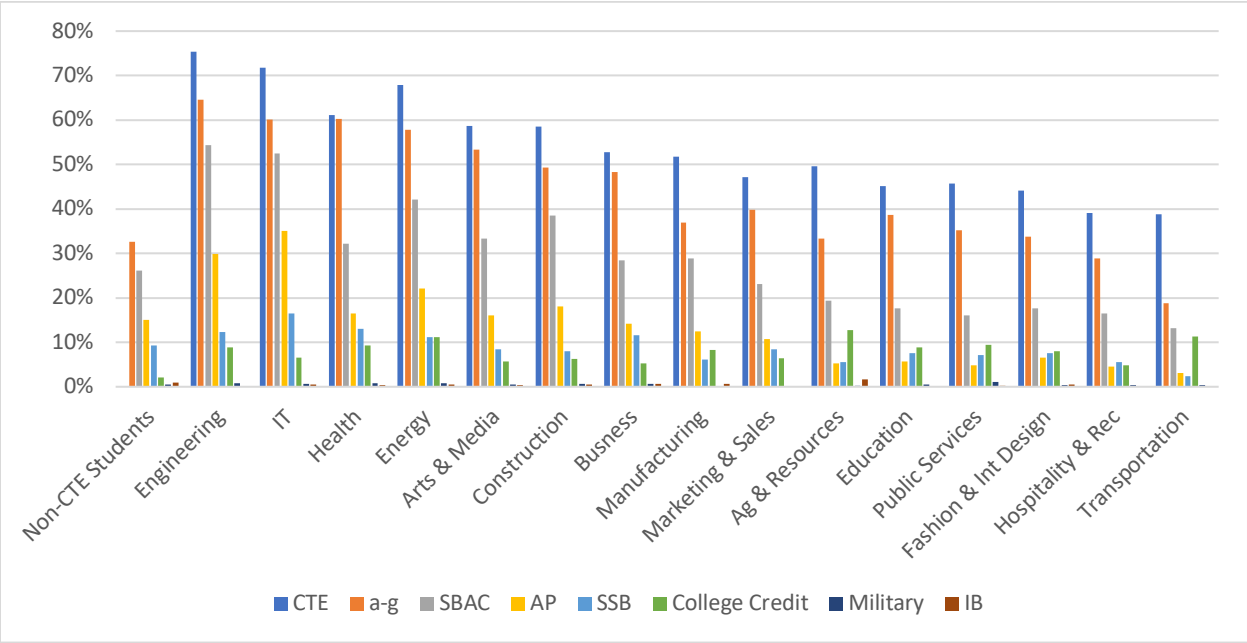
Career/College Readiness by Industry Participation



Pathways to Prepared by Industry Completion

Figure 12

Pathways to Prepared: Career/College Readiness by Industry for CTE Completers



Overall rates of and the specific pathways to career and college readiness vary vastly across industry groups, highlighting significant stratification among CTE students completing pathways in different industry groups. Notably, CTE completers in Hospitality & Rec and Transportation industries are even less likely than non-CTE students to achieve *prepared* via a-g (29% and 19% respectively). These rates are also much lower than the highest performing industry, Engineering, where 84% of students are considered *prepared* via a-g.

The remaining common routes to achieve *prepared* status for CTE completers are the SBAC and AP routes, 29% and 14% of CTE completers are *prepared* via these routes respectively (compared to 26% and 16% of non-CTE students). More than 50% of Engineering and IT pathway completers are *prepared* via SBAC, compared to 13% of Transportation completers and 16% of Public Service Completers (half the rate of non-CTE students). 35% of

IT completers and 30% Engineering completers are *prepared* via AP, compared to 3% of Transportation completers and less than 5% of Public Service and Hospitality completers (less than a third the rate of non-CTE students).

About 9% of both non-CTE students and CTE completers are *prepared* via the State Seal of Biliteracy. This rate is 17% for IT completers, 13% for Health completers, and 12% of Engineering completers, compared to only 2.4% of Transportation completers and less than 6% of Hospitality and Agriculture completers.

These patterns diverge for college credit pathways to college and career preparation. 2% of non-CTE students and 6% of CTE completers are *prepared* via college credit. Engineering, IT, and Health completers still perform above average (with 9%, 7%, and 9% *prepared* via college credit respectively), but Transportation and Agriculture CTE completers are also above average with 11% and 13% *prepared* via college credit respectively. The lowest performing groups in this category are Hospitality (4.8% *prepared*) and Business (5.2% *prepared*), which is typically quite average among CTE completers in other CCI categories.

Preparation via military and IB routes are generally quite uncommon, though there is variation across industry groups. Preparation via military is achieved by 0.44% of non-CTE students and 0.55% of CTE completers. It is particularly high for Public Service (1%), Energy (0.8%), and Health (0.78%) completers. It is particularly low for Manufacturing (0.14%), Marketing (0.13%), and Agriculture (0.27%). Preparation via IB is achieved by 0.96% of non-CTE students and 0.48% of CTE completers. 1.7% of Agriculture students are prepared via IB, while less than 0.1% of Marketing and Transportation completers are prepared via IB. These programs are particularly niche and these routes are so small these differences may not be

statistically significant, or could be heavily influenced by programs at a very small number of schools.

Distribution of CTE Opportunities Across Schools

To understand access to CTE opportunities for various student groups and school types I utilize school wide CTE participation rates as a proxy for access. I define several categories of school-wide CTE participation and then examine how access varies by student characteristics (including race/ethnicity, socioeconomic status, disability status, English learner status, homelessness, for foster youth, and by standardized test proficiency) and school characteristics (traditional high school, CA Partnership Academy, CTE grant school, charter or magnet schools, and alternative or continuation schools). Participation rates are calculated as the share of students in the 2017-18 cohort within each school participating in CTE.

The distribution of the overall student population across CTE categories reveals that a surprising number of students (11%) attend schools with no students participating in CTE, as well as a substantial share of students (38%) attending schools with high rates of CTE participation (greater that 45%). Additionally, 28% of students attend schools with very low (<10%) or low (10-25%) CTE participation and 24% attend schools with average rates of CTE participation (25-45%).

Table 9

Categories of School-wide CTE Participation

Category	School CTE Participation Rate	Student N 2017-18 Cohort	Share of 2017-18 Cohort
None	0%	55,162	11%
Very Low	>0 - 10%	64,985	13%
Low	>10 - 25%	75,617	15%
Average	>25 - 45%	124,108	24%
Moderately High	>45 - 60%	94,891	18%
High	>60%	103,144	20%

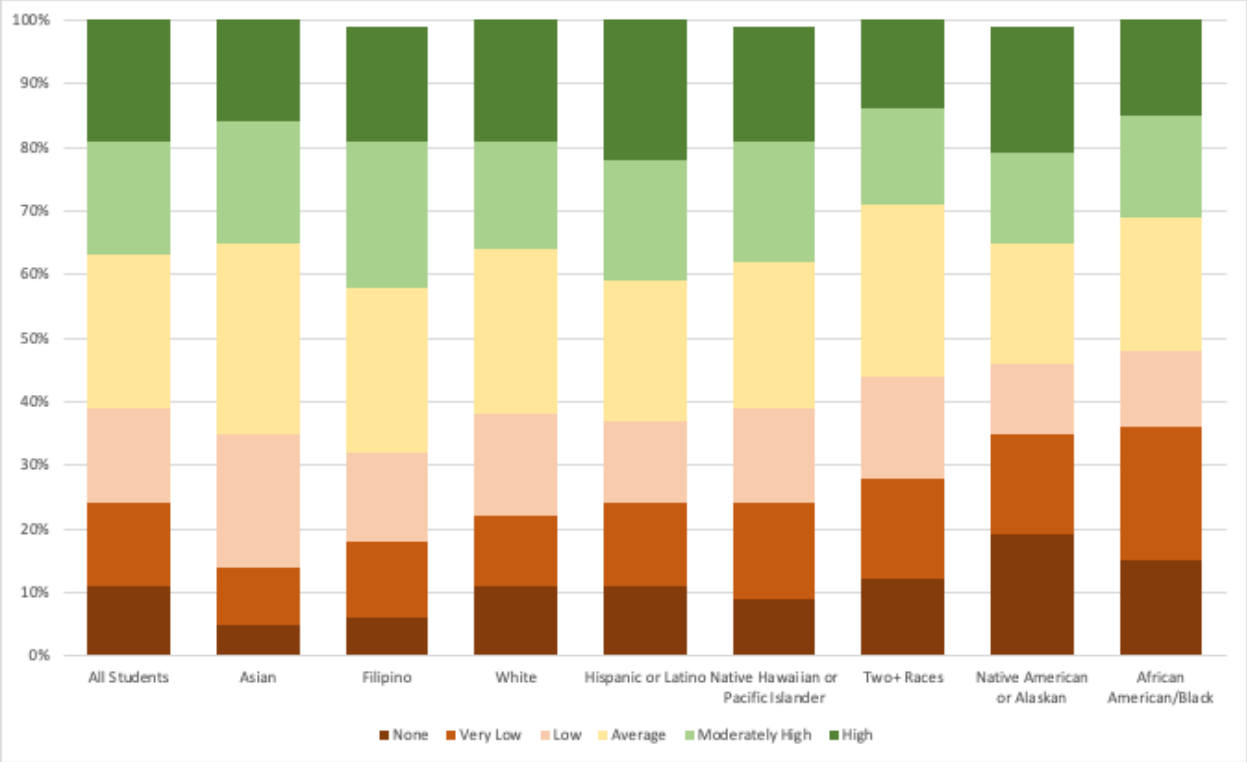
Race & Ethnicity

The greatest disparities in access to CTE occur by race and ethnicity. Overall, Asian and Filipino students have the best access to CTE schools and Native American or Alaskan students, students with two or more races, and African American / Black students have the least access. Latinx students have the greatest access to high CTE schools but are also more likely to be in schools with no or very low rates of CTE participation than Asian or Filipino students.

Native American or Alaskan students and African American / Black students are the most likely to be in schools with no CTE participation, however Native American or Alaskan students have above average access to high CTE schools, while Black and Multiracial students have below average. Native Hawaiian or Pacific Islander students are distributed across school participation levels similarly to the overall population. (See Appendix Table B4 for greater detail on representation of these racial and ethnic groups by industry).

Figure 13

CTE Access by Race/Ethnicity

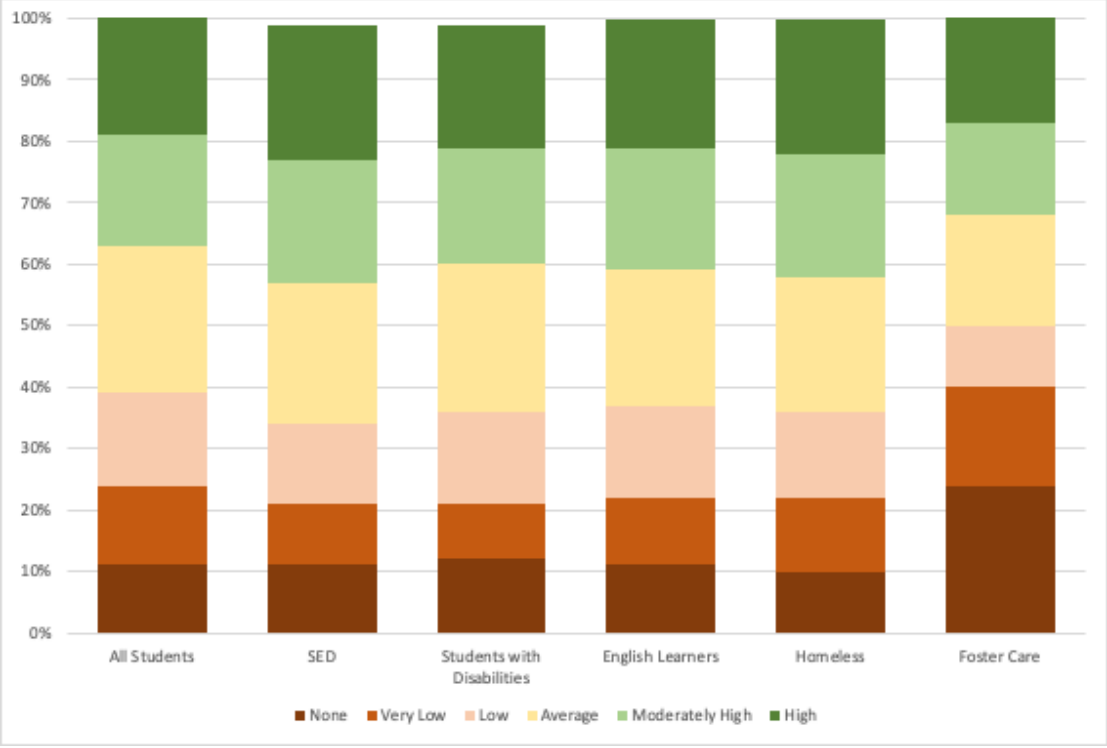


Special Populations

Across special populations, most groups have slightly better access to CTE than the average student. However foster youth are more than twice as likely to be in schools without CTE, substantially more likely to be in schools with very low participation and have limited access to high CTE schools. Socioeconomically disadvantaged students, students with disabilities, and homeless students have fairly similar access to CTE, being equally or slightly less likely than average to be in schools without CTE (except students with disabilities, who are more likely to be in schools without CTE but the least likely to be in schools with very low rates of CTE participation) and slightly more likely to be in schools with high rates of CTE participation.

Figure 14

CTE School Participation Levels by Special Populations

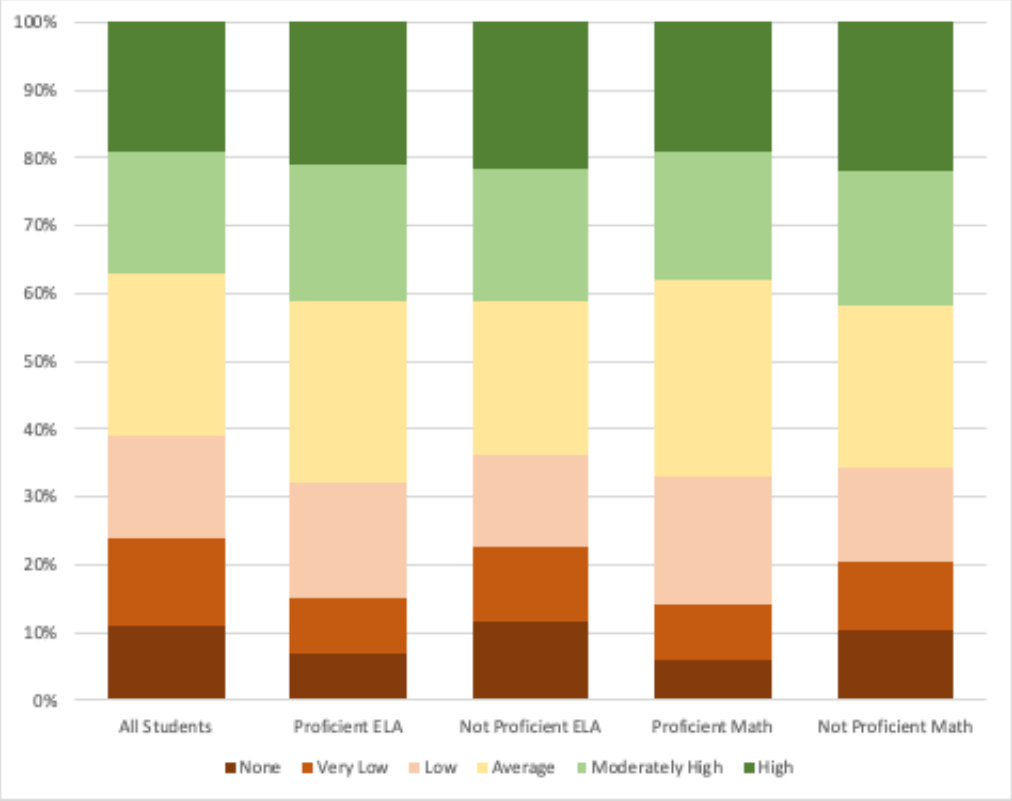


Standardized Test Proficiency

Students meeting or exceeding the standard (i.e., proficient) on either math or ELA SBAC exams are relatively unlikely to attend schools with no CTE or very low rates of CTE participation. Proficient students are relatively likely to attend schools with at least average levels of CTE participation, but they have about average access to moderately high or high CTE schools (this is driven by the fact that these groups have the most access to schools with average rates of CTE participation). Lower performing students are more likely to be in schools with either very low or very high levels of CTE participation.

Figure 15

CTE Access by Standardized Test Performance



School Type

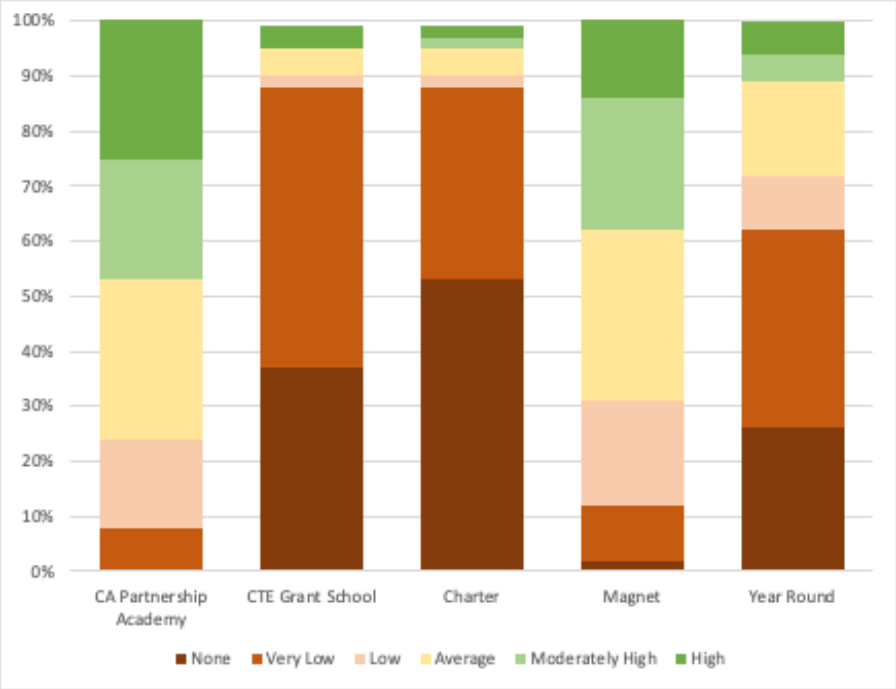
Panel A shows access to CTE for special groups of schools relevant to CTE, including schools with California Partnership Academies and schools receiving state CTE grants, as well as charter, magnet, and year-round schools. Students in California Partnership Academies and magnet schools have similar access to CTE, they are much more likely to attend schools with high rates of CTE participation, compared to students in charter schools and CTE grant schools, who are very likely to attend schools with no CTE participation whatsoever. However, a small share of students in charter or grant schools do attend schools with high or moderately high rates of CTE participation.

