12th Grade Course-taking and the Distribution of Opportunity for College Readiness in Mathematics

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PACE
Policy Analysis for California Education

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Executive Summary

In this report we explore the patterns in mathematics course-taking among California public high school seniors. We describe what courses students are enrolled in and how course participation varies by key student characteristics, such as race/ethnicity, socioeconomic status, and performance level on the state's 11th grade assessments. We also explore course-taking patterns for students eligible for California's public four-year colleges—California State University (CSU) and the University of California (UC), and for applicants and admitted students at the CSU and UC. Specifically, we find that:

- Approximately 75 percent of all California high school seniors were enrolled in a math class in 2016, 2017, and 2018. However, only 47 percent of seniors were enrolled in an advanced math or Advanced Placement (AP) class, above Algebra II.
- Asian, White, and high-income students were enrolled in advanced math courses above Algebra II at rates much higher than African American, Latinx, and low-income students.
- Nearly 40 percent of schools had no seniors enrolled in advanced math classes; one-third of these 942 schools are traditional high schools representing 2 percent of seniors in the state.
- Low-poverty schools (schools with a lower concentration of socio-economically disadvantaged students) had a larger percentage of students participating in advanced math courses compared to high-poverty schools.
- Over 70 percent of all California high school seniors satisfy the *conditionally ready* recommendations from the college readiness signal on the state's 11th grade assessment by enrolling in an AP or other advanced math course above Algebra II.
- Schools serving more socioeconomically disadvantaged students (high-poverty schools) were more likely to have students satisfy the college readiness signal for math course placement than schools serving fewer SED students.
- A significantly larger proportion of students who applied and were admitted to CSUs and UCs took advanced math courses in 12th grade compared to the overall population of 12th graders.
- Latinx, African American, and low-income students who applied and were admitted to either the CSU or UC systems were underrepresented in advanced math courses compared to White, Asian, and high-income students.

Our findings demonstrate that although a large majority of college-bound students enrolled in math in their final year of high school, advanced math pathways were not equally accessed among our high school seniors. These disparities in enrollment patterns by race/ethnicity and school characteristics likely contribute to disparities in postsecondary access and success.

Introduction

Mathematics is an oft-cited barrier on the road to college preparation (Burdman, 2018; Finkelstein et al., 2012). In 2018, only 13 percent of California 11th grade students were identified as "prepared" for college-level math based on their scores on the state's Smarter Balanced Assessments (California Department of Education, 2018).[1] Improving math preparation for college is therefore top of mind for local and state education agencies seeking to increase postsecondary access and success. In recent years, there has been a more explicit focus on having students make better use of their senior year to prepare for college through more rigorous course-taking experiences such as dual enrollment and Advanced Placement, and by taking coursework beyond the minimum required for eligibility by our state's public four-year institutions—California State University and the University of California.

In this report, we explore the patterns in mathematics course-taking among California high school seniors using data available to us through our research partnership with the California Department of Education. Specifically, we describe how many California 12th graders are enrolled in math courses and in what types of courses. We explain how course participation varies by key student characteristics, such as race/ethnicity, socioeconomic status, and performance level on the state's 11th grade assessments. Finally, we look at these patterns for students eligible for CSU and UC, and for applicants and admitted students at CSU and UC.

Background

Prior research suggests that preparation in high school is a key predictor of college success (Bettinger, Boatman, & Long, 2013; Long, Conger, & Iatarola, 2012; Howell, Kurlaender, & Grodsky, 2010). Specifically, students who take a more rigorous high school curriculum, such as AP and other college prep courses, have significantly higher postsecondary outcomes, including college entry and college completion (Altonji & Dunn, 1995; Clotfelter, Ladd & Hemelt, 2016; Gottfried, Bozick, & Srinivasan, 2014; Long, Conger, & Iatarola, 2012; Smith, Hurwitz & Avery, 2017; Trusty & Niles, 2003). For example, the highest level of mathematics a student is enrolled in is associated with the likelihood of being college prepared, attending college, the type of college attended (Dougherty, Goodman, Hill, Litke,& Page, 2017; Kim, DesJardins, & McCall, 2015; Long, Conger, & Iatarola, 2012), the likelihood of college completion (Adelman, 1999, 2006), and receipt of a degree within four years (Smith, Hurwitz & Avery, 2017). Students who complete more and higher levels of mathematics also tend to have higher earnings later in life (Adelman, 2006; Altonji & Dunn, 1995; Goodman, 2012; Rose & Betts, 2004). Although much of this research is correlational and should not be interpreted causally, it points to a consistent association between academic preparation in high school and later success.

Students choose their course-taking pathways as a function of personal tastes and abilities, as well as constraints they may encounter that limit those choices (e.g., information barriers, availability of these courses, weak prior preparation for advanced courses, admission policies/requirements defined by postsecondary institutions) (Crosnoe & Schneider, 2010; Finkelstein et al., 2012; Kurlaender & Hibel, 2018). Scholars have documented persistent disparities in opportunities for college preparatory classes in high school, particularly for minority and low-income students (Rodriguez, 2018; Crosnoe & Schneider, 2010; Kao & Thompson, 2003; Kim et al., 2015). Low-income and underrepresented minority students are less likely to be enrolled in higher-level math and science courses in secondary school (Adelman, 1999; Long, Iatarola, & Conger, 2009) and less likely to persist in high school math compared to their more advantaged peers (Crosnoe & Schneider, 2010). These disparities exist in part because these students may be in schools that are constrained in their ability to provide rigorous high quality academic resources (St John, Gross, Musoba, & Chung, 2006) compared to schools with a more affluent population that offer a vast number of advanced courses (Long et al., 2009). Additionally, prior studies that account for school differences suggest that disparities in course-taking are also a within-school phenomenon, rather than a between school phenomenon, whereby students may not be equally enrolled in advanced courses (Gamoran, 1987). Thus, curricular disparities may be a result of tracking through performance on standardized assessments or on the basis of other student characteristics (Attewell & Domina, 2008; Kelly, 2009; Roderick, Nagaoka, & Coca, 2009).

Our current research documents the various math courses in which seniors in California public high schools enroll, and how math course-taking varies by key student background characteristics, and by schools attended. In our analysis, we are unable to unpack the many explanations for why students enroll in particular math pathways during secondary school. However, this is the first time researchers have leveraged the rich student-level course data provided through the California Longitudinal Pupil Achievement Data System (CALPADS) to explore high school math course-taking patterns statewide. Our descriptive analysis, therefore, provides an important starting point for examining how disparities and access challenges to advanced math pathways may limit students' postsecondary success.

Data and Analytical Sample

To investigate the course-taking patterns of California seniors, we use course-level information for students enrolled in California public high schools from CALPADS.[2] Our sample consists of students enrolled in 12th grade in 2015-2016 (N=389,027), 2016-2017 (N=387,819), and 2017-2018 (N=397,485), who took the 11th grade Smarter Balanced Assessment (SBAC).[3] The dataset includes information on all the math courses taken by 12th grade students, their grades in each course, and demographic characteristics, including race/ethnicity, gender, and an indicator for socioeconomic disadvantage,[4] which allows us to explore how course-taking patterns vary by student subgroup. These data are merged with school-level characteristics, including the proportion of socioeconomically disadvantaged students, allowing us to observe differences across schools serving student populations of varying characteristics.