Panel B shows access to CTE by school type. Students in Traditional schools have the best access to CTE, they are the most likely to be in high CTE schools, and least likely to be in schools without CTE. Students in the remaining school types are particularly likely to attend schools without any CTE participation, in particular, more than 65% of students in special education schools/consortia and about half of students in juvenile court or youth authority schools and opportunity or county/ community day schools attend schools with no CTE. Of non-traditional schools, students at alternative/continuation schools have the best access to CTE, however more than 30% of students still attend schools with no CTE participation.

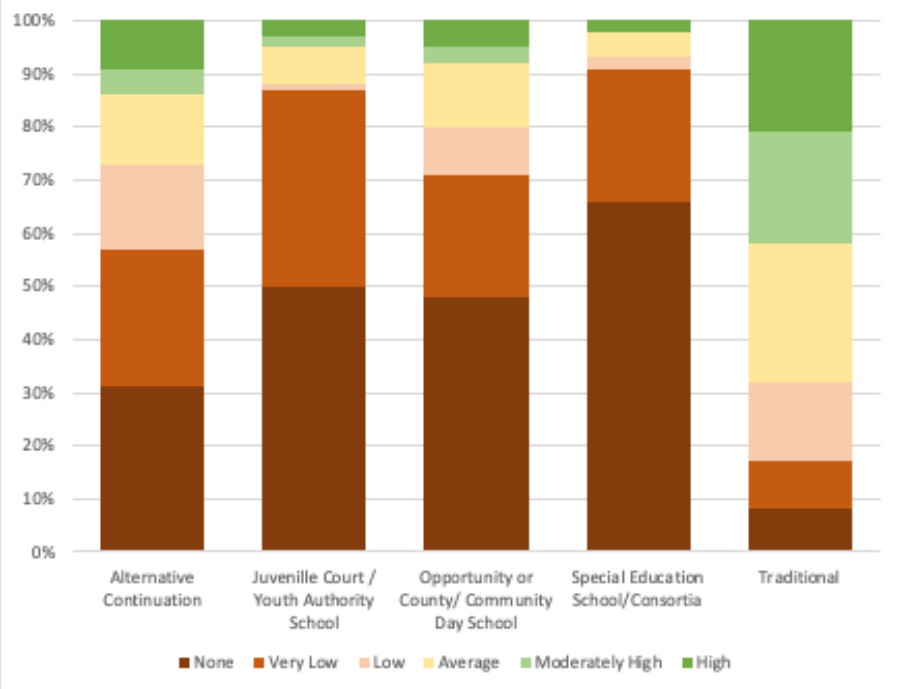
Figure 13

CTE School Participation Levels by School Characteristics (A) & School Type (B)

(A)



(B)



Discussion

CTE Student Population

In aggregate, career and technical education students appear to be broadly similar to non-CTE students by gender, race/ethnicity, socioeconomic status, English language learner status, disability status, homelessness, and foster care status. CTE students are generally more likely to be male (by 6 percentage points), Hispanic/Latino (by 8 percentage points), White (by 2 percentage points), and socioeconomically disadvantaged (by 3 percentage points). These differences are relatively small due to the overall size of these groups, all of which make up about half the population, with the exception of White students. This aligns with previous findings of limited stratification between CTE and non-CTE students in Texas (Giani, 2017) and that nationwide there is still some stratification between CTE and non-CTE students, though it is improving (Malkus, 2019).

College and Career Readiness

As a whole, CTE students are more prepared for both college and career than non-CTE students. Even CTE concentrators who are not eligible to earn a prepared status via CTE pathway completion outperform non-CTE students, especially in reaching the *approaching prepared* level of the Career/College Readiness Indicator. CTE completers are much more likely that non-CTE students to be considered prepared and are more likely to earn prepared status through more traditional academic routes like standardized test performance and completing college entrance coursework requirements. However, when CTE students are disaggregated across industry groups stark disparities emerge. Students in STEM fields are much more likely than students in other industries to be prepared and much more likely to be prepared via

traditional academic/college-focused pathways like standardized test performance, AP coursework, and completion of college entrance coursework.

This analysis reveals that the aggregation of CTE students into one group conceals significant stratification for students in nearly every sub-population that occurs across industry groups, raising serious concerns about continued but hidden tracking for minoritized or disadvantaged students. Collectively there are consistent patterns of representation and achievement across several fields. This pattern supports Malkus' theory that improvement in CTE students' achievement is driven by a changing composition of students, in particular attracting high performing students to 'new era' CTE pathways (2019) while the population of students in 'old era' traditional trades has not changed, continuing the same stratification of students by race and social class as historical vocational education (Bowles & Gintis, 1976; Tyack, 1974; Grubb & Lazerson, 1982).

Access to CTE Schools

Access to CTE opportunities varies widely, particularly by race/ethnicity and school characteristics and may compound stratification across industry groups. More than 10% of student attend schools with no CTE participation, though nearly twice as many attend schools with very high (>60%) rates of participation. A promising finding is that socioeconomically disadvantaged students and students in special populations have very similar access to school-level CTE opportunities as the overall population. However, there are stark disparities in access to CTE by race: Asian and Filipino students have the best access to CTE opportunities, while Black and Native American & Alaskan students have very limited access and are much more likely than their peers to be in schools without CTE opportunities. This complements the findings of Jacob & Guardiola (2020) that racial gaps in CTE participation are driven by

differences in access to CTE programs at the school level. Additionally, students that perform well on standardized tests are much less likely to be in schools with no CTE or very low rates of CTE participation than students who are not proficient. Traditional schools and those with partnership academies provide the best access to CTE opportunities, while students in non-traditional schools are very likely to attend schools with no CTE participation.

Patterns Across CTE Industry Groups

Science, technology, engineering, and mathematics (STEM) fields, including Heath Sciences, Engineering and Architecture, and Information and Communication Technology serve high performing students with underrepresentation from disadvantaged groups. Students Engineering & IT are much more likely to be White or Asian males with exceptionally high standardized test performance. They are also far less likely than their peers to be foster youth, homeless, English-learners, or students with disabilities. Healthcare fields are dominated by female students (about 70% compared to Engineering & IT's 20-30%) who also perform well on standardized tests. However, Healthcare tends to be slightly more accessible to students of color and socioeconomically disadvantaged students compared to other STEM fields.

Education, Hospitality, and Transportation fields serve high shares of disadvantaged students and students of color. Transportation is heavily dominated by Hispanic/Latino and White males. Hospitality is more racially representative, but students in both fields (Transportation and Hospitality) are more likely to be socioeconomically disadvantaged and/or homeless and especially likely to be English-learners, and/or have disabilities. They also tend to perform far below their peers in mathematics and English language arts standardized tests. Students in Education, Child Development, and Family Services are much more likely to be

female, Hispanic/Latino, and/or English-learners. They have the greatest overrepresentation of homeless students and are very likely to be socioeconomically disadvantaged.

Implications of Stratification Within CTE

'New-era' STEM-focused fields have students with very high performance on standardized tests and very low representation of marginalized groups, as well as especially severe disparities across gender lines, although there are STEM fields with overrepresentation of female students. This mirrors problematic stratification in STEM vs non-STEM pathways in other academic settings and in the labor market. The K-12 sector is ideally positioned to draw students from underrepresented populations into STEM fields in a more supportive and inclusive environment, in a way that community college and 4-year colleges are likely unable to do given their different student populations, organizational structures, objectives, and resources. Additionally, STEM educational backgrounds tend to yield well-compensated middle skill jobs in high-demand industries, especially for people without four-year degrees (Holzer, Linn & Monthey, 2013; Holzer and Baum, 2017), highlighting the importance of recruiting disadvantaged students to STEM fields.

The intention of STEM CTE is to provide a focused pathway for students into middle-skill or higher STEM careers (potentially via postsecondary education), but if the students engaging with STEM CTE are otherwise college-bound, particularly into STEM majors, then CTE may not yield benefits. In fact, it may be introducing harms. For example, Ecton (forthcoming) finds that higher-scoring students trade off advanced course-taking in advanced math and IB/AP classes in favor of CTE, reducing their college preparation. Additionally, CTE STEM pathways may be diverting additional resources to already successful students, and these resources could be substantial, i.e. robotics laboratories, computing equipment, etc. Recent

evidence from Massachusetts finds that students in industries like healthcare and IT see large gains in community college attendance without decreases in 4-year college attendance, which suggests those programs are well targeted to the students who benefit the most from them, though it is unclear how schools might identify these students a priori (Ecton, 2021).

Conclusion

There is substantial stratification across career and technical education industry groups in California. This stratification is hidden when considering CTE students as a single population, in comparison to non-CTE students, and gives the impression that historical patterns of tracking and stratification of students in career training have nearly disappeared. This is likely due to the inducement of high performing students into newly-developed STEM and 'new-era' CTE programs, changing the composition of the CTE student population. When student populations are examined by industry groups, historically familiar patterns of stratification reemerge. Given these results, the state of California should reconsider how it evaluates and monitors career and technical education in accountability systems.

Given the compositional differences in student populations across CTE industries, policy interventions to address equity concerns will require monitoring the participation of various subgroups across industries. Policymakers should consider how to recruit underrepresented students who would benefit from high quality 'new-era' CTE and incentivize participation. Some CTE programs should be well positioned to serve underrepresented female students, for example, Linked Learning, which emphasizes equity by design (Ruiz de Velasco, Newman, & Borsato, 2016).

Contribution

This work contributes to the literature by utilizing recent data to examine the population of career and technical education students in a large and diverse state and across many types of schools. Additionally, it disaggregates students by industry group to examine patterns of stratification, which highlights both the importance of attention to industry group participation in monitoring and accountability, and the need to pursue policy and research to improve equity in career and technical education programs.

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Appendix A: Definition of Terms

- CTE - career and technical education
- Pathway - a series of typically 3 increasingly rigorous courses within a defined field and industry
- Industry - CTE pathways are organized into 15 industries
- Participator - student that takes one CTE classes, or more than one class but not in a defined pathway
- Concentrator - student that completes 50% of a pathway (typically 2 classes)
- Completer - student that completes a pathway (typically 3 classes)
- Completer Plus - Students that successfully complete an articulated CTE pathway and are considered prepared on the CCI
- CCI - California's Career/College Readiness Indicator - Students are classified as not prepared, approaching prepared, or prepared. Students can be prepared via a combination of different achievements, including completion of California's a-g requirements for 4-year university enrollment, a semester of dual enrollment, or achieving minimum performance levels on the Smarter Balanced Assessment Consortium (SBAC) exam. Students may also achieve prepared status via other combinations of SBAC scores, AP/IB courses, dual enrollment, a-g courses, biliteracy, or leadership or military science.
- California Partnership Academy

Educational Options	
Alternative School of Choice	Alternative Schools, Provides different means of attaining the objectives of regular education and meeting students' needs; voluntary for districts, teachers, students, and their parents.
Community Day School	Serve high-risk youths, including those referred by expulsion, probation, or a School Attendance Review Board; provide challenging academic curriculum; and develop pro-social skills and resiliency.
Continuation School	Serves students sixteen years of age and older who have not graduated from high school, are at risk of not graduating, and are not exempt from compulsory school attendance.
County Community School	Serves students who are referred by a parent or a School Attendance Review Board, paroled, on probation, expelled, homeless, or not attending school.
District Special Education Consortia	An association of schools/districts who work collaboratively to provide special education programs and services to students with disabilities
Home and Hospital	School districts provide home and hospital instruction to maintain instructional continuity during a student's temporary disability.
Juvenile Court School	Serves students under the protection or authority of the juvenile court system and incarcerated in juvenile halls, homes, ranches, camps, day centers, or regional youth facilities.
Opportunity School	Serves students who are habitually truant, irregular in attendance, insubordinate, disorderly, or failing academically; Assigned/Referred, Grades 1-12, Temporary
Special Education School	Schools for students with disabilities
State Special School	Deaf/Blind Schools
Traditional	Traditional schools
Youth Authority School	Under Dept of Corrections, Juvenile Justice, incarcerated students

(CDE, 2019)

Appendix B: Summary Statistics Tables

Table B1. Summary Statistics: Student Characteristics

Student Characteristics	Full Sample	2015-16	2016-17	2017-18
N	1,498,894	481,541	499,446	517,907
Male	51%	51%	51%	51%
African American	6%	6%	6%	6%
Asian	12%	12%	12%	13%
Latino/Hispanic	52%	52%	52%	53%
White	25%	26%	26%	25%
SED	55%	55%	55%	56%
Students with Disabilities	9%	9%	9%	9%
English Learners	10%	10%	10%	10%
Proficient- SBAC ELA	50%	48%	51%	51%
Proficient- SBAC Math	27%	26%	28%	28%

Table B2. Summary Statistics: Career/College Readiness Indicator

Career/College Readiness Indicator	Full Sample	2015-16	2016-17	2017-18
N	1,498,894	481,541	499,446	517,907
CCI Approaching Prepared	20%	21%	20%	18%
CCI Prepared	46%	54%	42%	43%
CCI Approaching via SBAC	51%	61%	47%	46%
CCI Approaching via College Credit	2.4%	0.3%	1.1%	5.7%
CCI Approaching via CTE	16%	18%	15%	14%
CCI Approaching via a-g	41%	41%	41%	40%
CCI Prepared via CTE	8%	9%	7%	8%
CCI Prepared via SBAC	30%	39%	26%	26%
CCI Prepared via College Credit	1.6%	0.2%	0.7%	3.7%
CCI Prepared via AP	14%	13%	14%	14%
CCI Prepared via IB	0.8%	0.8%	0.8%	0.8%
CCI Prepared via a-g	35%	35%	35%	34%
CCI Prepared via Military	0.3%	-	0.4%	0.5%
CCI Prepared via SSB	6%	-	8%	9%

Table B3. Summary Statistics: School Characteristics

School Characteristics	Full Sample	2015-16	2016-17	2017-18
N	1,498,894	481,541	499,446	517,907
CA Partnership Academy	24%	25%	24%	24%
CTE Grant School	2%	2%	2%	2%
Charter	11%	12%	11%	11%
Magnet	11%	11%	11%	12%
Year Round	8%	8%	8%	7%
Instruction Level				
Elementary	0.1%	0.0%	0.0%	0.2%
Elementary-High Combination	6%	6%	6%	6%
High School	94%	94%	94%	93%
Intermediate/Middle/Junior High	0.3%	0.0%	0.0%	0.9%
Education Option Code				
Alternative/Continuation	8%	8%	8%	7%
Juvenille Court / Youth Authority School	0.5%	0.6%	0.5%	0.4%
Opportunity or County/Community Day School	1.6%	1.7%	1.6%	1.5%
Special Education School/Consortia	0.3%	0.1%	0.4%	0.4%
Traditional	90%	90%	90%	91%
School Ownership Code				
Alternative/Continuation	8%	8%	8%	7%
Juvenille Court / Youth Authority School	0.5%	0.6%	0.5%	0.4%
Opportunity or County/Community Day School	1.6%	1.7%	1.6%	1.5%
Special Education School/Consortia	0.3%	0.1%	0.4%	0.4%
Trad-Elementary	0.1%	0.0%	0.0%	0.1%
Trad-High	85%	85%	85%	85%
Trad-K12	4.8%	4.6%	4.9%	4.8%
Trad-Middle/Jr	0.3%	0.0%	0.0%	0.9%

*Table shows share of cohort students in each type of school (not share of schools)

Table B4. Industry Participation by Race & Ethnicity: 'Other' Category 2017-18

	Native American or Alaskan	Native Hawaiian or Pacific Islander	Filipino	Two+ Races
N	990	904	5,018	4,304
Cohort Share	0.54%	0.47%	2.6%	2.6%
All CTE Share	0.54%	0.49%	2.7%	2.3%
Agriculture and Natural Resources	1.1%	0.30%	0.8%	1.8%
Arts Media and Entertainment	0.44%	0.47%	3.0%	2.7%
Building and Construction Trades	0.65%	0.54%	2.6%	2.0%
Business and Finance	0.38%	0.45%	1.9%	1.5%
Education Child Dev and Family Services	0.58%	0.37%	2.3%	2.1%
Energy Environment and Utilities	-	-	2.6%	2.1%
Engineering and Architecture	0.38%	0.48%	3.3%	2.4%
Fashion and Interior Design	-	-	3.1%	2.7%
Health Science and Medical Tech	0.41%	0.56%	3.7%	2.6%
Hospitality Tourism and Recreation	0.51%	0.57%	2.8%	2.4%
Information and Communication Tech	0.54%	0.28%	2.5%	2.4%
Manufacturing and Product Dev	0.93%	0.29%	2.6%	2.4%
Marketing Sales and Services	0.42%	0.54%	2.5%	2.1%
Public Services	0.49%	0.63%	1.6%	1.7%
Transportation	0.64%	0.47%	2.1%	1.7%

*For reference the table includes N for racial/ethnic group sizes. This table shows the share of students in each industry that belong to each group, i.e. 1.1% of Agriculture students are Native American or Alaskan. Energy Environment and Utilities and Fashion and Interior Design are omitted due to insufficient sample size.

Native American or Native Alaskan students are proportionally represented in CTE while 'Native Hawaiian or Pacific Islander' and Filipino students are overrepresented in CTE (by 4.2% and 3.8% respectively) and students of two or more races are underrepresented in CTE (by 13%). All of these smaller race/ethnicity groups experience significant stratification across industries, in particular 'Native American or Native Alaskan' students, whose representation ranges from 30% less to 103% more than their population share.

Native American or Native Alaskan students constitute 0.54% of the population and are proportionally represented in CTE but experience significant stratification across industries. Native American or Native Alaskan students are most overrepresented in Agriculture and Natural Resources (1.1%) and Manufacturing and Product Development (0.93%) which are respectively 103% and 72% larger than their expected share of those industries. These students are especially underrepresented in Business and Finance (0.38%) and Engineering and Architecture (0.38%), each 30% smaller than their expected share.

'Native Hawaiian or Pacific Islander' students comprise 0.47% of the population and are slightly overrepresented in CTE. They are most overrepresented in Public Services where they are 0.63% of students, which is 34% higher than the population share. 'Native Hawaiian or Pacific Islander' students are most underrepresented in Information and Communication Technology (0.28%); Manufacturing and Product Development (0.29%); and Agriculture and Natural Resources (0.30%), each about 36% smaller than the expected population share of each industry.

Both 'Native American or Native Alaskan' and 'Native Hawaiian or Pacific Islander' students are most underrepresented in 'Energy, Environment and Utilities' and 'Fashion and Interior Design,' as they have cell sizes too small to report (<15), but these are also the smallest industries (representing only about 1% of CTE participation each) and likely to be noisy measures.

Filipino students make up 2.6% of the student population and are very slightly overrepresented in CTE. They are most underrepresented in Agriculture and Natural Resources (0.8%), which is 69% smaller than their population share. Filipino students are most

overrepresented in Health Science and Medical Technology (3.7%, 42% higher than expected) and Engineering and Architecture (3.3%, 27% higher than expected).

Students of two or more races are comprise 2.6% of the population and are underrepresented in CTE by 13%. They are most underrepresented in Business and Finance (1.5%, 42% higher than expected), Public Services (1.7%, 35% higher than expected), and Transportation (1.7%, 35% higher than expected). Students of two or more races are slightly overrepresented in Arts Media and Entertainment and (2.7%) Fashion and Interior Design (2.7%), each only 3.8% larger than their population share.

II: Dual Enrollment: How Opportunity and Participation is Distributed Across California's Schools

The research reported here was conducted under research partnership agreements between the University of California, Davis (Michal Kurlaender, PI) and the California Community Colleges Chancellor's Office and the California Department of Education, respectively. The research was supported by the Institute of Education Sciences, U.S. Department of Education, through Grants R305E150006 and R305A210217 to the Regents of the University of California. The findings and conclusions here are those of the author alone and do not necessarily reflect the positions of the Institute of Education Sciences or the agencies providing the data.

Introduction

California is committed to both increasing college enrollment and degree attainment and closing gaps for low-income and minoritized students in order to reduce poverty and address the impending skill shortage in the state. One avenue for improving college access and completion is by increasing participation in college-credit courses while students are still in high school. Research indicates that taking college courses in high school leads to an increased likelihood of college degree attainment, college enrollment, credit accumulation, completing high school, staying in school, and being college ready (Berger, Turk-Bicakci, Garet, Knudson, & Hoshen, 2014; Edmunds, Unlu, Glennie, Bernstein, Fesler, Furey, & Arshavsky, 2017; An, 2013; Giani, Alexander, & Reyes, 2014; Struhl & Vargas, 2012). Recognizing the potential of college courses in high school to improve student outcomes, the California Legislature adopted Assembly Bill 288, College and Career Access Pathways (CCAP), in 2015 to expand dual enrollment (DE) programs across the state through partnership agreements between K-12 school districts and community colleges (AB-288 Public schools: College and Career Access Pathways partnerships). Although dual enrollment rates have risen over recent years, the opportunity to participate is not necessarily equally distributed. Students' opportunities to take community college courses are often determined by the high school they attend, either through formal dual enrollment offerings or partnerships, or as the result of a culture of college course-taking or advising practices. The vast majority (84%) of California public high schools have at least one student taking a community college course while in high school, though participation rates vary dramatically from zero to over 95% of students. While there is at least some dual enrollment in most schools across the state, there is limited knowledge about variation in access and participation across schools.

Purpose

This work examines the full picture of DE participation across California and the extent to which students have access to college-credit courses while in high school as measured by attending schools with various participation rates. This study extends prior research, as it investigates the patterns of community college course-taking by the census of high school students in California, both independently and through formalized dual enrollment programs, and explores patterns in participation rates across all public high schools and community colleges in the state. This work is guided by the following questions:

- What are the state-wide patterns of dual enrollment participation at the school level?
- How does dual enrollment participation vary by school characteristics?
- How does access to schools with varying levels of dual enrollment participation vary by student subgroups?

Literature Review

Extant work on dual enrollment emphasizes formally structured school-wide programming via early and middle college high schools (Berger et al. 2014; Edmunds et al., 2017) or explicit partnerships across K-12 districts and postsecondary sectors (Giani, Alexander, & Reyes, 2014). The strongest causal evidence for DE comes from randomized controlled trials at Early College High Schools (Berger et al., 2014, Edmunds et al., 2017). Three additional studies using quasi-experimental approaches, in particular propensity score matching, meet the What Works Clearinghouse group design standards for research, suggesting these provide high quality evidence about dual enrollment (An, 2013; Giani, Alexander, & Reyes, 2014; Struhl & Vargas, 2012). However, these studies generally use data from the late nineties and early 2000s and have also typically drawn on a limited sample of students. (The total number of students

included across all five studies is 77,249.) An (2013) uses nationally representative data from 1988-2000, Giani, Alexander, and Reyes (2014) follow 9th graders in Texas from 2001-01 through 2009-10, and Struhl and Vargas use data on Texas students who graduated high school in 2004 and are followed through 2011.

Broadly, these studies find that dual enrollment leads to a host of postsecondary outcomes, including increased likelihood of college degree attainment, college enrollment, credit accumulation, high school completion, persistence, and being college ready. Dual enrollment programs use rigorous course taking and college prep environments to prepare students for college both socially and academically, while also giving students a head start on earning college credits. However, there is limited rigorous evidence to suggest these benefits of Early or Middle College High Schools (EMCHS) extend to any or all forms of dual enrollment. In Giani, Alexander, and Reyes' study, dual enrollment occurs in the context of district to postsecondary institution partnerships. These partnerships likely provide a more formalized structure than independent dual enrollment but may not be as organized or supportive as Early or Middle College High Schools (2014). Therefore, the type of school, as well as the mission and instructional model of a school, likely play an important role in students' participation in and benefits from dual enrollment.

The relevance of school settings is important given the prevalence of independent dual enrollment in California. A recent report from the Public Policy Institute of California (Rodriguez & Gao, 2021) describes dual enrollment patterns across these contexts. The authors identified 112,000 special admit students in community college enrollment data that belong to the 2019-2020 graduating class who participated in dual enrollment (defined as taking college courses in high school in this context). Of those 112,000 DE students, 11% participated in dual

enrollment via College and Career Access Pathways (CCAP), 9% via Early College High Schools, and 10% via Middle College High Schools. Therefore, only 40% of dual enrollment participation (for the 2019-2020 graduating class) in California occurs through formally organized programs (Early or Middle College High Schools, or CCAP agreements) while 60% occurs outside of these school settings (either students taking dual enrollment independently or in other partnerships (Rodriguez & Gao, 2021).

Recent research indicates that although participation in college-credit coursework while in high school is steadily increasing in California, access to these opportunities is highly unequal, with much lower participation rates among historically underserved students and schools (Kurlaender, Reed, Grosz, Mathias, & Hughes, 2021; Rodriguez & Gao, 2021; Wheelhouse, 2020). In fact, while over a four-year period participation in dual enrollment for all students grew, with the class of 2018-19 seeing an increase in participation rates by seven percentage points (18.2%) compared to the class of 2015-16 (11.3%) (Wheelhouse, 2020), gaps in these rates between students from different racial/ethnic subgroups have not changed. Even with the near doubling of participation by Black and Latinx students, their rates still lag behind their Asian peers by 10 percentage points (Wheelhouse, 2020). Moreover, only 16.3% of socioeconomically disadvantaged students and 10% of English Learners participated in community college courses in 2018-19 (Wheelhouse, 2020). Despite these historic trends, forthcoming research suggests that formal dual enrollment (DE) programs are leading to more equitable participation rates for Black and Latinx students and closing gaps by race/ethnicity (Kurlaender et al., 2021; Rodriguez & Gao, 2021).

Theoretical Framework & Significance

Improving Student Outcomes

Dual enrollment is one of a range of interventions to improve postsecondary attainment. Dual enrollment broadly is an educational intervention that utilizes rigorous coursework (similar to advanced, college-prep, AP, etc. work) in addition to a unique context or space (on a college campus or select high school classrooms) to both educate students at a high level and socialize them to a college setting where they can build an identity as a college student with a sense of belonging to college spaces. Rigorous coursework operates through a variety of mechanisms to improve academic outcomes including peer effects, improved teacher quality, and signaling (Long, Conger, and Iatarola, 2012). These mechanisms are theorized to improve secondary and postsecondary attainment and achievement (Giani, Alexander, Reyes, 2014). Additionally, school-wide dual enrollment programs (i.e., EMCHSs) add additional supports like wrap around counseling from counselors specializing in local dual enrollment processes, and other specialists with particular experience, for example in bridging entitlement programs especially for Els & SWDs from K12 to postsecondary settings (Rodriguez & Gao, 2021; Hughes, Rodriguez, Edwards, Belfield, 2012). A school-wide emphasis on dual enrollment may enhance the impacts of dual enrollment by creating a culture of high expectations and rigorous work and providing broader access to a unique set of peers that may, for example, be more college focused or motivated. It is also likely to be key in addressing equity gaps in participation by providing the appropriate support for students without the resources or sociocultural capital to navigate college enrollment independently (Kurlaender, Reed, Grosz, et al., 2021).

Patterns of Enrollment

I define several typologies of student dual enrollment participation: *independent DE*,

semi-organized DE and *formal school-wide DE*. *Independent DE* (sometimes called informal or one-offs) occurs at a student level by definition, as it is characterized by student behavior that is independent of school-level policy or organization. *Semi-organized DE* and *formal school-wide DE* are characterized by school-level policies and practices.

Independent Dual Enrollment

I characterize *Independent dual enrollment* as that which generally occurs among students from highly resourced and traditionally high achieving groups with access to high levels of social and cultural capital and school and familial support. According to Castro & Collins (2018), most students participating in dual enrollment are doing so independently, and they are more likely to be high achieving and from families with high levels of educational attainment income. In this case, students may have developed stronger academic skills from prior schooling or received additional supports and encouragement from those in their social networks, such as families or teachers. These students use dual enrollment in the context of increased competition at selective institutions which has resulted in greater pursuit of rigorous coursework (Bound, Hershbein, & Long, 2009). They are likely college-bound before engaging with dual enrollment and take college classes to gain more advanced preparation, fill a particular requirement, or accumulate credits. They may be utilizing dual enrollment strategically in a similar pattern to 'double-dipping' students at 4-year institutions who supplement their coursework with classes at a community college (McCormick, 2003)[6]. They are less likely to utilize dual enrollment to

[6] Many students take community college coursework while they are simultaneously enrolled at a four-year college. Students' enrollment may be characterized as *supplemental*, where enrollment is used to accelerate program completion, reduce expenses at lower cost institutions, or make up credits (i.e., incomplete or failed classes), or *strategic*, where their enrollment in community college courses is used to avoid low grades in difficult courses at their four-year institution (McCormick, 2003). These strategies can have substantial impact; for instance, McCormick (2003) finds that students who 'double-dip' (i.e., take courses at outside institutions without transferring from their four-year college) are 10 percentage points more likely to graduate within four years than their peers who do not utilize this strategy. If highly resourced students are using dual enrollment in high schools in a similar pattern to supplemental or strategic enrollment, it is likely to compound equity gaps.

fulfill high school requirements and may not even report to their high school that they are taking community college courses. This *independent* pattern is the dominant form of dual enrollment.

Formal School-Wide Dual Enrollment

Formal school-wide dual enrollment is that which occurs at schools that are Early or Middle College High Schools, that have College and Career Access Pathways (CCAP) agreements, or high-school only dual enrollment as defined in Kurlaender et al., (2021). These schools are likely to serve populations specifically targeted in AB 288 i.e., students that were not typically college bound (Kurlaender, Reed, Grosz et al, 2021). These settings tend to provide more equitable access to dual enrolment. For example, high-school only courses almost no gap in participation rates by race (Kurlaender et al., 2021), CCAP programs have equitable representation of Latino students, but underrepresentation of Black students, and EMCHSs have equitable representation of Black students but underrepresentation of Latino students (Rodriguez & Gao, 2021). Importantly, Black and Latinx students complete more substantially more units and more transferrable units in formal school-wide dual enrollment environments.

CCAP agreements are novel (only implemented starting in 2016), and specific to the California accountability system, which emphasizes multiple pathways to career and college readiness. From the differences in course-taking across these school types, it appears that there may be substantive differences between EMCHSs and CCAP schools. CCAP students are much more likely to be in career education and complete fewer credits, they also attend four-year colleges at much lower rates and two-year colleges at much higher rates than EMCHS students (Rodriguez & Gao, 2021).

Semi-Organized Dual Enrollment

Semi-organized dual enrollment is that which occurs in a school with high rates of dual enrollment participation but not in a formal school-wide dual enrollment environment (Early or Middle College High Schools or schools with CCAP agreements). *Semi-organized dual enrollment* can take several forms, particularly career and technical education focused, or more similar to either formal or independent dual enrollment. It is possible that well-resourced high performing schools have high rates of *independent dual enrollment* participation that reach a level that give the appearance of a school-wide effort, especially in consideration of the demographic characteristics of the population of students that attend such schools. Alternatively, these schools may be pursuing dual enrollment in the spirit of EMCHSs, or as a part of other pathways, particularly career and technical education (CTE), though without a formal CCAP agreement. About 20% of all dual enrollment coursework occurs in career education, while 30% of CCAP courses and 25% of informal and semi-organized dual enrollment ('other dual enrollment courses') courses occur in career education (Rodriguez & Gao, 2021). *Semi-organized schools* with high rates of CTE participation are likely to be distinct from college-prep programs similar to EMCHSs, and may constitute an additional dual enrollment typology reflecting the context of California's focus on articulated career programs leading to postsecondary certificates. This expansion is being pursued via a number of programs including the Strong Workforce Program, California Career Pathways Trust, and the CTE Incentive Grant Program. Following these programs over time and collecting detailed data should yield more insight to the various typologies of dual enrollment programs, and thus an understanding of the mechanisms and effects of such programs for various subgroups of students. *Semi-organized* schools could be distinguished by the share of students participating in dual enrollment overall,

in both dual enrollment and CTE, as well as by the type of coursework (by subject and transferability) and the share that are using dual enrollment for high school credit.

The Role of Schools in Decision Making

Economic theory suggests that students select optimal courses, which limits the benefits of rigorous course-taking programs, such as dual enrollment, to students self-selecting into such programs. Those students are also likely to have other (potentially unobservable) personal characteristics that impact their likelihood of academic achievement, such as cultural expectations or familial college goals. Students independently accessing college coursework in high school (i.e., without school support), are likely to have very different social and cultural capital to navigate college systems and dual enrollment programs. Rational choice theory has also been deeply criticized in education as self-selection and choice occurs in a constrained context colored by inequality, as schools may be structurally constrained in their ability to provide rigorous course options (Kurlaender & Hibel, 2018) or the appropriate supports for particular groups. Furthermore, structural and institutional factors directly affect a student's choice to pursue opportunities like dual enrollment, such as access to information, school advising, school culture, and expectations, among others.

I theorize that school-level features are essential to the success of at-promise and underrepresented students. For example, successful dual enrollment programs are likely to have a culture of college-going behavior, high expectations for all students, counselors that understand dual enrollment processes, and specialized supports for particular groups, such as students with disabilities (Hooker, Finn, Nino, & Rice, 2021). Therefore, understanding dual enrollment patterns and disparities requires a detailed analysis of access to particular schools and the characteristics of such schools. Given the potential inequalities that bound access to rigorous

college preparatory experiences and its ability to influence students' trajectories, it is critical to consider the ways in which schools can more equitably expand access to opportunities to support college-going, such as dual enrollment.

Policy Context

In recent years, California has taken several steps to increase dual enrollment participation and access and remove earlier legislative barriers. In 2015, AB 288 was enacted to authorize community colleges and K-12 districts to develop formal partnerships via Career and College Access Pathways agreements. These partnerships were intended to increase access to dual enrollment, particularly for students from underrepresented groups, whereas prior programs limited dual enrollment access to students who were considered to be 'college ready' and restricted the number of courses students could take (Kurlaender et al., 2021). AB 30 (2019) extended authorization for CCAP agreements, while AB 413 (2019) identified Middle College High Schools to serve at-promise youth at schools on community college campuses and utilize career education and college preparatory curriculum (Rodriguez & Gao, 2021). These formalized opportunities provide a school-level organizational structure to support and facilitate dual enrollment, compared to informal dual enrollment, where individual students access college opportunities independently of school-support.

Data & Methodology

This work utilizes data from the California Department of Education's (CDE) California Longitudinal Pupil Achievement Data System (CALPADS) and Community College Chancellor's Office (CCCCO). The analytical sample was created by merging: (1) information from the CCCCO on high school students enrolled in community college courses, and (2) student-level data from CDE for four cohorts of California high school seniors (students

expected to graduate 2015-2016, 2016-2017, 2017-2018, and 2018-2019). In particular, I utilize data from the College/Career Readiness Indicator (CCI) cohort files. Nearly all of the results presented are for the 2018-2019 cohort of students, which includes 1,987 schools and 395,885 students. I also include all schools available within our sample, and do not limit schools to those with a minimum number of students in the cohort as in Kurlaender, Reed, Grosz, Mathias, & Hughes (2021). Additionally, I reviewed school names and websites for the 30 schools with the highest levels of dual enrollment participation to identify Early and Middle College High Schools (EMCHS).

Presently, California lacks a statewide longitudinal data system that crosses education sectors and thus unique student identifiers to connect students from K-12 to postsecondary data systems are unavailable. Therefore, I match students by unique non-missing name and birthdate data.[7] I identify dual enrollment participants as those enrolling in any credits prior to the summer of their expected graduation. Notably, by merging these data, I am able to specifically describe differences in participation rates by students (e.g., race/ethnicity, socioeconomic disadvantage, among others) and schools, including location (e.g., county, urbanicity), type (e.g., traditional, alternative, charter), and key characteristics (e.g., enrollment size, racial composition) for the population of California students. This analysis uses demographic measures from CALPADS CCI cohort files, which indicate membership to groups while in high school, i.e., English Learners are those students who are currently ELs in high school, not students that were ever Els and reclassified.

[7] I am able to do this match as a result of research partnership agreements between the University of California, Davis (Michal Kurlaender, PI) and the California Community Colleges Chancellor's Office and the California Department of Education, respectively.