We also link the individual-level 12th grade course data with individual-level data for all first-time freshmen applicants to CSU[5] and UC campuses for the 2015-2016 senior cohort. Linking the high school and postsecondary data allows us to investigate variation in 12th grade course-taking patterns across groups of students who apply and are admitted to four-year public universities within the state.

In our analyses, we categorize math courses taken by seniors in the five categories described in Table 1 (on the following page). All categories are mutually exclusive (i.e., students are counted only in the most advanced math class they enrolled in during their senior year). For example, if a student is taking an Algebra II course and an AP Statistics course, they are counted in the AP math category. If students fall in any of the first four categories, they are not counted in the "other" category.

There are some limitations to our analysis. First, our sample only reflects students enrolled in 12th grade, not all of whom will necessarily graduate; and does not include students who took the SBAC in 11th grade, but do not appear in the 12th grade course-taking data (these students may have dropped out, switched to a non-traditional school, or moved to a school outside the state). Second, our analysis does not analyze course-taking patterns in previous grades, as a transcript analysis could do. Finally, it is important to note that our estimates of math course-taking in high school are likely an undercount of overall math course-taking, as some high school seniors may be taking courses outside their regular high school schedule (e.g. at a community college or online).

Table 1. Categorization of math courses

Category	Description
Advanced Placement (AP) Math Courses	Higher level AP math courses with stringent requirements in terms of course content and teacher preparation. Examples include AP Statistics, AP Calculus, etc.
Advanced Math Courses	Courses with Algebra II as a prerequisite, not including AP math courses. Examples include Calculus, Trigonometry and Math Analysis, etc.
Algebra II Courses	Integrated Math III/Algebra II courses
Below Algebra II Courses	Courses taken before Algebra II in the math sequence. Examples include Geometry, Algebra I, etc.
Other Courses	Courses that do not fall into the above math categories, and have requirements below/equal to Algebra II.

High School Math Curricula

Core high school math curricula in most of the country comprises two years of algebra and one year of geometry (National Governance Association, 2010; NCTM, 2018; Porter et al., 2011). Algebra is emphasized in school because it prepares students for calculus, which, when taken in high school, helps with admission to selective colleges and is typically needed to pursue STEM majors. In many middle schools nationwide, substantial numbers of students enroll in Algebra I, so they can take calculus by their senior year (Loveless, 2013). In particular, Algebra II is the course considered a stepping stone to calculus and hence has become a signal for a college preparatory track and for admission to a selective college (Rosenstein & Ahluwalia, 2016). The Common Core State Standards include an option of an "integrated" curriculum, which makes connections between areas like geometry and algebra. The standards include additional math content, such as statistics and probability, and prioritizes skills students should learn regardless of the content of the courses (Burdman, 2018; CDE, 2015). Under Common Core, students' math pathways—whether traditional or more integrated—are intended to more directly align with their intended area of postsecondary study. Both the traditional and integrated math pathways inform our categorization of courses above and below Algebra II.

Math Course-taking in the Senior Year

Our analysis reveals that about 75 percent of all California high school seniors were enrolled in a math class. Table 2 shows the distribution of students across math course categories over the recent three-year period: an average of 21 percent of the seniors took an AP math class, 26 percent an advanced math class (not including AP), 12 percent an Algebra II class, 18 percent other math courses including Algebra II prerequisites, and 24 percent of 12th graders were not enrolled in a math class. (Table A1 in the appendix provides the list of nearly 25 specific math courses in which 75 percent of all California seniors were enrolled in 2017-2018.) Table 2 also shows that math course-taking has modestly risen over the past several years. In 2015-2016, approximately 74 percent of seniors took a math class, a proportion that increased 1 percentage point in 2016-2017, and then reached 76 percent in 2017-2018.

Table 2. Math course-taking by California 12th graders in recent cohorts

	Percentage of Students		
	2015-2016	2016-2017	2017-2018
AP Math	20.1	22.2	20.6
Advanced Math	22.5	25.5	25.5
Algebra II	12.7	11.8	12.1
Below Algebra II	14.0	10.6	12.9
Other	4.2	4.4	4.7
No Math	26.5	25.5	24.3
N	389, 027	387, 819	397, 485

Importantly, of the 24 percent of the students not enrolled in a math class in 12th grade (in 2017-2018), approximately 60 percent took an Algebra II or higher math class in the 11th grade. Consequently, we estimate that about 72 percent of California students graduate from high school having completed a math course at or above Algebra II. Notably, 9 percent of the students who did not enroll in a math class in 12th grade were also not enrolled in a math class in 11th grade.[6]

Individual Differences in Course-taking

Substantial disparities exist in math course-taking by students' background characteristics. Figure 1 shows differences in course-taking by race/ethnicity for 12th graders in 2017-2018. From this figure, we note that 43 percent of 12th grade Asian students were enrolled in an AP math class compared to only 11 percent of African American seniors and 14 percent of Latinx seniors. Moreover, only 17 percent of 12th

grade Asian students were not enrolled in a math class compared to over 26 percent of the seniors in all other racial/ethnic groups.