I also define additional subgroups underreported in educational research: Black, Indigenous, and people of color and students from special populations. I include Black, Latinx, Filipino, Native American or Alaskan, Native Hawaiian or Pacific Islander, and students of two or more races in Black, Indigenous, and people of color. Students in special populations are defined as any student in at least one of the following categories: students with disabilities, English learners, foster youth, and students experiencing homelessness. The definition of special populations mirrors work from Hooker, Finn, Nino, and Rice (2021). Importantly, I also consider students in the intersection of these two groups.

To understand more about how the opportunity to participate in college courses is distributed across schools for particular subgroups in California, I categorize schools into one of five bins – described in Table 1 – based on overall dual enrollment participation rates, and define six categories of dual enrollment participation (no DE, low, below average, average, above average, and high). The number of students and schools in each category is listed in the table below. Figure 1 shows schools and students in each category as a percent of their respective groups. To understand differences in patterns of dual enrollment opportunity I calculate the

share of students in particular sub-groups or types of schools that attend a school in each of the six categories.

Table 1

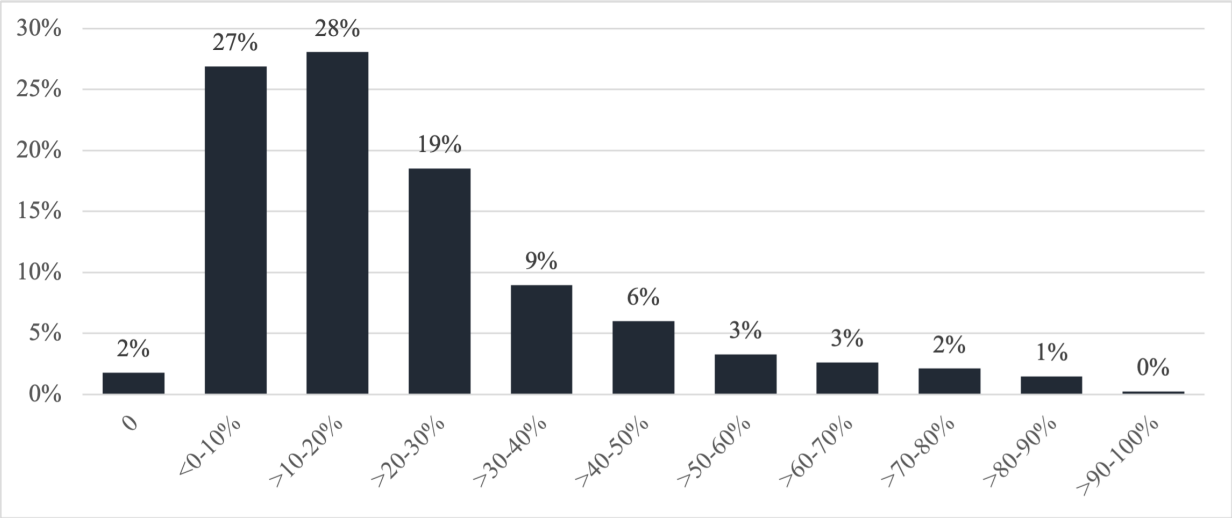
Schools and Cohort Students (N) by Dual Enrollment Participation Rates, 2018-19 Cohort

DE Participation Category	DE Participation Rate	Schools (N)	Students (N)
No DE participation	0	319	2,148
Low DE participation	0 to <6%	234	71,122
Below Average DE participation	6% to <12%	301	90,256

Average DE participation	12% to <18%	282	80,566
Above Average DE participation	18% to <30%	398	88,349
High DE participation	> 30%	453	63,444

Figure 1a

Distribution of Schools by Dual Enrollment Participation Rates, 2018-19 Cohort



Results

Figure 1a depicts the distribution of schools (N = 1,987) in the 2018-19 cohort by dual enrollment participation rates. In total, students from 1,668 schools took community college courses during high school, while in 319 schools (16%), no graduates from the same cohort participated in dual enrollment (Figure 1)[8]. While over 300 schools have no students participating in dual enrollment, these schools serve a very small proportion (0.5%) of the statewide cohort.

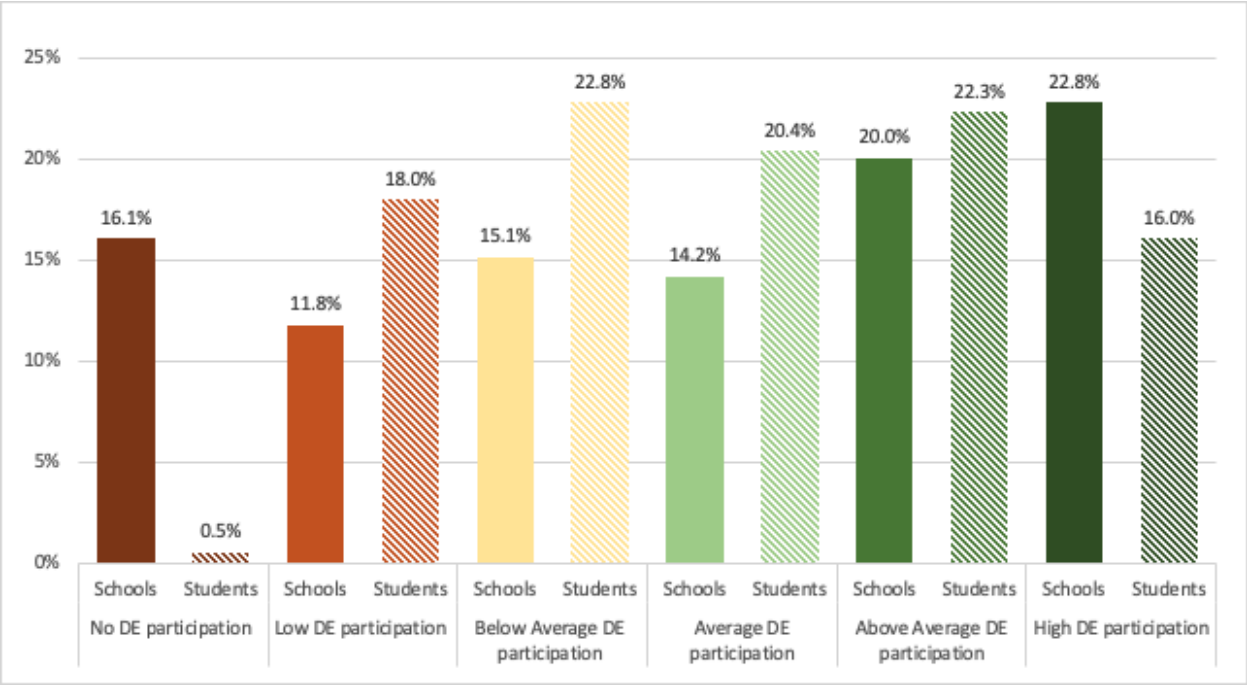
[8] Note that this contrasts sharply with Rodriguez & Gao's 2021 finding that only 36% of students in the 2018-19 cohort attend a school with dual enrollment, however this analysis uses student-level matching across K12 and community college data without relying on the special admit indicator.

Figure 1b depicts the distribution of both schools (N = 1,987) and students (N = 395,885) by participation categories. More than a quarter of schools (27%) have low (>0-6%) or below average (>6 to 15%) rates of dual enrollment participation, and these schools serve 41% of students. Additionally, 14% of high schools in California have average dual enrollment participation (ranging from 12% to 18% participation rates); in this case, these schools serve 20% of the students in the 2018-19 cohort. (Note that the mean dual enrollment participation rate for the cohort is 18%, but the median is 14%, as the distribution is right-skewed by schools with very high participation rates.)

Just over 40% of the state's high schools, serving 38% of the cohort students, demonstrate dual enrollment rates above the statewide average (>18%). Few schools demonstrate universal (or near universal) participation. Nearly a quarter (n=453) of schools have high (>30%) dual enrollment rates, though only 16% of students in the cohort attend these schools. Differences in the tails of the distribution of students and the distribution of schools are driven by small schools, where a few students participating in dual enrollment can have large effects on the school-wide dual enrollment participation rate.

Figure 1b

Distribution of Schools and Students by School-Level Dual Enrollment Participation Rates, 2018-19 Cohort



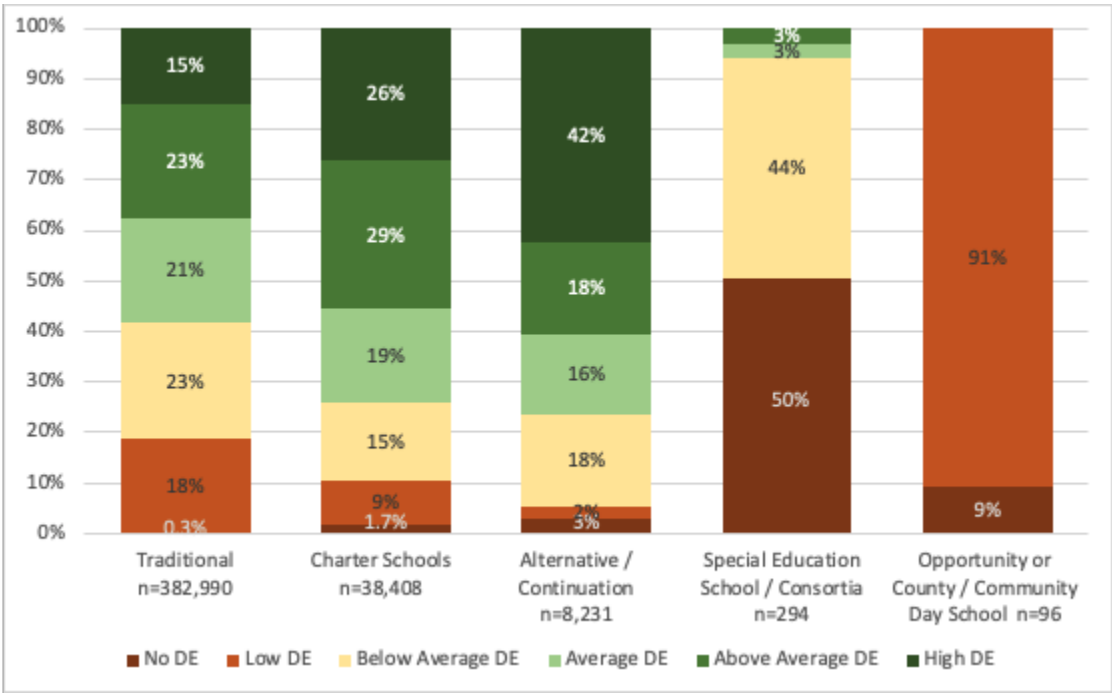
School Type

Non-traditional and charter schools have unique patterns of enrollment relative to traditional and non-charter schools. There are high rates of dual enrollment participation in schools considered by CDE to be alternative or continuation schools, often serving students who struggle in the traditional school environment or in need of credit recovery. In Figure 2, 60% of students in alternative and continuation schools in California (n=294 students) attend schools with high or above average dual enrollment participation.

Additionally, there are high rates of participation in ECHS and MCHS. Of the 30 schools with dual enrollment participation rates between 80-95%, at least 23 of 30 schools are Early or Middle College High Schools (based on the school name or a brief review of the school's website).

Figure 2

Dual Enrollment Participation by School Type



Note. For the remainder of this paper I present a series of stacked bar graphs by subgroups of students or school-types, at the student level. For example, the first column of Figure 2 shows the distribution of students in traditional schools (n=382,990), where 15% of students attend a school with a high DE participation rate, 23% of students attend a school with an above average participation rate, 21% of students attend a school with an average DE participation rate, and so on. In the second column, 26% of students that attend charter schools attend a school that has a high DE participation rate and in the third column, 42% of students attending alternative or continuation schools attend a school that has a high DE participation rate.

A closer look at schools without dual enrollment

The 319 high schools at which no students participate in dual enrollment are more likely to be located in rural areas and serve a particular population of students, with very high shares of students with disabilities (46%) and English learners (17%) and a unique racial composition, suggesting stark disparities in access to dual enrollment. They also have high rates of socioeconomic disadvantage, homelessness, and large shares of foster students. In this case, 58% of students in these schools belong to special populations (i.e., students with disabilities, English learners, homeless, and/or foster) compared to only 24% of students in the 2018-2019 cohort overall. Schools without dual enrollment typically serve twice as many Black students as the population average and half as many Asian students. Additionally, students in schools without dual enrollment participation are much more likely to live in rural communities (29% versus the state average of 6%); however urban students are overrepresented, while suburban students are very underrepresented. Schools without dual enrollment are also more likely to be special education schools or consortia, alternative or continuation schools, charter schools, and K-12 schools than traditional high schools. Interestingly, while charter and alternative and continuation schools are more likely to have no dual enrollment, they are much more likely than traditional schools to have very high levels of dual enrollment.

A closer look at schools with the highest rates of dual enrollment participation

There are 65 schools with DE participation rates between 70 and 95% and they serve a very small student population, with 4,572 students in the 2018-19 cohort attending these schools[9]. All schools in the top 65 have at least four students in the cohort and at least three

[9] Note that there are 12 additional LEAs with >95% participation, but they are very atypical. As most have only one or two students in the cohort and include five district offices of education and four closed schools, I ignore these in the examination of the top schools.

students in DE. Just over half (35) of these schools have 70-79% participation, and 30 schools have 80-95%. On average, these schools have 70 students in the cohort and 56 students in DE, which is small relative to the average of 252 cohort students per school. A significant number of these schools are alternative or continuation schools (17) versus 46 traditional schools, and 2 LEAs are district offices of education (Dublin Unified & Pleasanton Unified). Interestingly, of the 46 traditional schools, most (27) are charter schools. Most of these schools are urban (23) or suburban (21), while nine are rural, and six are town schools.[10]

School Locale[11]

Most of the 2018-19 cohort attend suburban or urban schools (n=342,276), with slightly more attending those in suburban areas. Urban students tend to have better access to schools with average or higher dual enrollment, with fewer students in low DE schools and more in the top three categories combined (Figure 3). This is likely due to the prevalence of community colleges in urban areas, where greater numbers of students are living in close proximity to at least one, if not several community colleges.

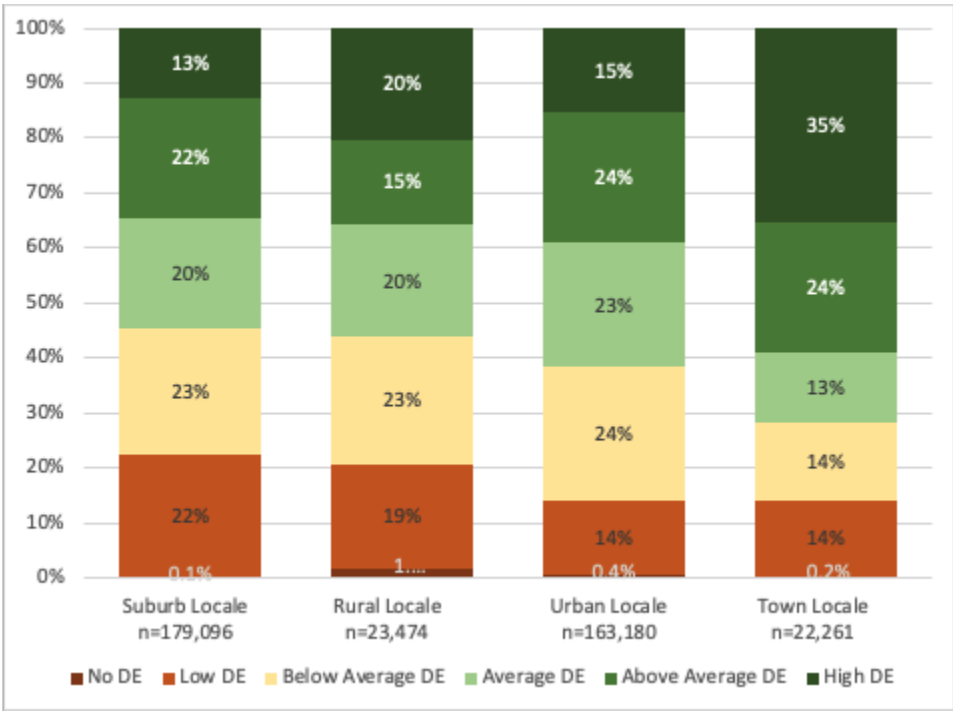
Students in towns (n=155 schools and n=22,261 students) have the best access to schools with high rates of DE participation, as more than a third of town students attend schools with high rates of formal dual enrollment. Rural students have more extreme patterns of access to dual enrollment. In this case students in rural areas are the most likely to attend schools with no overall dual enrollment, but students in rural schools still see greater DE participation opportunities at schools with high participation rates than suburban or urban students. This may

[10] These results do not reflect information from six schools, for which geographic locale data is missing.
[11] The locale of a district is defined by the National Center for Education Statistics at the Institute of Education Sciences, U.S. Department of Education. Locale is a measure of location based on data from the U.S. Census Bureau and is determined by population size and distance from an urban center.

be explained by some rural high schools and community colleges being co-located in a centralized location i.e., the county seat, while other high schools are in more isolated parts of their respective counties. Rural high schools with community colleges in close proximity may utilize dual enrollment in particular as a strategy to address staffing shortages for specialized courses or rigorous college-prep courses, e.g., schools struggling to hire calculus or AP teachers can offer access to similar instructional opportunity via dual enrollment with a nearby community college (Goldhaber, Strunk, Brown, Naito, & Wolff, 2020).

Figure 3

Dual Enrollment Participation by Geographic Locale



Student Characteristics

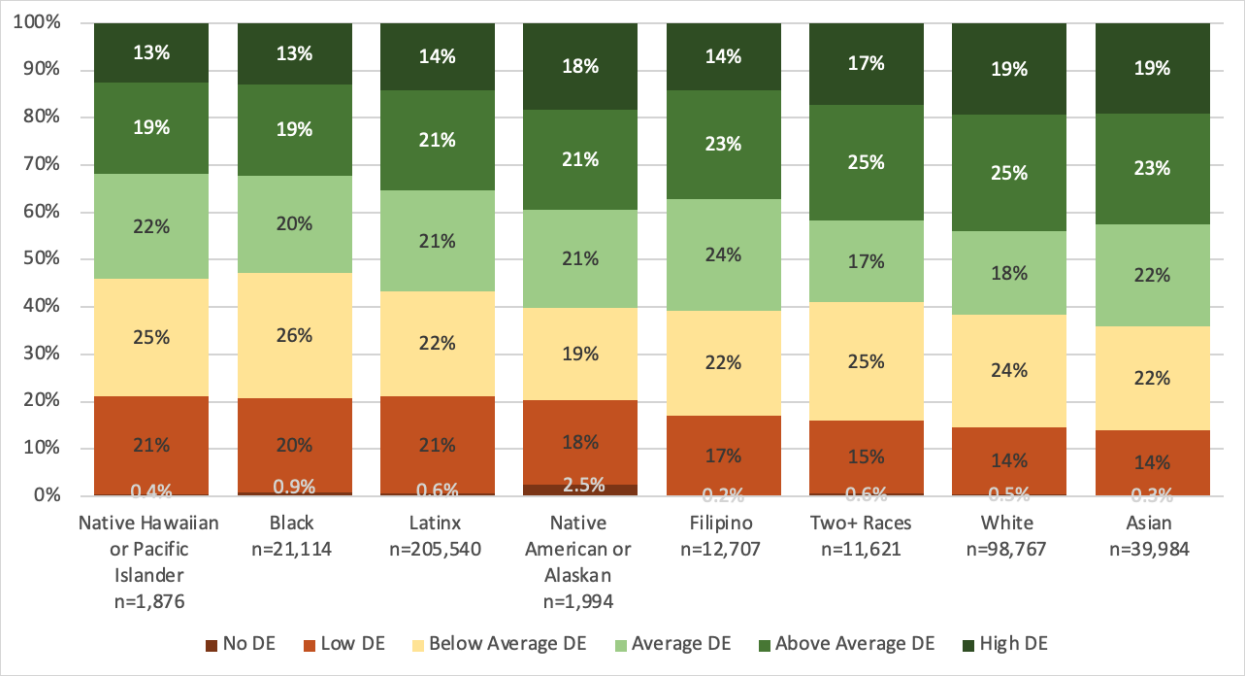
The varying rates of participation across schools suggests that access to dual enrollment opportunities is not universal. Figures 4, 5, and 6 illustrate the percent of students within each

subgroup that attend schools with varying levels of dual enrollment participation. Figure 7 explores dual enrollment opportunities for Black, Indigenous, and people of color jointly (Black, Latinx, Filipino, Native American or Alaskan, Native Hawaiian or Pacific Islander, and students of two or more races), special populations (defined as any student in at least one of the following categories: students with disabilities, English learners, foster youth, and homeless students), and the intersection of these two groups.

Figure 4 maps disparities in school-level dual enrollment participation categories by race and ethnicity. Asian and White students are most likely to attend schools with high rates of dual enrollment (19% of each population attends such schools) and least likely to attend schools with low rates of dual enrollment (14% of each population attends such schools). In contrast, Black and Native Hawaiian/Pacific Islander students are the least likely to attend schools with high DE participation (13% of each population attends such schools, a 6 percentage point gap from White and Asian students) and the most likely (with Latinx students as well) to attend schools with low rates of DE participation (about 20% of each population attends such schools, also a 6 percentage point gap from White and Asian students). Native American or Alaskan students are the most likely to attend schools with no dual enrollment opportunities, with 2.5% of the population attending such schools, which is substantially larger than the approximately 0.5% cohort average. Interestingly, Native American or Alaskan students are nearly as likely to attend schools with high dual enrollment participation rates (18%) as White and Asian students. This evidence indicates that students from historically marginalized subgroups attend schools with lower dual enrollment participation rates.

Figure 4

Dual Enrollment Participation in Schools by Racial Subgroup of Students



Similarly, as displayed in Figures 5 and 6, English learners, students with disabilities, socioeconomically disadvantaged (SED) students, homeless students, and foster youth are all both less likely to attend schools with high DE participation and are more likely to attend schools with low DE participation than peers that do not share these identities. There is a 5-percentage point gap between the share of English learners and the share of non-English Learners, and a 7-percentage point gap between SED and non-SED students that attend schools with low DE participation. Students with disabilities typically have similar access to DE opportunities as students without disabilities, except that they are particularly likely to attend schools with no dual enrollment relative to other subgroups. Additionally, foster students and students with disabilities are the most likely to attend schools with no dual enrollment, at 3.1% and 2.2%, respectively.

Figure 5

Dual Enrollment Participation in Schools for English Learners, Students with Disabilities, and by Socioeconomic Disadvantage

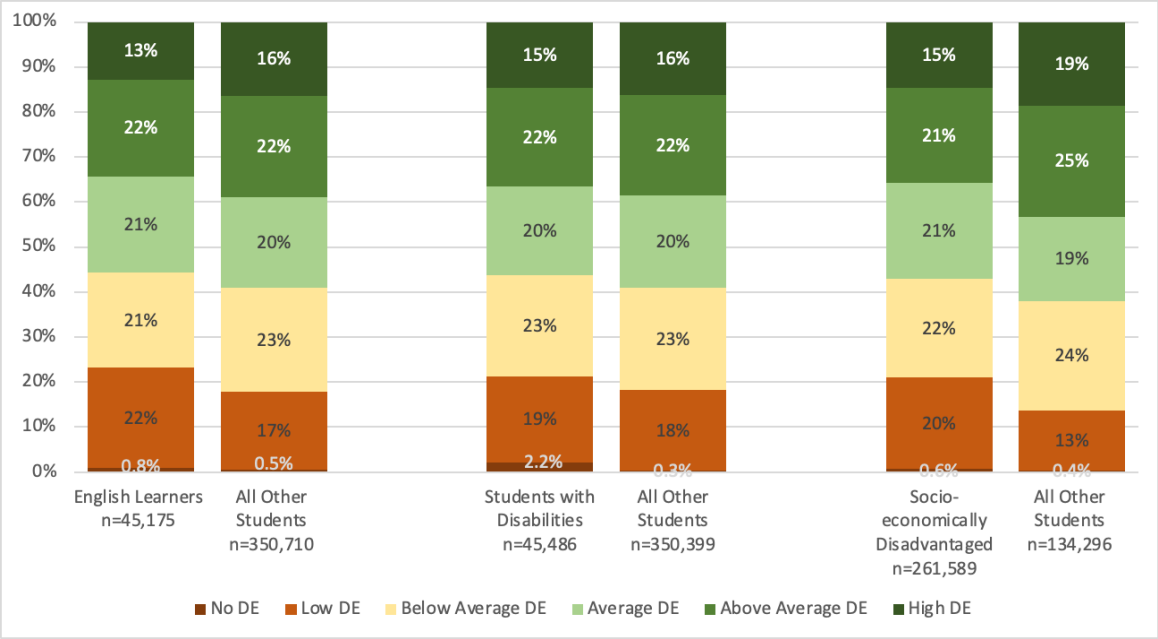
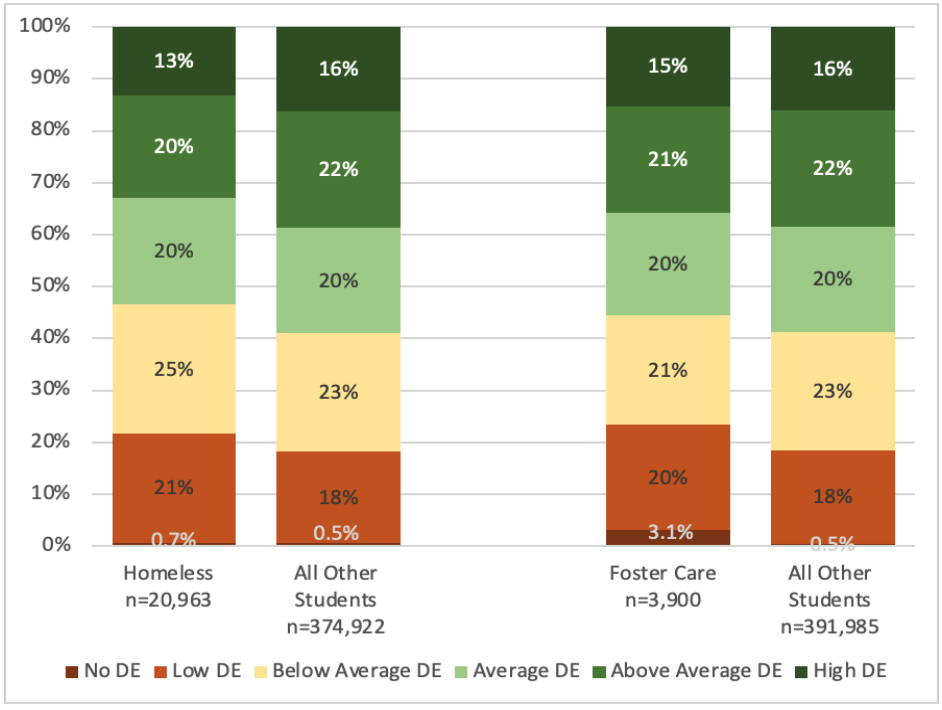


Figure 6

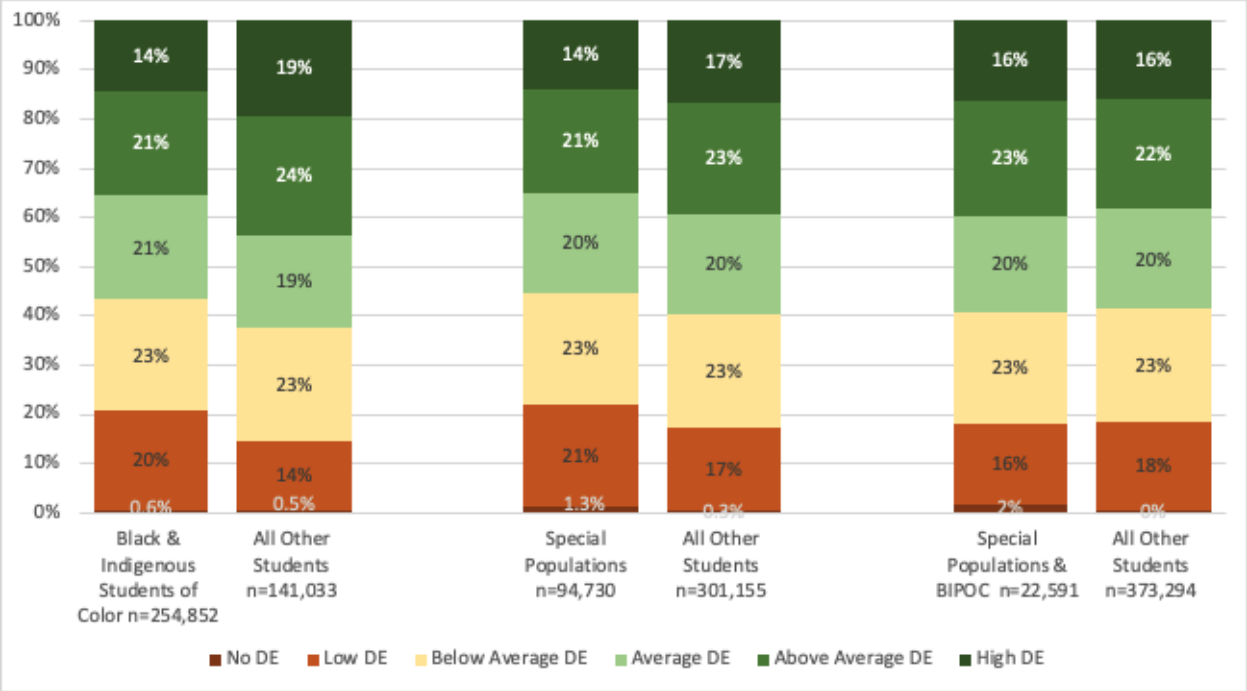
Dual Enrollment Participation for Homeless and Foster Youth



Students in special populations (students with disabilities, English learners, foster youth, and homeless students) as a whole are 3 percentage points less likely to attend high DE schools, and 4 percentage points more likely to attend low DE schools relative to other students (Figure 7). Black, Indigenous, and people of color (BIPOC) as a whole are 5 percentage points less likely to attend high DE schools, and 6 percentage points more likely to attend low DE schools relative to their White and Asian peers. Interestingly, when considering the intersection of these identities (students that are both members of a special populations group and Black, Indigenous, and people of color), I find close to parity with other students, except that this group is 2 percentage points more likely to attend schools with no dual enrollment.

Figure 7

Dual Enrollment Participation for Special Populations and Students of Color



Discussion & Conclusion

Dual enrollment participation rates vary substantially by the type of school students

attend. The findings for alternative or continuation and charter schools are promising, suggesting that dual enrollment is a feasible strategy for college and career readiness in smaller schools or specialized schools serving vulnerable populations. Although these schools serve a small proportion of high school graduates, their high dual enrollment participation rates may indicate concerted efforts to ensure that graduates obtain both a high school diploma and college experience, and possibly a leg up on a technical certificate or college degree, particularly in alternative or continuation schools.

It is surprising that school-level dual enrollment participation rates over 30% are considered high, suggesting that dual enrollment may be an underutilized strategy for improving college and career readiness. Even some early and middle college high schools have participation rates substantially below 100% (I identified some programs with rates as low as 72%), though nearly all of the schools with the highest levels of participation were early college and middle college high schools. This aligns with prior research on the importance of *formal school-wide dual enrollment* policies and practices in ensuring dual enrollment success (Berger et al. 2014; Edmunds et al., 2017).

Patterns of access by locality reveal both challenges and opportunities for schools. A large share of rural schools have high rates of dual enrollment participation, but a large share also have low rates. This suggests that some rural schools are close enough to a community college to utilize classes for dual enrollment, which could be a strategy to provide course offerings that are difficult to staff at rural schools (Goldhaber, Strunk, Brown, Naito, & Wolff, 2020). While students in rural schools are more likely than students in other localities to attend schools with no dual enrollment, that rate is still very low, suggesting that distance to community colleges is not an insurmountable hurdle for schools that are interested in building dual

enrollment programs. However, these results could be driven by highly resourced students with greater access to transportation engaging in *independent dual enrollment* in rural settings. Urban students are less likely to attend schools with high rates of dual enrollment participation, which is surprising given their general proximity to community colleges, though this could be driven by demographic differences in the urban student population associated with less *independent dual enrollment*. There may be opportunities for urban schools to better utilize community colleges for dual enrollment via CCAP agreements.

Across all student subgroups, I find disparities in access to schools with high rates of dual enrollment participation are most stark by race. This suggests that increasing the rate of participation in DE for students of color relies on building dual enrollment programs in the schools that they attend. I also find that students in special populations, both as a group and by sub-group, have more limited access to dual enrollment opportunities than other students. The finding that half of students in special education schools or consortia attend schools with no dual enrollment may explain higher rates of students with disabilities and more broadly, special populations attending schools without dual enrollment, though these schools represent a very small share (n=294) of students. Hooker et al. (2021) identify a number of school barriers to dual enrollment success for special populations (e.g., counseling and student services shortages, cultures of low expectations, and informational barriers). Moreover, a particular challenge for students with disabilities and English learners is differences in laws and policy regarding specialized services between K-12 and postsecondary institutions. These findings reiterate the importance of *formal school-wide dual enrollment*

These results have important implications for policymakers and educators seeking to improve college readiness and postsecondary outcomes. Specifically, emerging findings suggest

that formalized dual enrollment programs result in more equitable participation by student race/ethnicity and socioeconomic status (Kurlaender et. al, 2021). Moreover, findings indicate that while few schools have high participation rates, these schools tend to be small, specialized high schools. By exploring how participation varies, both among subgroups of students and across high schools and community colleges, I identify opportunities for growth in dual enrollment programs.

This paper investigated state-wide patterns of dual enrollment, including school participation, characteristics, and student demographics to determine whether the opportunity to participate in dual enrollment programs was equally available to all students. Using a unique sample of California high school students from four graduating classes, I found that dual enrollment participation varied considerably by school and student characteristics.

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III: A Foot in the Door: Growth in Participation and Equity in Dual Enrollment in California

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Introduction

Dual enrollment allows high school students to take college courses and earn college credits that can provide a valuable head start toward a college degree. The practice has multiple benefits for students in both systems, improving college preparation and increasing efficiency toward completion of degrees and certificates (Collins, Castro, Vargas, & Hooker, 2018). Many states -- including California -- have capitalized on these benefits by increasing high school student access to community college courses (Kelley & Rowland Woods, 2019), though not all students have benefited equally.

This brief builds on previous Wheelhouse research by providing a closer examination of dual enrollment growth in California. We present data about which students are participating in various types of dual enrollment in the California Community Colleges (CCC) – the primary provider of dual enrollment statewide. Matching the most recently available K-12 and CCC data, we also document how participation differs across high schools and course subjects pursued.

There is cause in our findings for optimism, in that one type of dual enrollment -- courses taught exclusively to high school students -- is growing and appears to be increasing equity in participation. However, dual enrollment opportunities remain scarce or non-existent for many students and largely depend on the high schools they attend.

- High school students represent an increasing share of community college enrollment; they are present in nearly 14% of all CCC courses.
- The number of community college courses that enroll only high school students has grown substantially -- representing nearly 5% of all courses with high school students participating -- in the past several years.

- Dual enrollment equity gaps among racial/ethnic subgroups are smaller in courses that enroll only high school students, and have narrowed over time, when compared to overall gaps in dual enrollment participation.
- Despite increases in dual enrollment in recent years, student opportunity to take community college courses often depends on the high school they attend.

Policy Context & Literature Review

California's Recent Path to Dual Enrollment

In California, state policy was at times considered a barrier to dual enrollment. Legislation in 2003 restricted student eligibility and participation, and applied rules on the conditions under which high schools and colleges could claim funding for dually enrolled students. An audit of the community college system that year left education institutions cautious about partnering to offer dual enrollment (Collins et al., 2018).

In 2016, the California State Legislature enacted Assembly Bill 288, the *College and Career Pathways Partnerships Act.* The law authorized community college districts to enter into a College and Career Access Pathways (CCAP) partnership with a school district for the purpose of creating or expanding dual enrollment, with an emphasis on "students who may not already be college bound or who are underrepresented in higher education, with the goal of developing seamless pathways from high school to community college for career technical education or preparation for transfer, improving high school graduation rates, or helping high school pupils achieve college and career readiness" (AB 288).

Previously, although many high school students enrolled in community colleges independently, participation was often limited to students with resources and knowledge about the benefits of getting a head start on college. AB 288 provided a framework through which

more structured opportunities for dual enrollment could be embedded in high school students' regular coursetaking. In particular, it created a path to offer community college courses exclusively to high school students, often delivered on high school campuses. This model facilitated access to an important means of college preparation and acceleration for more students, but particularly for those who may not have had the resources to seek these opportunities independently.