Figure 1. 12th grade math course-taking by race/ethnicity in 2017-2018

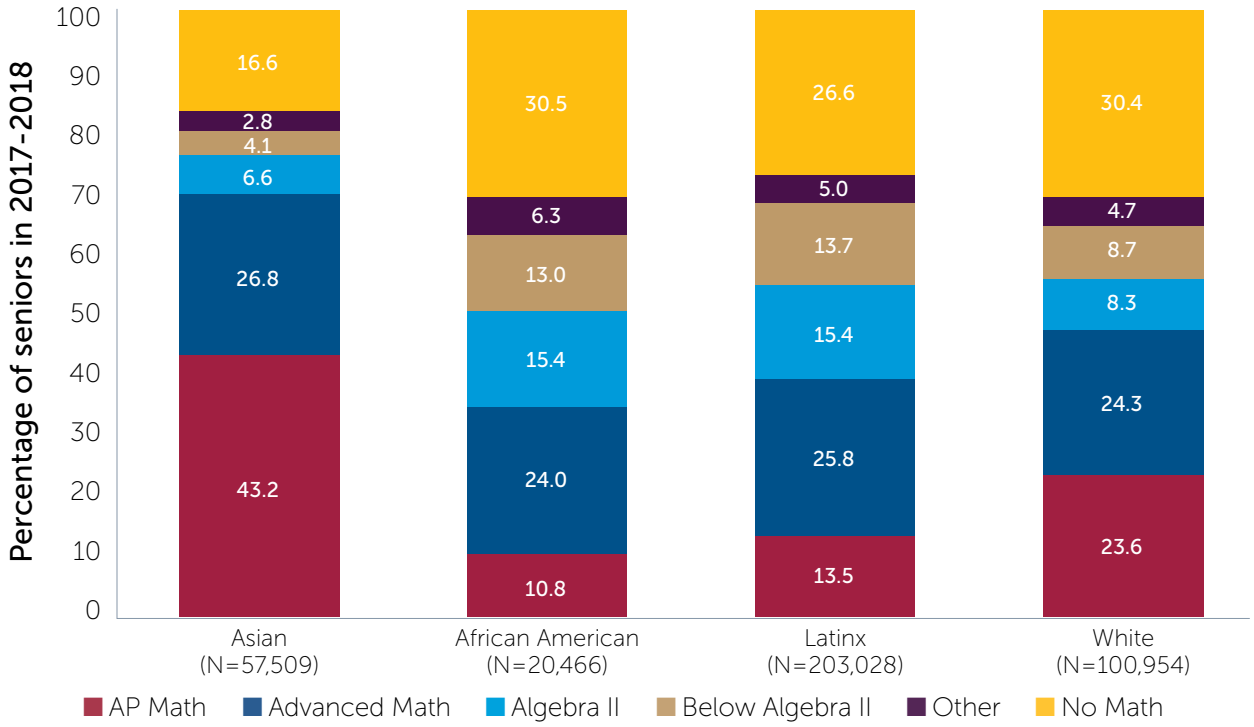
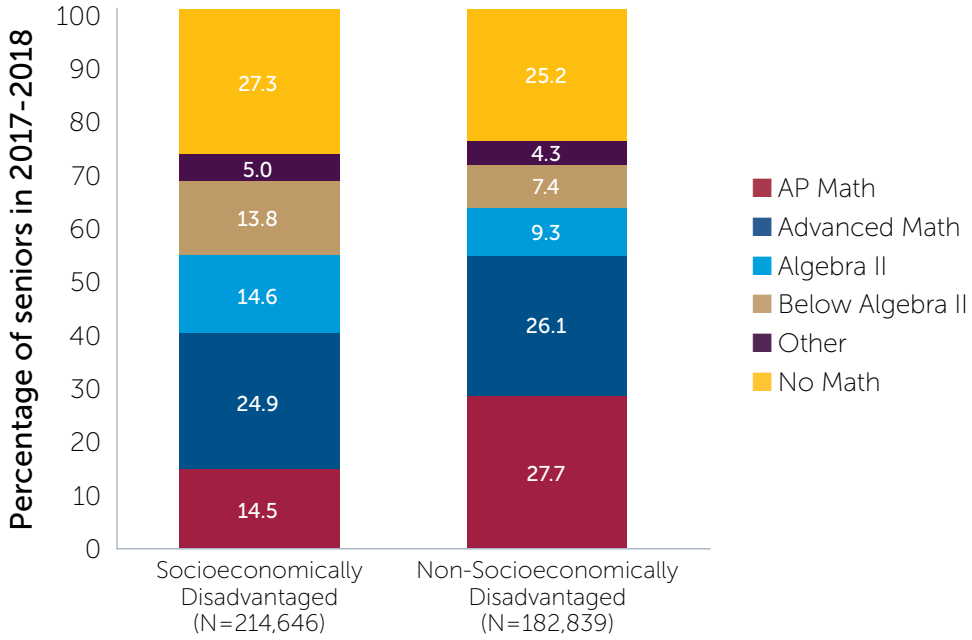


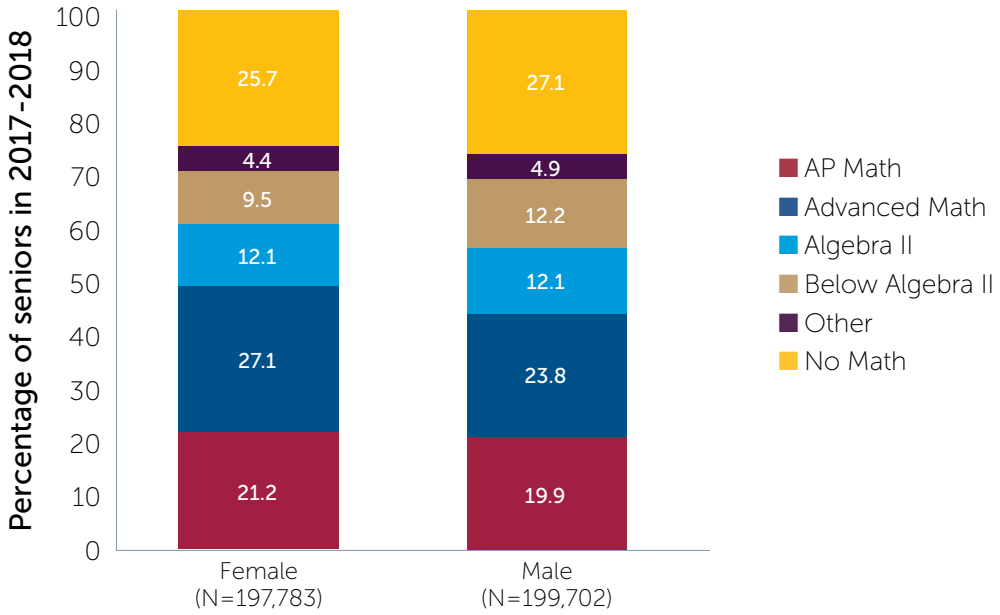
Figure 2. 12th grade math course-taking by socioeconomically disadvantaged status in 2017-2018



Similarly, disparities exist in course-taking by socioeconomic status (Figure 2). Only 40 percent of socioeconomically disadvantaged (SED) 12th graders took advanced math courses above Algebra II, compared to 54 percent of seniors who were not socioeconomically disadvantaged.

We also observe differences in course-taking by gender, as shown in Figure 3. Specifically, female students in 12th grade are slightly more likely to take advanced math courses (48 percent) compared to their male counterparts (44 percent).

Figure 3. 12th grade math course-taking by gender in 2017-2018



Finally, we find that disparities—albeit small—exist in course-taking within each of the racial/ethnic groups by socioeconomic status and gender as depicted in Figures 4 and 5 respectively. For example, in 2017-2018, 15 percent of African American students who were not identified as socioeconomically disadvantaged took an AP math class in 12th grade compared to 8 percent of African American students identified as socioeconomically disadvantaged (Figure 4). White students, in particular, had the largest gaps by socioeconomic status: 27 percent of advantaged students took AP math compared to only 13 percent of disadvantaged students. Similarly, we note race-gender differences are most pronounced for African American and Latinx students: although only 9 percent of male African American students took an AP math class in 12th grade, 12 percent of female African American students did so; and for Latinx students, 14 percent of female students enrolled in AP courses, while only 13 percent of male students did so (Figure 5).