The Case for Dual Enrollment

Numerous studies have shown benefits for participants of dual enrollment relative to nonparticipants. These studies found that dual enrollees have higher rates of high school graduation, college enrollment, credit accumulation, persistence, and completion (Allen & Dagdar, 2012; An, 2013; Edmunds, Unlu, Glennie, Bernstein, Fesler, Furey, & Arshavsky, 2017; Giani, Alexander, & Reyes, 2014; Hughes, Rodriguez, Edwards, & Belfield, 2012; Struhl & Vargas, 2012; Taylor, 2015). The overall body of literature includes different methodological approaches and student samples. Five of these studies meet the most rigorous research design standards of the Institute for Education Sciences' What Works Clearinghouse (US Department of Education Institute of Education Sciences, 2017), providing greater assurance that the positive outcomes participants experience can be attributed to dual enrollment and not to other factors.

Given the acknowledged benefits of dual enrollment and its potential as a strategy to increase college access and attainment, broad availability and equitable access are essential. A recent Community College Research Center analysis of access to college credit opportunities across U.S. school districts, including those in California, found considerable inequity in access to dual enrollment in districts with larger proportions of Black and Latinx students (Xu, Solanki, & Fink, 2021).

In addition to access, it is important to ensure that all student groups are able to gain the full advantages of their dual enrollment experience. While one Texas study found positive benefits of dual enrollment on college degree attainment for all racial groups and students from low-income families, an Illinois study found smaller positive effects for students of color and low-income students. In the Illinois case, dual enrollment was not succeeding as a strategy to reduce equity gaps in college attainment (Struhl & Vargas, 2012; Taylor, 2015). A study of career-focused dual enrollment programs in California underscored the importance of providing both academic and nonacademic support to the underrepresented and low-income students the programs targeted (Hughes, Rodriguez, Edwards, & Belfield, 2012).

Prior Research on Participation in California

The California Community Colleges Chancellor's Office (CCCCO) recently reported that enrollment through CCAP agreements is increasing as a share of all dual enrollment. In 2016-17, 35 colleges had such agreements, but by 2019-20 that number increased to 52. A more recent PPIC report finds that 83 colleges offered dual enrollment as part of an established CCAP (California Community Colleges Chancellor's Office, 2021). The CCCCO estimates that in 2019-20, 37.5% of high school students concurrently enrolled in community college were participating via CCAP partnerships. But many questions remain regarding the implementation of CCAP agreements across the state and whether AB 288 is meeting its intended goal of increasing educational opportunities for historically underserved groups. The CCCCO report concludes that, thus far, Black and Latinx students comprise a higher share of CCAP versus non-CCAP dual enrollment, but Black students in particular are still underrepresented.

In a prior report, *A Leg Up on College*, we presented data showing that dual enrollment participation among California high school students was higher than commonly understood, and

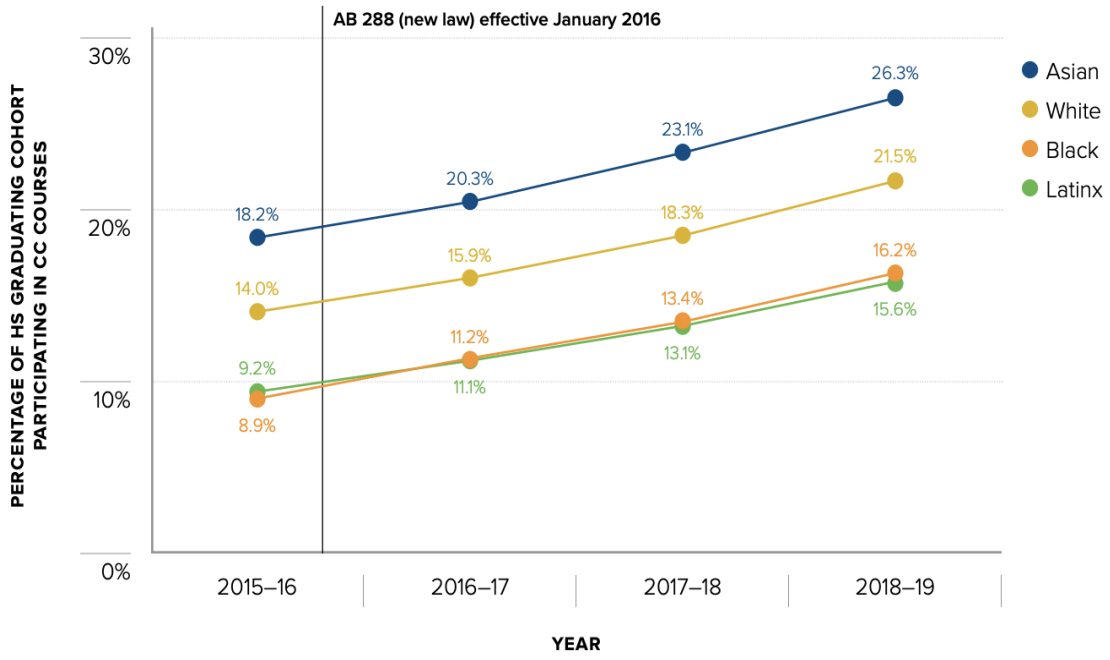
slightly higher than the national average. The overall rate, approximately 13% for the high school graduates of 2016-17, included enrollment in any community college course prior to high school graduation, whether through formal dual enrollment programs (such as CCAP or other partnership agreement) or standalone courses taken independently.

A subsequent analysis, *A Rising Tide*, provided updated data showing substantial recent growth in dual enrollment participation across student subgroups. The rate of community college participation among high school graduates increased dramatically from 11.3% for the 2015-16 cohort (pre-AB 288) to 18.2% for the 2018-19 cohort. This growth provides some evidence suggesting that AB 288 may be contributing to greater opportunity and participation.

However, while the growth is evident across all student groups, disparities in participation levels across different racial/ethnic and other subgroups persist. As shown in Figure 1, Asian and White students are more likely to take part in dual enrollment than Black or Latinx students.

Figure 1

Dual Enrollment Participation by Student Race/Ethnicity and Over Time

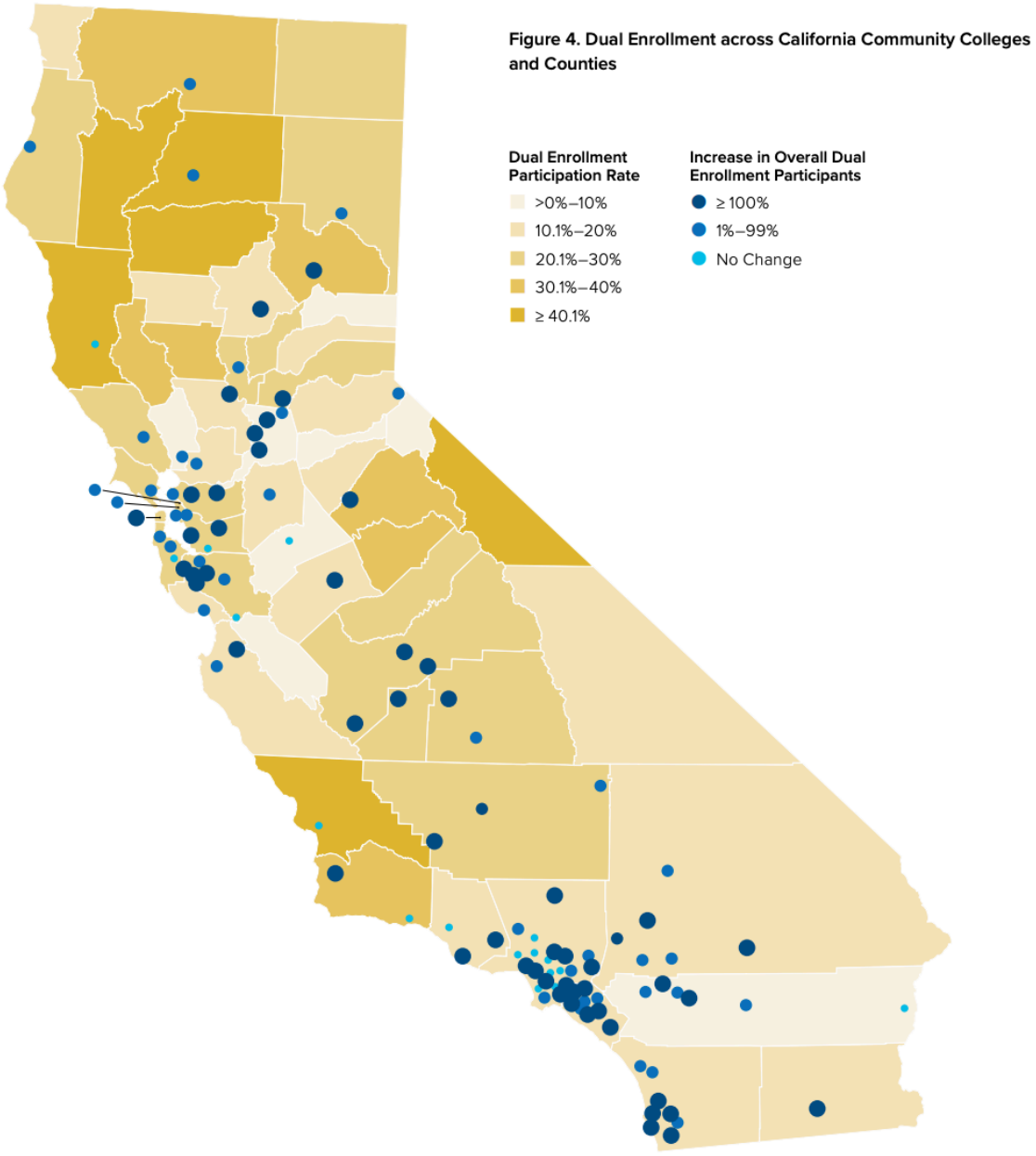


Note. Figure from *A Rising Tide* (2020). Statistics calculated by merging student-level College/Career Indicator (CCI) data from the CDE and special admit data from the CCCCO. Years limited to those for which CCI data was available.

With this growth, the dual enrollment population is shifting, and in some colleges and regions quite rapidly. Figure 2 shows a map of the state's community colleges highlighting the colleges with the largest changes in dual enrollment in recent years. The colleges represented by the largest markers more than doubled their dual enrollment population since 2016–17; colleges with the smallest markers experienced no change in dual enrollment participation in recent years. The shading on the map illustrates dual enrollment participation for the 2018–19 graduate cohort across California's 58 counties. While some counties have dual enrollment participation rates over 50% (e.g., Mendocino, Shasta, San Luis Obispo, Trinity), others show less than 10% of high school graduates participating.

Figure 2

Dual Enrollment Participation Across California Counties, 2018-19 Graduating Cohort



Note. Analysis of CCCCO administrative data merged to student-level K-12 data from CDE. Dual enrollment participation rates for each county represent Data reproduced from *A Rising*

Tide Appendix of County Level Stats (2021). Statistics calculated by merging student-level College/Career Indicator (CCI) data from the CDE and special admit data from the CCCCO.

Data, Methods and Limitations

This brief draws on data from two sources. First, we employed statewide student-level data from the California Department of Education's (CDE) College/Career Indicator (CCI) for the 2015-16 through the 2018-19 public high school graduating cohorts, focusing primarily on the most recent cohort. We limited our sample to students in the four-year cohort who entered a California public high school as 9th graders and were expected to graduate in four years. The CCI data include information on high school graduation and student demographic characteristics. Second, we used data from the CCCCO, which comprises the population of community college students, including high school students who are enrolled as "special admit" students. These data include information on course enrollments and fields of study, as well as credits attempted and earned.

This analysis is made possible by linking administrative data from these two education sectors, a rare opportunity given the absence of a statewide longitudinal data system. Specifically, we merged community college and K-12 data to examine high school students' college course taking patterns statewide. We linked these four high school cohorts to community college data that span the duration of students' four normative high school years. To identify different types of dual enrollment participation, we leveraged detailed student-level and course-level information to isolate the courses that had only high school "special admit" students enrolled; we refer to these as HS-Only courses. By contrast, when courses contained a mix of special admits and regular community college students, we categorized them as HS-CC Mixed.

Enrollment rates reported here may undercount the full population of dual enrollment students for several reasons. First, we limited the sample of high school students to those included in the four-year graduating cohort, excluding some students such as those who take longer to graduate. Second, our match between the CCI and community college data used unique and non-missing first and last names and date of birth in each dataset, resulting in the removal of some high school students and community college special admits with missing data points. In addition, the matched sample may differ from the full special admit population at the CCC because the full special admit population also includes students enrolled in private high schools or participating in homeschooling. We may also have missed some students if they were not accurately classified as special admits in the CCCCO data. Finally, it is important to note that while the bulk of dual enrollment in California happens through community colleges, some high school students may also enroll in courses at four-year institutions, such as at the California State University, and this enrollment is not captured in our analysis.

Results

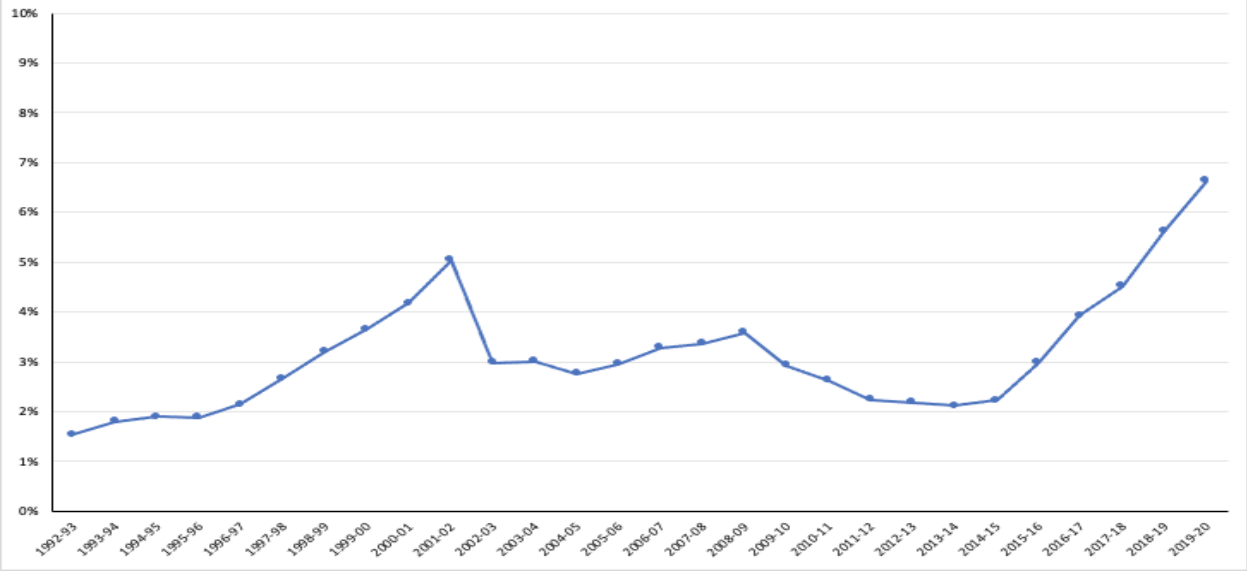
California Community Colleges Serve an Increasing Number of High School Students

Our match of K-12 and CCC data data allowed us to distinguish between two different types of dual enrollment participation: students enrolled in community college courses that only enroll high school students, and students enrolled in community college courses that include a mix of high school students and regular community college students. We examined changes in student participation by these enrollment types among different student subgroups to show which type of dual enrollment participation is growing, in which high schools and colleges, and for which students.

Since 2014, the percentage of special admit students in CCC has steadily and rapidly increased, becoming almost 7% of total CCC enrollment in the 2019-20 academic year (Figure 3). These students enrolled in many community college courses. In 2019-20, 13.7% of community college courses had at least one high school student enrolled. Considering the distribution of dual enrollment across community college courses (Figure 4), we note that approximately 2,600 courses (or 4.8% of all courses with high school students enrolled) have *only* high school students enrolled in them. It is these courses that we term "HS-Only" dual enrollment courses – those exclusively serving high school students.

Figure 3

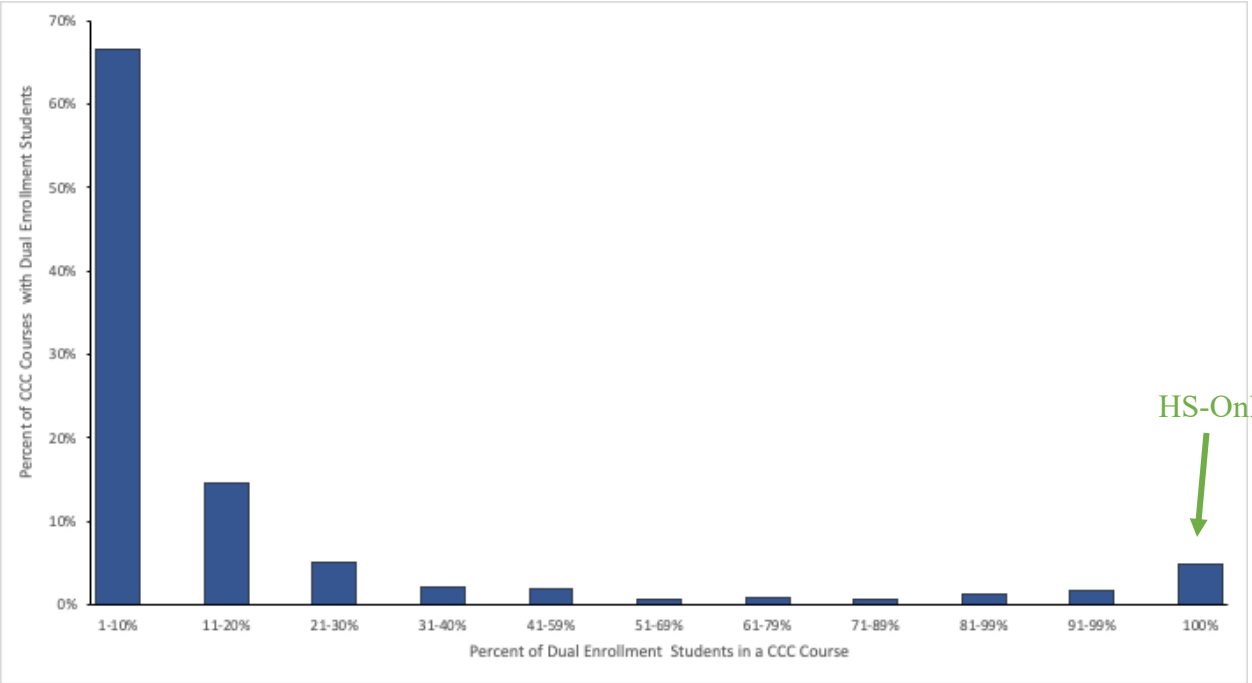
Percent of CCC Students Who Are Special Admits



Note. Data from CCCCO Datamart.

Figure 4

Percent of CCC Courses with Dual Enrollment Students, 2019-20



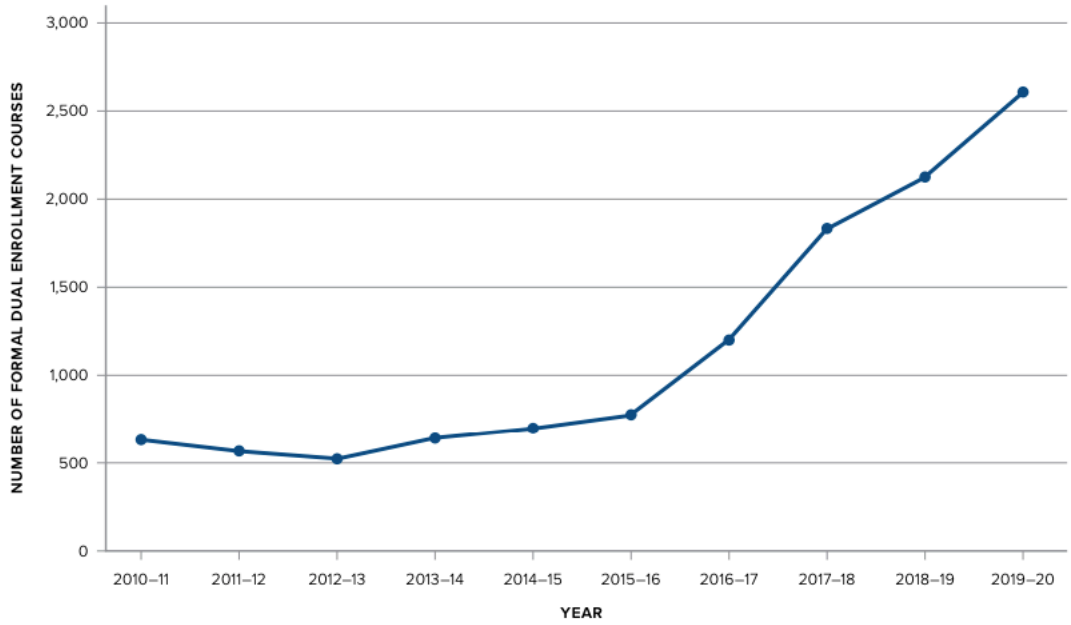
Note. Cross-sectional analysis of CCCCO administrative data based on special admits in the 2019-20 academic year.

A Growing Number of CCC Courses Enroll Only High School Students

Although a small share of all community college courses exclusively enroll high school students, these HS-Only dual enrollment courses have seen substantial growth over time. In 2010, there were 624 HS-Only dual enrollment courses across the CCCs; 10 years later, that number had more than quadrupled to 2,601 courses (Figure 5).

Figure 5

Dual Enrollment across California Community Colleges



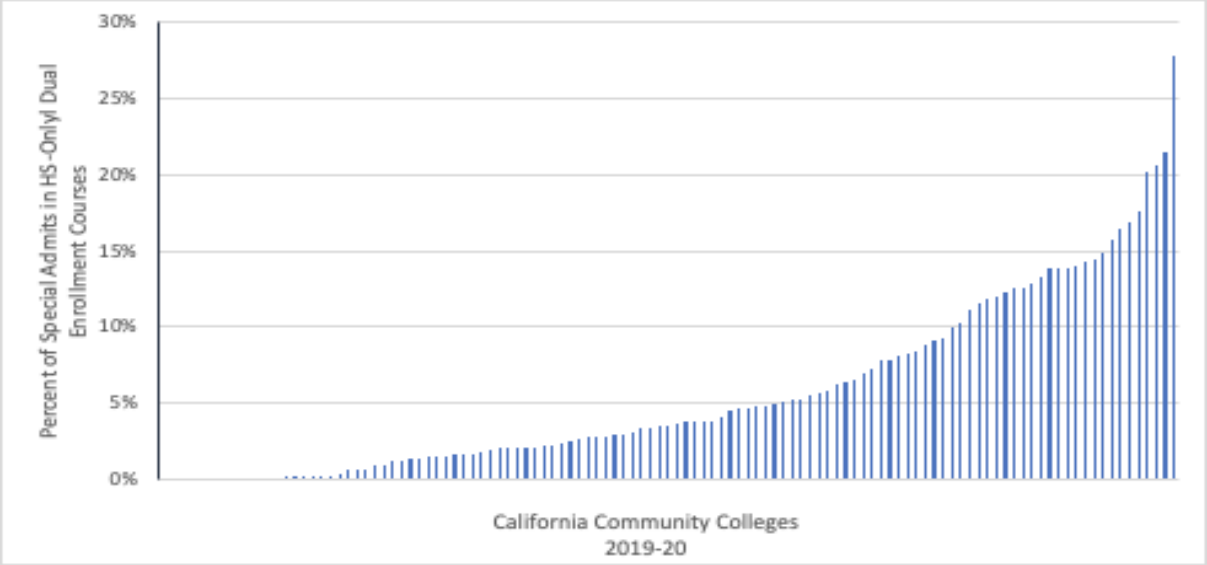
Note. Analysis of CCCCO administrative data merged to student-level K12 data from CDE between 2016-17 and 2019-20.

Participation in HS-Only dual enrollment is not evenly distributed across California's community colleges. There is considerable variation among the colleges in the share of the dual enrollment population in these HS-Only courses versus more typical HS-CC Mixed dual enrollment courses. Figure 6 displays the distribution of HS-Only community college enrollment as a share of overall dual enrollment across the state's colleges. There are four colleges where

HS-Only represents more than one-fifth of the total special admit enrollment. In contrast, there are 21 colleges with no HS-Only dual enrollment.

Figure 6

Percent of Special Admits Enrolled in HS-Only Dual Enrollment Courses, by College



Note. Cross-sectional analysis of CCCCO administrative data based on special admits in the 2019-20 academic year. Each bar represents a community college in California. Twenty-one colleges have no students enrolled in HS-Only courses.

High School Students Participate at Increasing Rates

High school students enroll in different types of dual enrollment classes. Figure 7 shows the combination of student enrollment types – students who enroll in HS-Only courses, students who enroll in HS-CC Mixed courses (meaning their dual enrollment takes place in classes that include community college students), and those who enroll in a combination of the two. We present these by raw numbers (Figure 7a) and by percent of dual enrollment participants in the cohort (Figure 7b). Several trends are worth noting. First, the number of students participating in dual enrollment is growing with each cohort, and significant growth is coming from participation in HS-Only courses (Figure 7a). The large majority (87.6%) of students from the high school

class of 2015-16 who took community college courses enrolled in community college courses that included a mix of high school students and regular community college students (Figure 7b). Yet, this type of enrollment is a decreasing share of dual enrollment overall. For the 2019-20 cohort, less than 75% of dual enrollment participants enrolled in this type of course. Increased proportions of students took a mix of types of dual enrollment or participated solely in HS-Only community college courses.

Figure 7a

Number of Students by Dual Enrollment Type, by Graduation Cohort

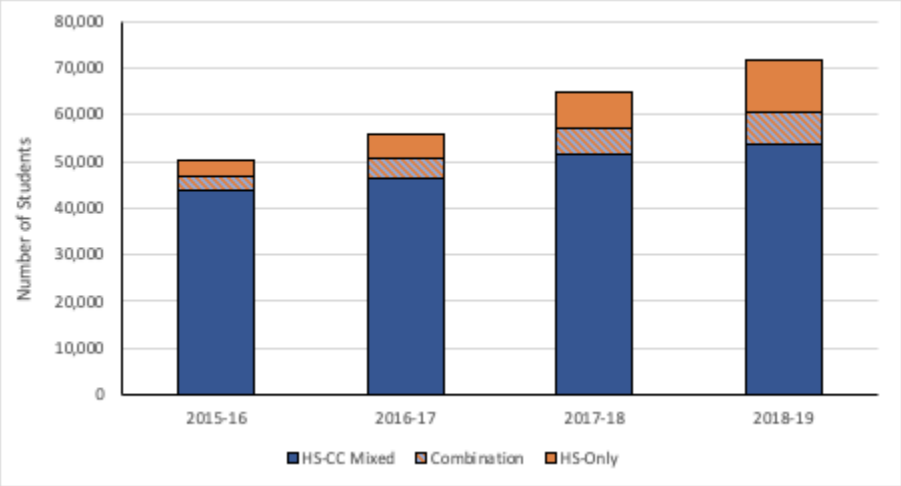
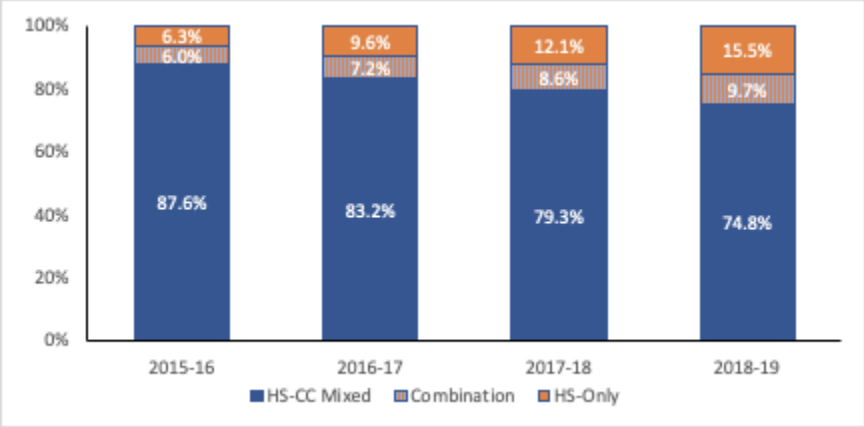


Figure 7b

Percent of Students by Dual Enrollment Type, by Graduation Cohort



Note. Cohort-level analysis conducted by merging student-level College/Career Indicator (CCI) data from the CDE and special admit data from the CCCCO. Each bar represents a public 4-year high school graduating cohort and their course-taking during the four normative years of high school. Cohorts limited to those in which CCI data was available.

Importantly, dual enrollment patterns vary substantially by racial/ethnic subgroups (Figure 8a & 8b). Far more Latinx students participate in dual enrollment than students in any other racial/ethnic subgroup, partly due to the fact that they make up the majority (52%) of the 2018-19 cohort. A larger share of Latinx dual enrollees (over 30%) participate in HS-Only courses or a combination of HS-Only and HS-CC Mixed courses, while the great majority of Asian (81%) and White (78%) dual enrollment participants enroll only in HS-CC Mixed courses. In fact, Latinx students have the highest participation rate in HS-Only courses at 18.6%. The rate of participation in HS-Only or a combination of HS-Only and HS-CC Mixed courses among Black students is higher than Asian or White students.

Figure 8a

Number of Racial/Ethnic Subgroup by Dual Enrollment Type, 2018-19 Cohort

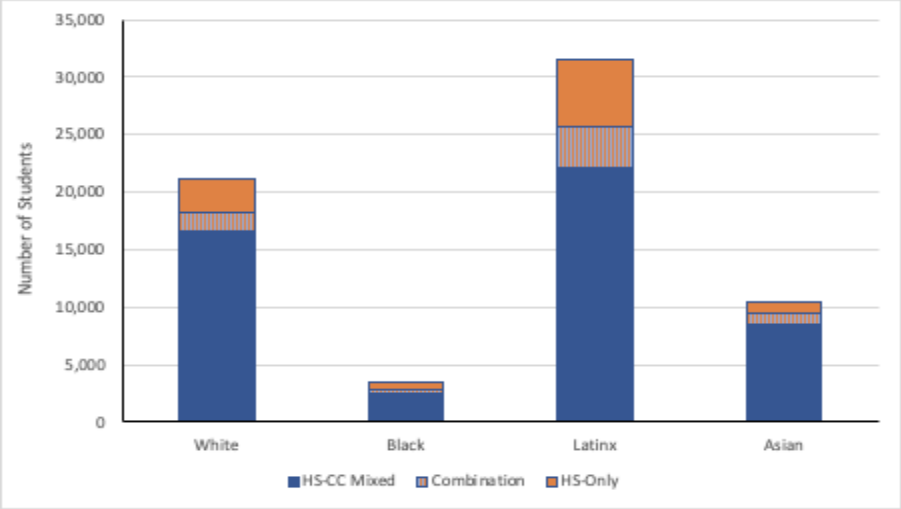
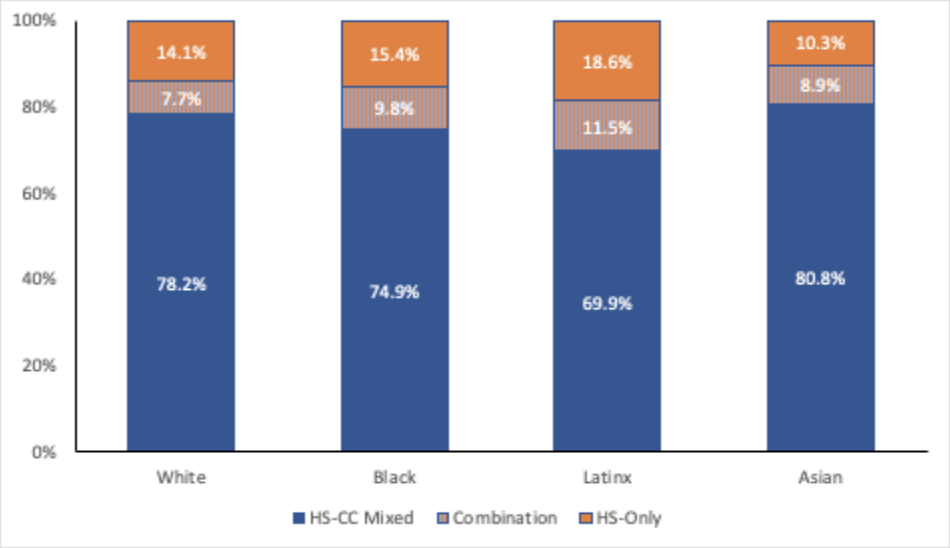


Figure 8b

Percent of Racial/Ethnic Subgroup by Dual Enrollment Type, 2018-19 Cohort



Note. Cohort-level analysis conducted by merging student-level College/Career Indicator (CCI) data from the CDE and special admit data from the CCCCO. Each bar represents a student subgroup from the 2018-19 public 4-year high school graduating cohort (the most recently available) and their course-taking during the four normative years of high school.

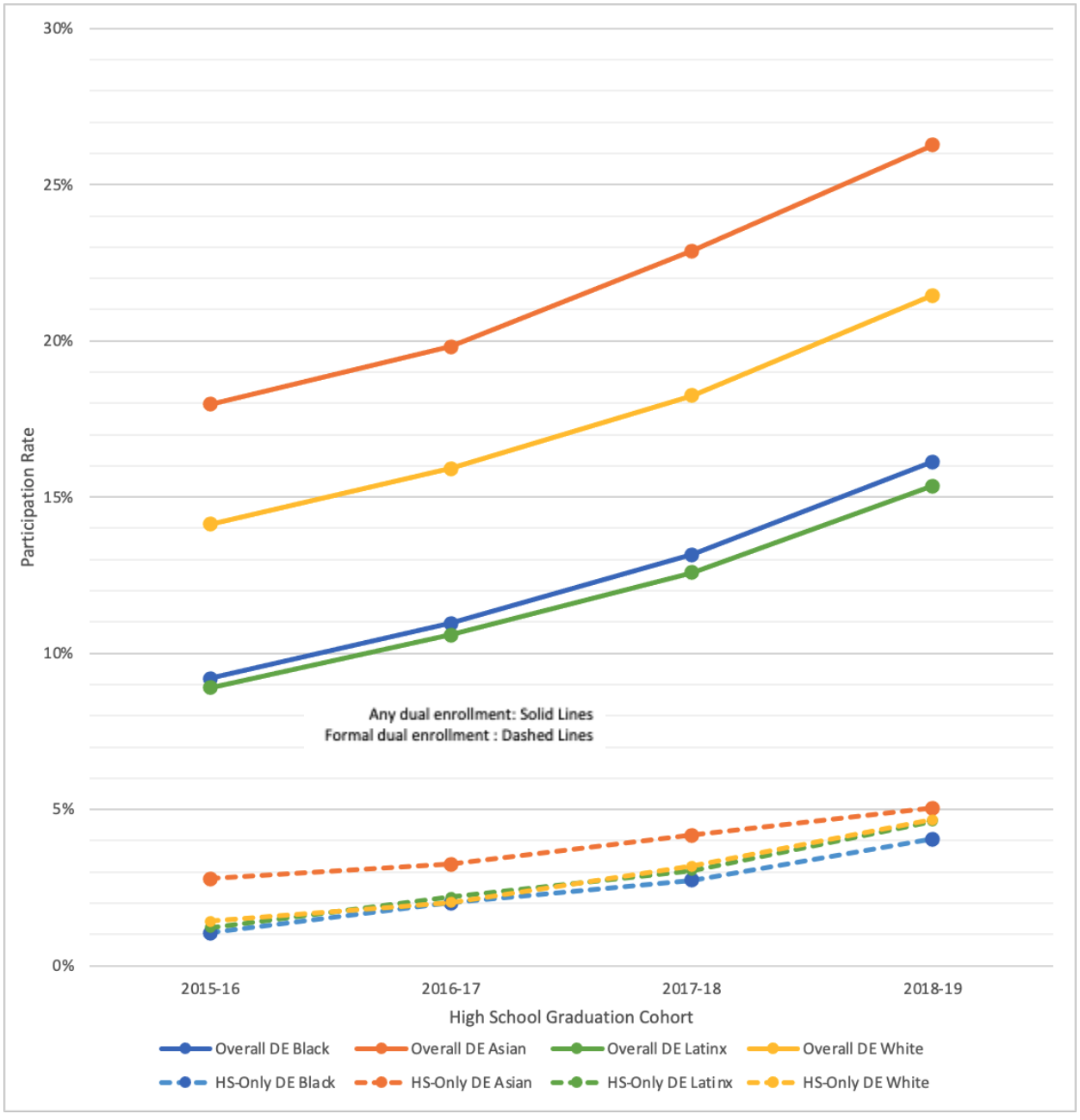
Notes: Statistics calculated by merging student-level College/Career Indicator (CCI) data from the CDE and special admit data from the CCCCO. Years limited to those in which CCI data was available.