Figure 4. 12th grade math course-taking by race and socioeconomically disadvantaged status in 2017-2018

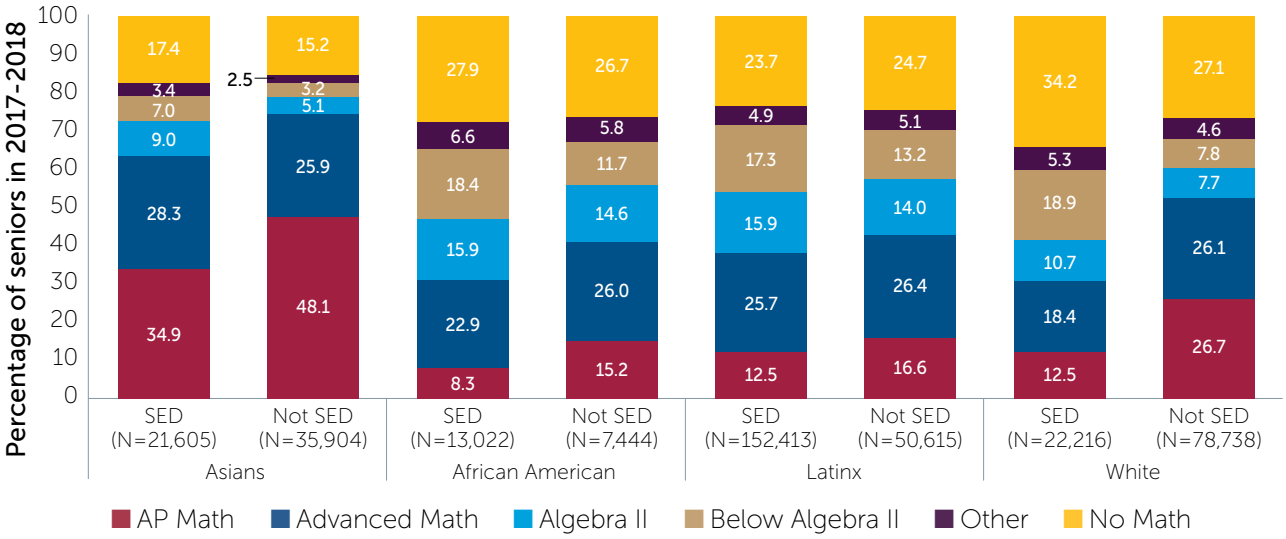
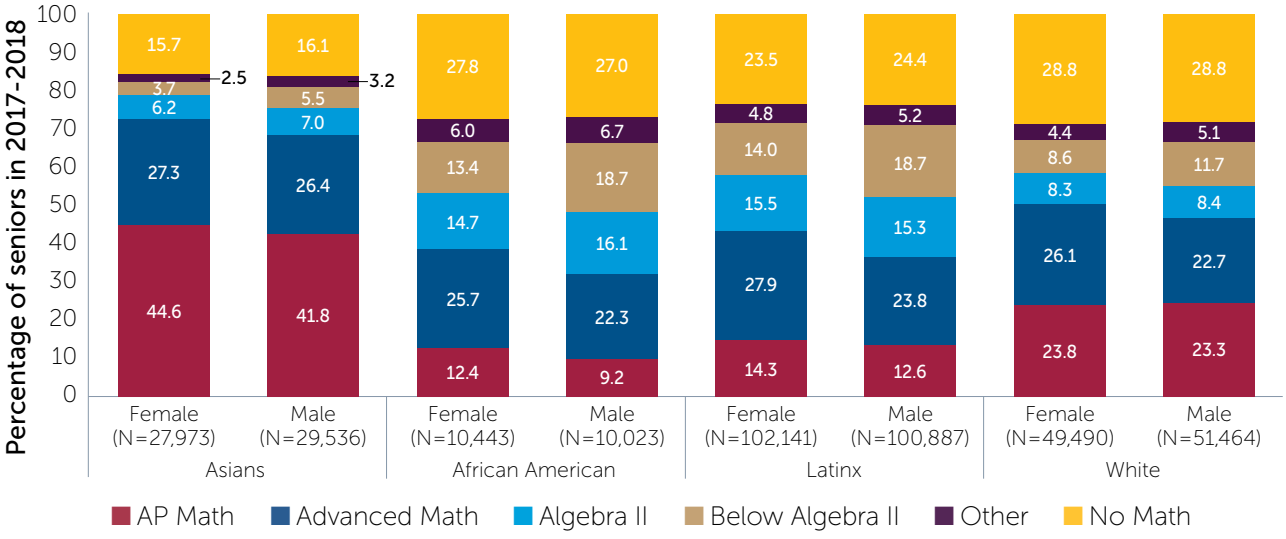


Figure 5. 12th grade math course-taking by race and gender in 2017-2018

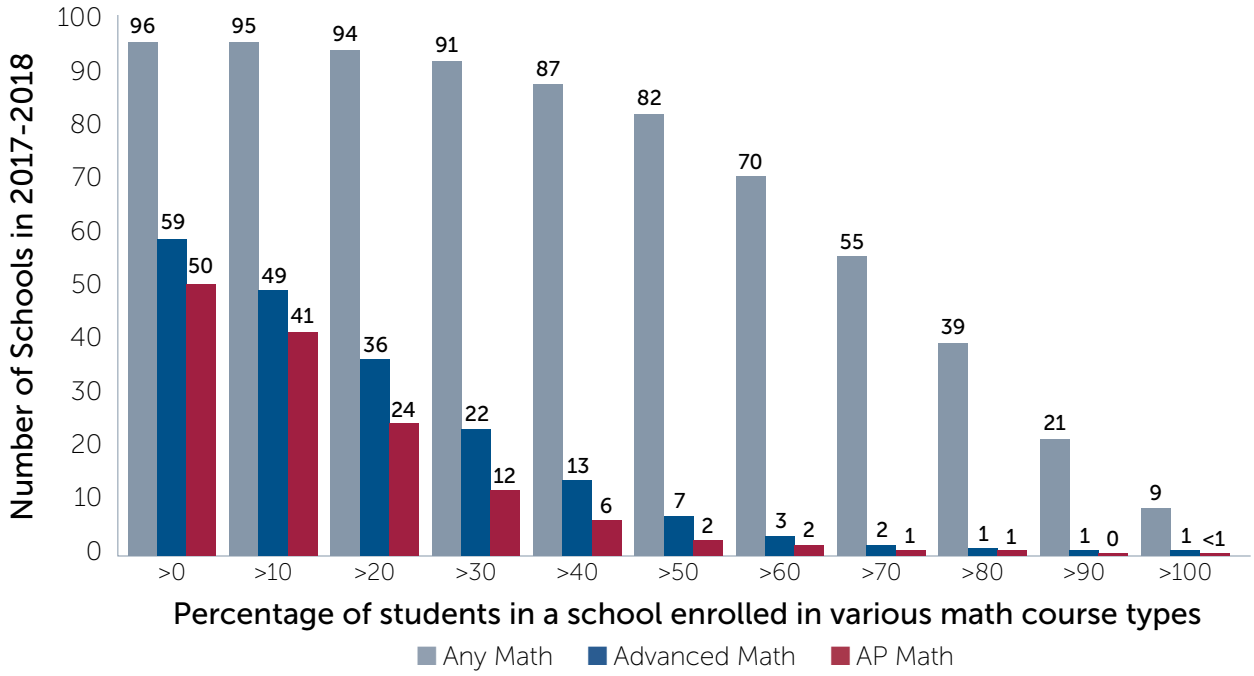


School-level Differences in Math Course-taking

Important differences in senior year math course taking exist across schools, and by school characteristics as well. This may be in part the result of differing high school graduation requirements in math. Figure 6 depicts the percentage of schools by proportion (0 to 100 percent) of students who took any math, any advanced math and specifically AP math (respectively) in 12th grade. Not surprisingly, 96 percent of schools had at least one senior taking a math class in 2017-2018, but only 9 percent of schools had nearly all seniors taking a math class. Moreover, only 59 percent and 50 percent of schools

had at least one 12th grader enrolled in an advanced and AP math class, respectively, and less than 1 percent of schools had nearly all seniors taking an advanced math class. Figure 6 also shows that about 82 percent of the schools had more than half of their seniors enrolled in math courses (of any type). However, only 2.4 percent of the schools had more than half of their seniors enrolled in an AP math class.