Figure 9 shows that participation in any dual enrollment has increased across all racial and ethnic groups, with roughly parallel patterns of growth and thus participation gaps for subgroups. We also note increases in HS-Only enrollment for all racial and ethnic groups. Unlike the patterns observed in overall dual enrollment and reported in *A Rising Tide*, however, the gaps in HS-Only dual enrollment participation by racial and ethnic subgroups are smaller and closing over time. Only 1.5% of the 2015-16 graduating cohort participated in HS-Only dual enrollment, but this rate increased to 4.5% for the 2018-19 cohort. About 3% of Asian 2015-16 graduates participated in HS-Only courses, compared to 1% of Black, Latinx and White students. By 2018-19, Asian, Latinx, and White students were participating at nearly equal rates of about 5%. Though Black students also experienced a growth in participation over the same time period, there are still some disparities--albeit smaller--between Black students and other racial subgroups.

Community college courses that are designed for high school dual enrollment are clearly on the rise. And, greater equity in this type of enrollment across student sub-groups offers promise that policies such as AB 288 may improve access to important college readiness opportunities for historically marginalized high school students.

Figure 9

Participation Rates in Any Dual Enrollment and HS-Only Dual Enrollment by Racial/Ethnic Subgroup



Note. Cohort-level analysis conducted by merging student-level College/Career Indicator (CCI) data from the CDE and special admit data from the CCCCO. Each year on the horizontal axis

represents a public 4-year high school graduating cohort and their dual enrollment participation during the four normative years of high school. Cohorts limited to those in which CCI data was available.

Course Subjects Vary Greatly

Dual enrollment participants enroll in a wide variety of community college courses. Table 1 provides a comprehensive picture of the fields of study that high school students pursue. About one-third (33%) of all dual enrollment participants took a Career Technical Education (CTE) course and more than a third (38%) took courses categorized as Basic Skills by the community college. Rates of enrollment in CTE were slightly higher (nearly 40%) among students who only enroll in HS-Only courses, and slightly lower in Basic Skills (29.2%). Courses in the Humanities and Social Sciences have the highest rates of participation, followed by courses in Mathematics and Fine & Applied Arts, and then Psychology, Education, and Interdisciplinary Studies. These patterns of enrollment by fields of study are similar among the students who only participated in HS-Only dual enrollment courses.. The dual enrollment type and subject area reveal some differences in course taking patterns by student race/ethnicity (see Appendix).

Table 1

Dual Enrollment Participation Across Fields of Study Types, 2018-19 Cohort

	Dual Enrollment Type			
	Any DE	HS-Only	Combination	HS-CC Mixed
Number of Students	71610	11111	6959	53540
Agriculture & Natural Resources	3.3%	4.4%	5.5%	2.8%
Architecture	0.6%	0.4%	0.5%	0.6%
Environmental Sciences	1.6%	1.2%	2.1%	1.6%
Biological Sciences	15.2%	11.0%	17.8%	15.8%
Business & Management	14.0%	13.5%	19.5%	13.3%
Media & Communications	10.3%	8.1%	11.8%	10.6%
Information Technology	9.7%	7.1%	15.4%	9.5%
Education	26.8%	21.6%	37.3%	26.5%
Engineering & Industrial Arts	6.2%	8.6%	9.7%	5.3%
Fine & Applied Arts	35.3%	30.1%	46.4%	35.0%
Foreign Language	14.2%	10.0%	26.0%	13.6%
Health	7.7%	9.7%	10.0%	7.0%
Family & Consumer Sciences	14.0%	13.7%	17.3%	13.6%
Law	0.4%	0.4%	0.4%	0.4%
Humanities	50.3%	45.9%	63.1%	49.5%
Library Science	1.5%	0.7%	1.4%	1.7%
Mathematics	39.8%	31.6%	45.2%	40.9%
Military Studies	0.0%	0.0%	0.0%	0.0%
Physical Sciences	19.7%	13.4%	25.0%	20.3%

Psychology	27.1%	21.1%	34.9%	27.3%
Public & Protective Services	9.3%	9.9%	11.5%	8.9%
Social Sciences	47.3%	41.6%	61.2%	46.6%
Commercial Services	0.2%	0.2%	0.4%	0.3%
Interdisciplinary	25.0%	28.6%	31.7%	23.4%
Took Any CTE	33.0%	39.8%	29.1%	51.4%
Took any Basic Skills	38.0%	29.2%	35.6%	69.8%

Note. Cohort-level analysis conducted by merging student-level College/Career Indicator (CCI) data from the CDE and special admit data from the CCCCO. Each cell represents the percent of students from the subgroup of dual enrollment participants named at the top of the column (and from the 2018-19 public 4-year high school graduating cohort) who take a course in that particular field of study during the four normative years of high school. Percentages in each column total more than 100% as students often take more than one course. Shaded rows indicate the most popular courses in dual enrollment overall.

Dual Enrollment Students Accumulate College Credits

Enrollment in CCC courses results in meaningful college credit accumulation for high school graduates (Table 2). On average, participating students earn 7.62 units by the time they graduate high school, equivalent to approximately two and a half courses or slightly more than half of a full-time semester of college. Importantly, most of these units (6.83, on average) are transferable to a four-year university. Students who take HS-CC Mixed courses accumulate more units on average than students who exclusively take HS-Only dual enrollment courses. This suggests room for growth in partnerships between high schools and community colleges in their course offerings.

Table 2

Units Attempted and Earned by Dual Enrollment Participants, 2018-19 Cohort

	Dual Enrollment Type			
	Any DE	HS-Only	Combination	HS-CC Mixed
Number of Students	71610	11111	6959	53540
Average Units Attempted	8.784	6.276	19.86	7.864
Average Units Earned	7.62	5.529	17.84	6.727
Average Transfer Units Earned	6.825	4.694	16.14	6.057
Average CTE Units Earned	1.564	1.631	3.405	1.311

Note. Cohort-level analysis conducted by merging student-level College/Career Indicator (CCI) data from the CDE and special admit data from the CCCCO. Each cell represents the percent of students from the subgroup of dual enrollment participants named at the top of the column (and from the 2018-19 public 4-year high school graduating cohort) and the number of units attempted or earned during the four normative years of high school.

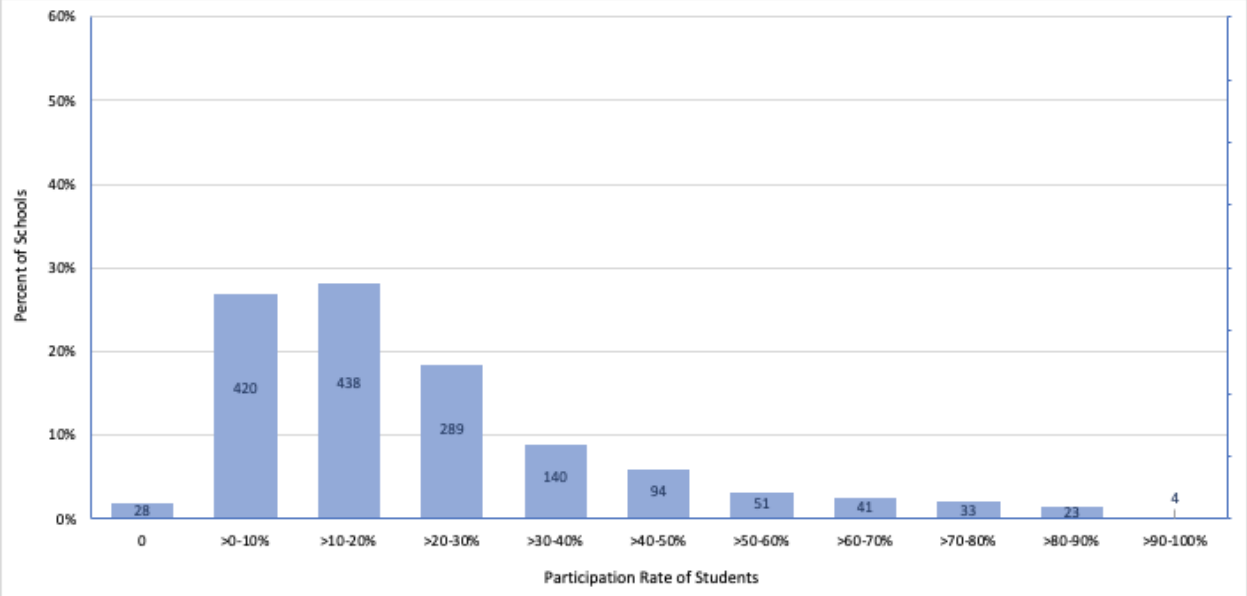
Participation is Uneven Across CA High Schools

Although dual enrollment rates have risen in recent years, our analysis shows that the opportunity to participate is not equally distributed. Students' opportunities to take community college courses are often determined by the high schools they attend. Nearly all California public high schools (98%) have at least one student participating in dual enrollment, but participation rates vary greatly by school, from less than one percent to 95% of students. Figure 10 shows the distribution of California high schools by their dual enrollment participation rates. Nearly three-quarters of all schools in California have dual enrollment participation rates below 30%, including one-quarter of schools with fewer than 10% of the graduating cohort participating.

Very few schools have high participation; only 152 schools statewide have more than half of their students participating, and only four schools have nearly all students (90% or more) taking community college courses in high school.

Figure 10

Distribution of Schools by Overall Dual Enrollment Participation Rates, 2018-19 Cohort



Note. Graph includes 1561 California public high schools with 15 or more graduates in the 2018-19 4-year public high school cohort. Graph excludes 426 small schools, 319 of which did not have any dual enrollment participation. The vertical axis represents the percent of the 1561 schools in each category of student participation rate and the numbers in bars represent the number of schools in each category.

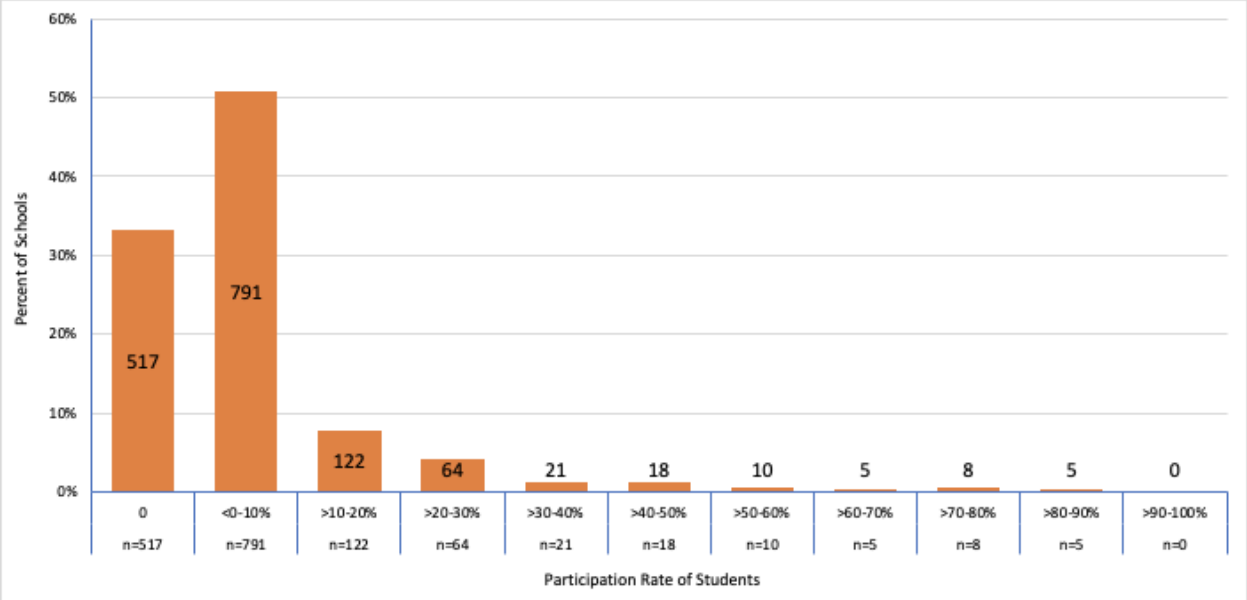
Student Access to HS-Only Dual Enrollment

While almost all schools have some students participating in dual enrollment, students do not necessarily have equitable access to these opportunities. Figure 11 depicts the distribution of California high schools by their participation rates in HS-Only courses and Table 3 shows how students are distributed across schools with varying HS-Only dual enrollment rates. Slightly less

than 70% of schools provide HS-Only dual enrollment opportunities for at least some students; yet, the great majority of public high school graduates in California (74%) attended schools where five percent or less of the cohort participated in HS-Only community college courses, including 22 percent of high school graduates who attended schools with no HS-Only dual enrollment participation at all. Only five percent of the 2018-19 graduates attended schools in which at least a fifth of students participated in HS-Only dual enrollment courses.

Figure 11

Distribution of Schools by HS-Only Dual Enrollment Participation Rates, 2018-19 Cohort



Note. Graph includes 1561 California public high schools with 15 or more graduates in the 2018-19 4-year public high school cohort. Graph excludes 426 small schools, 319 of which did not have any dual enrollment participation. The vertical axis represents the percent of the 1561 schools in each category of student participation rate and the numbers in bars represent the number of schools in each category.

Characteristics of Schools with Varying Rates of HS-Only Dual Enrollment Participation

We sought to understand differences across schools that provide HS-Only dual enrollment opportunities. Table 3 provides information about key characteristics of schools and the students they serve by varying rates of HS-Only dual enrollment participation. For this description, we collapsed HS-Only dual enrollment participation rates into six levels: 1) no HS-Only dual enrollment; 2) greater than zero to 2%; 3) greater than 2% to 5%; 4) greater than 5% to 10%; 5) greater than 10% to 20%; and 6.) more than 20%

Schools with no HS-Only dual enrollment participation and those with higher participation rates (20% and above) share some key characteristics. They tend to be smaller in size and more likely to be charter or alternative/continuation schools. This suggests that small schools, charter schools and alternative/continuation schools are either engaging deeply with dual enrollment programming or avoiding it altogether.

Schools with no participation in HS-Only dual enrollment have the largest share of rural students and below average shares of suburban and urban students, possibly indicating difficulty in developing dual enrollment partnerships in rural areas where distances between high schools and community colleges may be substantial. However, schools with greater than 20% HS-Only dual enrollment rates have the second highest share of rural students, so some rural schools have clearly overcome this obstacle. Students in schools with HS-Only dual enrollment participation rates 10% and higher have the highest likelihood of attending schools in small towns and are less likely to attend suburban (~35-38%) schools than students in other groups. This evidence, along with the student characteristics of these schools may point to a more concerted effort to establish more formalized dual enrollment programs in small towns or rural areas.

There are few substantial differences in the demographic characteristics of students across schools with varying rates of HS-Only dual enrollment participation. White students are slightly overrepresented in schools with the highest HS-Only dual enrollment participation rates. Whereas, Latinx students are overrepresented among schools with greater than 10% participation rates, relative to the overall cohort.

The evidence on HS-Only dual enrollment programs offers a promising picture of access to this important opportunity for historically marginalized high school students. Unfortunately, only about 12% of the 2018-19 graduating cohort attended schools with 10% or more participation, highlighting the limited access to more formalized dual enrollment opportunities despite the promise of this important opportunity for more of California's students. Of course, these descriptive characteristics only explain the differences across schools of varying participation levels, not within schools, which could also reveal differential access.

Table 3

Characteristics of Schools by Varying Rates of HS-Only Dual Enrollment Participation

		Schoolwide Participation Rates in HS-Only Dual Enrollment Courses					
	2018-19 Total	None	>0-2%	>2-5%	>5-10%	>10-20%	>20%
Number of Schools	1,561	517	360	245	186	122	131
Number of Students	393,930	86,275	134,416	73,375	52,109	27,480	20,275
Average School Size	418	362	482	431	415	359	276
Share of the Cohort	99.5%	22%	34%	19%	13%	7%	5%
SED	66%	64%	64%	66%	70%	75%	66%
English Learners	11%	11%	11%	12%	12%	13%	11%
Asian	10%	9%	10%	10%	12%	7%	9%
Black	5%	5%	5%	5%	5%	6%	4%
Latinx	52%	48%	50%	54%	55%	62%	54%
White	25%	28%	26%	22%	21%	20%	27%
Other	7%	8%	8%	7%	6%	5%	6%
Charter School	10%	16%	8%	5%	8%	9%	16%
Alternative/ Continuation	2%	4%	1%	1%	1%	4%	4%
Traditional	98%	96%	99%	99%	99%	96%	96%
Rural Locale	6%	13%	3%	4%	4%	5%	10%
Town Locale	6%	5%	3%	6%	3%	18%	18%
Suburb Locale	46%	47%	55%	35%	44%	35%	38%
Urban Locale	42%	34%	39%	54%	48%	42%	34%

Note. Table includes 1561 California public high schools with 15 or more graduates in the 2018-19 the 4-year public high school cohort. Table excludes 426 small schools, 319 of which did not have any dual enrollment participation.

Conclusion

Our findings suggest reason for cautious optimism that California may be on a path toward realizing the promise of dual enrollment. This analysis of matched data from two systems offers educators and policymakers a better understanding of growth across types of dual enrollment and the variability in course taking statewide. It also hints at the particular promise, from an equity perspective, of HS-only dual enrollment to provide greater opportunity for college preparedness and acceleration among students historically underserved in their paths to and through college.

Through dual enrollment, California Community Colleges play an increasingly important role as an onramp from high school to college. The CCCCO's Vision for Success puts forth a bold set of commitments to address equity gaps across the colleges, and dual enrollment can contribute to achieving this vision if it is implemented with equity at the forefront. The expansion of HS-Only courses in the CCCs embodies an important partnership across segments to reach students historically underserved by dual enrollment and underrepresented in college.

Qualitative research, like that found in the Public Policy Institute of California's recent report, *Dual Enrollment in California: Examining Student Access, Success and Equity* (Rodriguez & Gao, 2021), helps us better understand how CCAP agreements are playing out locally. Future Wheelhouse research will consider critical, broader questions about the longer-term relationship between different types of dual enrollment participation and students' educational trajectories, how high schools expand opportunities for dual enrollment, and the impact of state policy on both dual enrollment expansion and, ultimately, college enrollment and completion outcomes.

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