Figure 6. 12th grade math course-taking across schools in 2017-2018

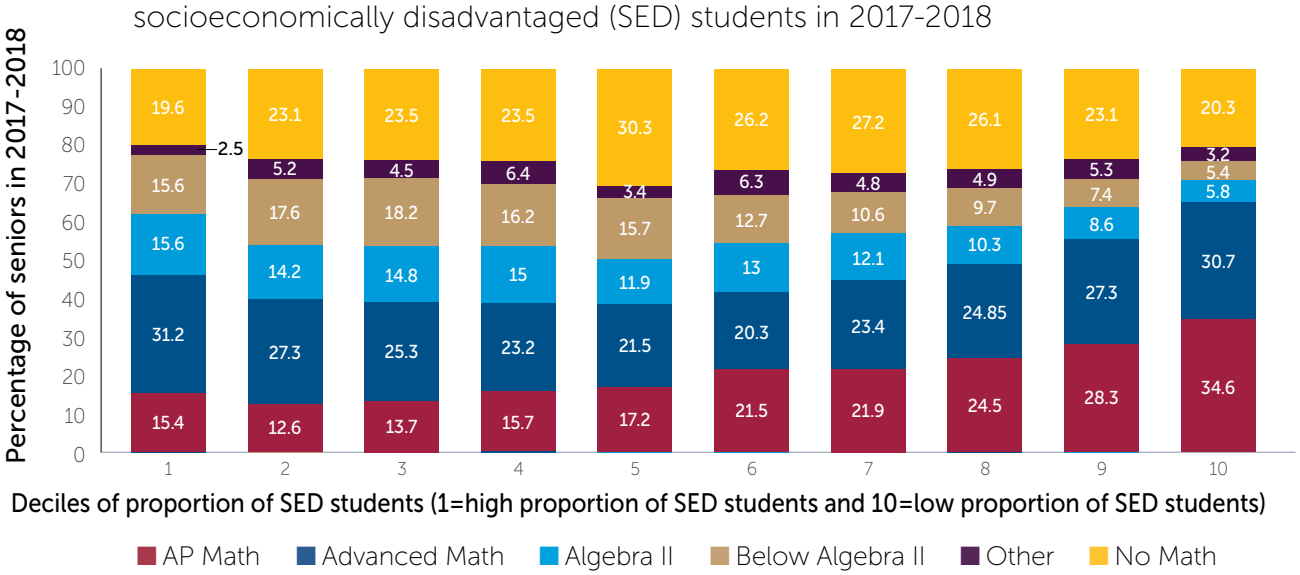


This figure suggests that access to higher-level math courses differs across California high schools. Our census level course-taking data allows us to empirically identify schools where no students took an advanced math course, most likely because these schools did not offer such courses, and consequently left students enrolled in these schools at a potential disadvantage for postsecondary success. Specifically, in 942 schools, no students are enrolled in advanced or AP math in 12th grade, representing 41 percent of all schools and about 6 percent of all students. The majority (641 schools representing 15,799 seniors) of these are alternative schools of choice, continuation high schools, county community schools, district community day schools, juvenile court schools, opportunity schools, and public special education schools. There are also 301 traditional public high schools (representing 7461 seniors) with no students enrolled in advanced or AP math in their senior year; stated another way, approximately 20% of traditional public high schools in the state (serving approximately 2 percent of the state's seniors) have no 12th graders taking advanced math courses.

In Figure 7, we plot course-taking across school socioeconomic deciles as measured by percentage of students who are socioeconomically disadvantaged. The first

decile includes the most disadvantaged schools with the highest proportions of students who are socioeconomically disadvantaged.[7] In these schools about 47 percent of students took an advanced or AP math class, compared to 65 percent of the students in the 10th decile, with the fewest socioeconomically disadvantaged students. Overall, we see clear differences in course-taking. On average, schools serving more low-income students have fewer seniors enrolled in advanced math classes as compared to schools serving fewer low-income students. However, we also note an interesting U-shape pattern in Figure 7, where schools with the greatest number of low-income students (Decile 1) have higher rates of advanced math and AP course-taking relative to other schools serving large percentages of low income students (Deciles 2, 3, and 4), which suggests that there may be specific efforts to improve access to rigorous college preparatory courses in the lowest income schools.

Figure 7. Differences in 12th grade math course-taking by deciles of proportion of socioeconomically disadvantaged (SED) students in 2017-2018



California's College Readiness Signal

California's standardized tests for accountability (Smarter Balanced Assessments), universally administered to 11th grade students, are also used to gauge high school students' readiness for college-level coursework in English and math. Specifically, the Smarter Balanced Assessment achievement levels align with four college-readiness categories: *1-Not Ready, 2-Not Yet Ready, 3-Conditionally Ready, 4-Ready*.[8]

These signals of college readiness, developed in collaboration with the California State University system (and utilized by both CSU and the California Community Colleges), determine course placement in college. Importantly, students who earn a *conditionally ready* score in math may meet additional college readiness requirements during their

senior year and avoid remedial summer coursework[9] or co-requisite coursework in their first year of college.[10] The additional college readiness requirements for seniors deemed *conditionally ready* include enrolling in an Algebra II or higher math course and earning a grade of C- or better in the course.[11] Thus, being identified as *conditionally ready* could encourage students to take more advanced math coursework and improve their preparation for college.[12]

Table 3 provides a summary of how seniors in the last three years performed on their 11th grade Smarter Balanced Assessment in math. We note that approximately 19 percent, 21 percent, and 20 percent of all California seniors achieved the level of *standard met* in 2015, 2016, and 2017 respectively, obtaining the *conditionally ready* signal.

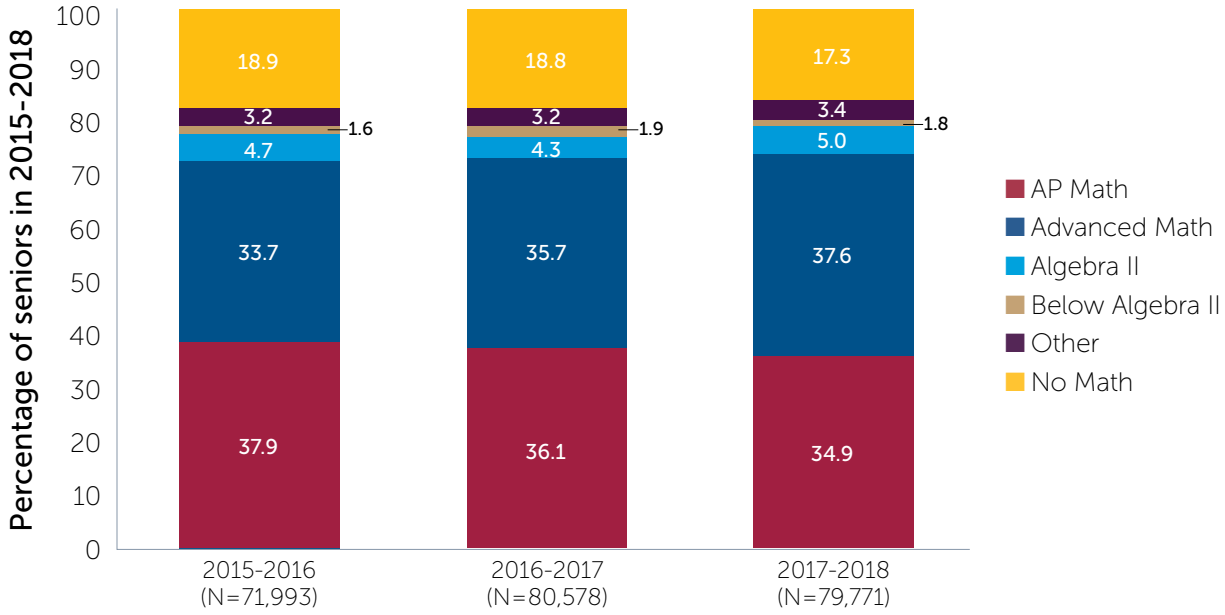
Table 3. Percent of students at each achievement level of Smarter Balanced Math Assessment

		Percent of Seniors at Each Level in 11th Grade		
Smarter Balanced Achievement Levels	College Readiness Categories	2015-2016	2016-2017	2017-2018
Standard Not Met	Not Ready	38.8	37.0	38.9
Standard Nearly Met	Not Yet Ready	24.1	24.7	23.8
Standard Met	Conditionally Ready	18.5	20.8	20.1
Standard Exceeded	Ready	11.7	13.5	13.8
	N	389,027	387,819	397,485

Figure 8 depicts the courses the students at the *standard met* or *conditionally ready,* level took in 12th grade. Over 70 percent of students who met the standard satisfied the *conditionally ready* requirements by enrolling in an AP or other advanced math course above Algebra II (and assuming their grade was a C- or higher). However, in 2017-2018, 17 percent of the students deemed *conditionally ready* did not enroll in any math class in 12th grade. These students, therefore, had to demonstrate their college preparedness for CSU or community college in another way (e.g., SAT/ACT scores or via additional assessments provided by the colleges).

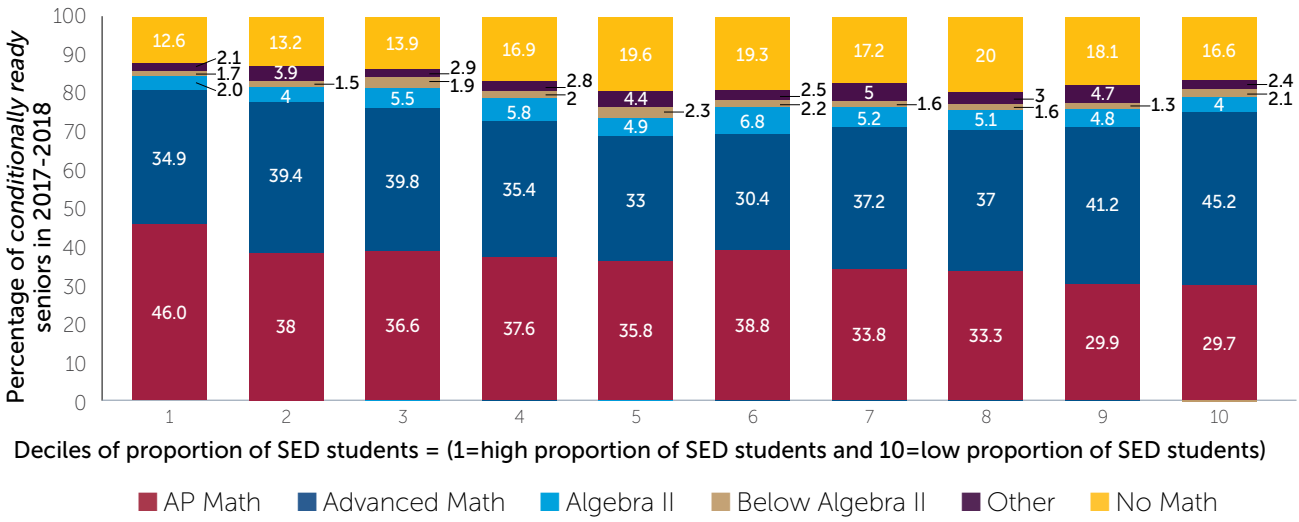
Figures A2 and A3 in the Appendix show differences in course-taking for these students who met the standards on the Smarter Balanced Assessment for math by racial/ethnic groups and socioeconomic status respectively. The differences across racial/ethnic and socioeconomic groups among students who achieved the *standard met* level were not as stark in comparison to the differences across racial/ethnic and socioeconomic groups for the full population of 12th graders previously described. This suggests that scores on the 11th grade assessment may be, at least in part, driving the sorting into different math courses regardless of student characteristics. That is, the racial/ethnic and socioeconomic disparities in senior year math course-taking are substantially smaller among students who score similarly on the state's standardized assessments.

Figure 8. 12th grade math course-taking for students who met the standard on the 11th grade Smarter Balanced Math Assessment



Given the signal to enroll in math in the senior year that is intended by the *conditionally ready* designation, it is important to consider school differences in math course enrollment by students achieving Standard Met (Level 3). In Figure 9, we present the distribution of course-taking across socioeconomic deciles. We find that fewer *conditionally ready* students from high-income schools enrolled in advanced math classes (10th decile) compared to similar scoring students attending low-income schools (1st decile). Notably, 46 percent of students in the 1st decile schools took an AP math course compared to 30 percent of the students in the 10th decile schools. This suggests that schools serving more low-income students may utilize the college readiness signal for math course placement to a greater extent than schools serving fewer low-income students.[13]

Figure 9. Differences in 12th grade math course-taking among *conditionally ready* students across schools serving varying proportions of socioeconomically disadvantaged students



Patterns in Math Course-taking for CSU and UC Applicants and Admits

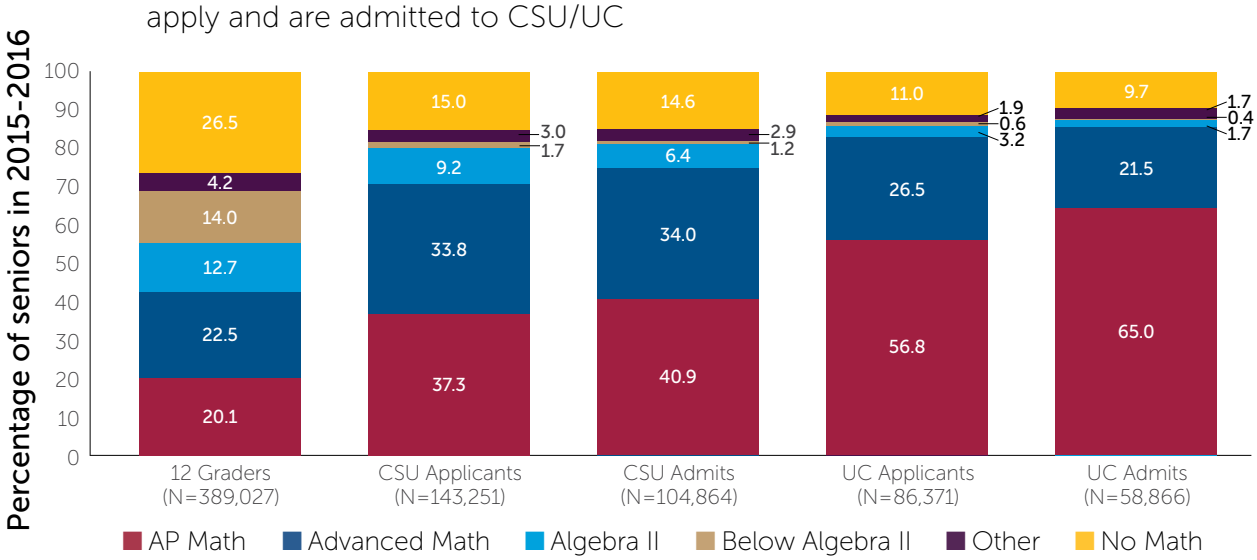
The California State University and the University of California have a common eligibility requirement often referred to as 'A-G'.[14] Specifically, eligibility for CSU and UC requires students to complete a minimum 15-unit pattern of courses during high school across specific subject areas. Each unit is equal to a year of study in a subject area. A grade of C- or better is required for each course to meet any subject requirement. For math these include three years (4 years recommended) and courses include Algebra I, Geometry, Algebra II, or higher mathematics (one taken each year).[15]

Utilizing data from California's College and Career Readiness Indicator (CCI), approximately 33 percent of all 12th graders in California schools are "prepared" on the A-G indicator in the CCI.[16] We also assess course-taking patterns for these A-G eligible students. Of California's A-G eligible students, 70 percent take an advanced math course in 12th grade (see Tables A4 and A5 in the Appendix for these percentages by race/ethnicity and socioeconomic groups).

Approximately 37 percent of all 2015-2016 seniors applied to a CSU (N=143, 251) and, of these, 73 percent were admitted (N=104,864). Over 70 percent of applicants and 75 percent of admits to CSU took an advanced or AP math class in 12th grade, as shown in Figure 10.[17] Perhaps not surprisingly, these percentages are very high compared to the population of all 12th graders (43 percent). Relatedly, about 26 percent of all 12th graders were not enrolled in a math course in 12th grade in contrast to only 15 percent of CSU applicants and admitted students.

Among all 12th graders in 2015-2016, 22 percent applied to the UC (N=86, 371) and 68 percent were admitted (N=58,866). Over 80 percent of UC applicants and 85 percent of UC admits took an advanced or AP math class in 12th grade. Again, these percentages are quite high compared to the population of all 12th graders.

Figure 10. 12th grade math course-taking among high school seniors in 2015-2016 who apply and are admitted to CSU/UC



Importantly, we observe differences in course-taking patterns by race/ethnicity and socioeconomic status among 12th graders, CSU and UC applicants and admitted students. Figure A6 in the Appendix illustrates differences by race/ethnicity. In particular, 84 percent of Asian admits to a CSU took an advanced math class above Algebra II in 12th grade compared to only 63 percent of African American applicants and 73 percent of Latinx applicants. Disparities—albeit smaller—also exist across socioeconomic status (see Figure A7 in the Appendix). Specifically, 75 percent of CSU applicants and 77 percent of CSU admits who were not socioeconomically disadvantaged took an advanced or AP math class in 12th grade, compared to 68 percent and 73 percent of socioeconomically disadvantaged applicants and admits, respectively.

Likewise, course-taking patterns among UC applicants and admitted students differ by race/ethnicity and socioeconomic status, though differences are overall smaller (perhaps due to the more selective nature of UC admissions). Nevertheless, among Asian applicants to the UC, 88 percent took an advanced math class above Algebra II in their senior year compared to only 73 percent of African American and 80 percent of Latinx UC applicants; patterns for admitted students are similar (see Figure A8 in the Appendix). Finally, we see differences among UC applicants and admitted students by socioeconomic status. Figure A9 illustrates that 85 percent of UC applicants and 87 percent of UC admits who were not socioeconomically disadvantaged took an advanced or AP math class in 12th grade compared to 81 percent and 86 percent of socioeconomically disadvantaged applicants and admits to the UC system, respectively.

Conclusion

Improving college readiness and postsecondary outcomes remains a priority for policymakers in the state of California, and mathematics is often touted as the culprit for students' weak academic preparation. In this report, we look at how many California high school seniors are enrolled in math, and what math courses they take. Using detailed course information from 2016-2018, we describe how course participation varies by individual characteristics, such as race/ethnicity; socioeconomic status; performance on the Smarter Balanced Assessments in 11th grade; and school characteristics, such as the concentration of low-income students in a school. We also describe these patterns for applicants and admitted students to the state's CSU and UC systems.

Our results reveal the following:

- Substantial variation exists in course-taking at the student level. Asian, White, and high-income students were enrolled in advanced math courses above Algebra II at rates much higher than African American, Latinx, or low-income students. Moreover, more females in each of the racial/ethnic groups took advanced math courses compared to males. These findings align with previous evidence on individual-level variation in course-taking (Conger et al., 2009).
- Between-school differences also exist in course-taking; nearly 40 percent of schools had no seniors enrolled in advanced math classes, though a great majority of them were alternative or very small schools, serving a small number of students. Moreover, schools with fewer low-income students had a larger percentage of students participating in advanced math courses compared to schools with higher concentrations of socioeconomically disadvantaged students. Our findings point towards disparities that exist in opportunities for college preparatory classes at the school level, which, as research has shown, directly impact educational attainment for students, particularly those who are socioeconomically disadvantaged (Crosnoe & Schneider, 2010). Moreover, evidence suggests that students in high-poverty schools benefit more from taking advanced courses (in terms of high school graduation and college enrollment rates) than those in higher-income schools (Rodriguez, 2018; Long et al., 2012), underscoring the importance of addressing differential access to advanced courses.
- Over 70 percent of students deemed *conditionally ready* satisfy the recommendations from the college readiness signal by enrolling in an AP or other advanced math course above Algebra II. The signal and corresponding course-taking have implications for students' postsecondary success (Jackson, 2015). Moreover, we find that there was little student-level variation in course-taking patterns among students who score similarly on the test, but disparities do

exist between schools. More students in high-poverty schools who received the *conditionally ready* signal enrolled in advanced math courses than students in higher-income schools, suggesting that schools serving more low-income students likely utilized the college readiness signal for math course placement to a greater extent than schools serving fewer low-income students.

- A significantly larger proportion of students who applied and were admitted to CSUs and UCs took advanced math courses in 12th grade compared to both the entire population of 12th graders and to all A-G eligible students. This is perhaps not surprising given related research, which suggests that students who take rigorous math courses are 5 to 6 percentage points more likely to enroll in college (Long et al., 2012) and to complete college (Altonji & Dunn, 1995; Clotfelter, Ladd & Hemelt, 2016; Gottfried, Bozick, & Srinivasan, 2014; Smith, Hurwitz & Avery, 2017; Trusty & Niles, 2003) than students who do not. Of course, it is difficult to establish a causal relationship between math course-taking and later college outcomes since the host of inputs that lead some students to enroll in advanced math in the first place (e.g., prior achievement, availability, support, advising, etc.) are also the inputs that determine who enrolls in college, where they enroll, and the likelihood of completing.
- Individual differences in course-taking patterns by race/ethnicity and socioeconomic status exist among CSU and UC applicants and admitted students. Latinx, African American, and low-income students who applied and were admitted to either the CSU or UC systems were underrepresented in advanced math courses.

Over the past year, the California State University has been considering the adoption of a policy that would require students to complete a fourth year of math for college entry—a move that has been the source of some controversy (Gordon, 2019). On the one hand, a substantial amount of research suggests that additional preparation in math will serve students well in their readiness for college. On the other hand, additional requirements may pose barriers for students who are either discouraged by an additional step in the already highly structured A-G curriculum, or are simply unable to access such a course. Our work provides important descriptive evidence of math course-taking patterns in the state of California. More specifically, we demonstrate that although a large majority of college-bound students are enrolled in math in their final year of high school, advanced math pathways are not equally accessed among our high school seniors, even those with similar performance on standardized assessments, and disparities in enrollment patterns by race/ethnicity and school characteristics exist. If CSU (or UC) plans to increase requirements for college eligibility, they need to be mindful of the critical need to equalize access to college preparation across our state. Our future work will continue to assess patterns of course-taking and unpack the plausible reasons for the individual- and school-level disparities observed.

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Endnotes

[1] By "prepared" we are referring to students who scored a level 4 on the Smarter Balanced 11th grade assessments and therefore receive a "prepared" signal from the California State University and California Community Colleges.

[2] We include traditional public schools (elementary, high, middle, K-12 and special education schools), continuation high schools, and alternative schools of choice, charter schools, county and district community schools, juvenile court schools, state special schools, and youth authority facilities in our analysis.

[3] Our sample only reflects enrolled 12th graders, not all of who necessarily graduate. In addition, our sample also does not include students who took the SBAC in 11th grade, but do not appear in the 12th grade course-taking data (the students may have dropped out, switched to a non-traditional school, or moved to a school outside the state).

[4] The indicator for socioeconomic disadvantage provided by the California Department of Education is determined from the combination of eligibility for free and reduced-price meals and parent level of education (i.e., students are eligible for FRPM *or* parents have not graduated from high school).

[5] Following methods established by Kurlaender, Reed, Cohen, Naven, Martorell, and Carrell (2018), we merge 12th grade course-taking data with 6 terms of applicant data. This method allows us to capture first-time college enrollment during the first year-and-a-half following a student's expected high school graduation, ensuring our sample includes as many students matriculating from high school to the CSU or UC system as possible.

[6] These students may be enrolled in a math course not through their regular public school (e.g., at a community college or online).

[7] In total, 93 percent of students in the first decile and 9 percent of students in the 10th decile of schools, on average, are socioeconomically disadvantaged.

[8] For additional information on California's Early Assessment Program, which aligns the state's 11th grade standards to college readiness signals see: https://www.calstate.edu/eap/documents/EAP-Poster.pdf

[9] CSU adopted a new policy last year removing any non-credit remediation courses and associated entry-level identification for remediation.

[10] The CSU academic senate has identified a list of approved courses that students may take in 12th grade to fulfill the college-readiness requirements for seniors deemed *conditionally ready*.

[11] Although these courses are typically required to be above Algebra II, CSU policy also permits Algebra II to satisfy the *conditionally ready* requirement in certain cases. See: https://www.csuenglishsuccess.org/hs_course_msw_counselors

[12] It is also possible that an early negative signal (being told you are not yet ready for college) could discourage students from attending college or push them into attending a less academically demanding college; although, prior research suggests otherwise (Jackson, 2015).

[13] Schools serving higher-income students may be more focused on sending students to more selective schools (i.e. UC and private or out of state), and therefore may find the college readiness signal provided in the 11th grade assessment less relevant.

[14] For more information on student eligibility rates (beyond A-G courses) for admissions to CSU and UC see https://www.cde.ca.gov/nr/ne/yr17/yr17rel58.asp

[15] CSU and UC eligibility consists of 15 college preparatory courses with a grade of C- or better: History/Social Studies "A" (Two years, including one year of world history, cultures and geography; and one year of US history, or a half-year of US history AND a half-year of American government.); English "B" (Four years of college-preparatory English.); Math "C" (Three years of college preparatory mathematics; the minimum pattern is Algebra I, geometry, and Algebra II. Math courses taken in the 7th and 8th grades that the student's high school accepts as equivalent to its own may be used to fulfill a part of this requirement.); Science "D" (Two years of laboratory science—three years recommended—in at least two of three subjects: biology, chemistry, and physics.); Language other than English "E" (Two years of the same language other than English. Courses taken in the 7th and 8th grades may be used to fulfill part of this requirement if the student's high school accepts them as equivalent to its own courses.); Visual and Performing Arts "F" (One yearlong visual or performing arts class such as dance, drama, music, or visual art.); College Preparatory Elective "G" (One year chosen from additional "A-F" courses beyond those used to satisfy the requirements above, or courses that have been approved elective classes.)

[16] The College/Career Indicator (CCI) of the California School Dashboard includes eight pathways through which a student may demonstrate preparedness for college and career. To be deemed "prepared" on the A-G pathway, a student must complete the necessary A-G courses with a C- or better and one of the following: score a Level 3 or higher on ELA/math and Level 2 or higher in other subject area; complete 1 semester/2 quarters of college credit courses with a grade of C- or better in academic/CTE subjects; score a 3 or higher on one AP exam; score a 4 or higher on one IB exam; or complete a CTE pathway. For the 2015-16 high school graduates, 33% were "prepared" on the A-G indicator in the CCI; 40% completed A-G courses without also completing the additional criteria required for "prepared" status on the CCI.

[17] It is important to note that available data did not allow researchers to calculate the number of 2015-2016 seniors who applied and were admitted to CSU and UC and completed an advanced mathematics course in 11th grade or earlier. It is therefore likely that the percentage of CSU and UC applicants and admitted students completing Algebra II or other advanced math courses are underestimated.

About

Policy Analysis for California Education (PACE) is an independent, non-partisan research center led by faculty directors at Stanford University, the University of Southern California, the University of California Davis, the University of California Los Angeles, and the University of California Berkeley. PACE seeks to define and sustain a long-term strategy for comprehensive policy reform and continuous improvement in performance at all levels of California's education system, from early childhood to postsecondary education and training. PACE bridges the gap between research and policy, working with scholars from California's leading universities and with state and local policymakers to increase the impact of academic research on educational policy in California.

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