



Getting Down to **FACTS**



Does your Math Pathway Make a Difference? High School Mathematics and College Outcomes

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Abstract

High school math has been the subject of countless discussions among California policymakers, educators, researchers, and other stakeholders in recent years. This study extends prior work by drawing on student- and course-level data for the census of California high school graduates in 2022 in the first statewide study exploring how math coursetaking is associated with college enrollment. Results reveal that student enrollment in more years of high school math (4 years compared to 3 or fewer) and student enrollment in advanced math (Precalculus, AP-Statistics, and Calculus) are associated with greater likelihood of college attendance, particularly 4-year college enrollment. Mathematics intensity appears to be especially consequential for socioeconomically disadvantaged (SED) students, suggesting that more opportunities and support for advanced math coursetaking could play a role in narrowing the 4-year college enrollment gaps between SED and non-SED students.

Acknowledgements

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Introduction

Discussions regarding the importance of high school math coursetaking are ubiquitous in the education policy space. In just the past five years, policymakers, educators, researchers, and other stakeholders in California have engaged in policy discussions about math admissions requirements for public 4-year universities, high school math course sequencing, and the overall mathematical preparedness of public high school students for college (Academic Senate of the CSU, 2023; Burdman, 2025; Darling-Hammond, 2024; Fensterwald, 2023; University of California, 2024). Moreover, the state has set an ambitious target of increasing postsecondary attainment to 70% by 2030 (State of California, Office of the Governor, 2022), and invested in postsecondary preparation for jobs critical to the state’s economic, environmental, and social wellbeing, many of which are in Science, Technology, Engineering, and Mathematics (STEM) fields (Master Plan for Career Education, 2025; Golden State Pathways Program, 2022). Together, these efforts make preparation for college in mathematics a key policy target.

These policy conversations are important for California student outcomes, as research shows that mathematical coursework and preparation is connected to an array of postsecondary outcomes. In particular, taking advanced math courses during high school is positively associated with enrollment in college (Dougherty et al., 2017; Kim et al., 2015; Long et al., 2012; Wainstein et al., 2023) and key to admission and success in STEM majors (Burdman et al., 2024; ICAS, 2025; Jia, 2021; Wainstein et al., 2023). In addition to college access, both more math taking and advanced math taking are linked to higher rates of persistence in college, degree completion and higher wages after college (Adelman, 1999, 2006; Black et al., 2021; Rose & Betts, 2004; Smith et al., 2017).

Recent research examined the relationship between high school math and postsecondary outcomes for students graduating from Los Angeles Unified School District schools and found that students who take math in 12th grade are more likely to enroll and persist at 4-year universities than their peers (Wainstein et al., 2023). Researchers also found that the type of math courses students take also matters (Wainstein et al., 2023). More research—both for confirmation through replication and to understand how current results extend to other populations—about the connection between high school mathtaking and college outcomes is necessary so that California policy makers can make informed decisions about mathematical preparation for college. Of particular interest are the outcomes

of students who take four full years of math instruction in high school, as well as the outcomes of students who take math courses beyond Algebra 2—the minimum requirement for admissions to California’s 4-year public universities.

This paper contributes important descriptive evidence to inform these ongoing policy discussions. Drawing on student-level data, including high school math coursetaking and postsecondary enrollment, for the census of California public high school graduates in 2022, we investigate the following research questions:

How many years of mathematics do California public high school students take? How are the number of years of high school math coursetaking related to college enrollment?

Are students who take math courses beyond Algebra 2 (or its equivalent) more likely to enroll in college? To what extent do the particular math courses students take relate to college enrollment?

How do each of these relationships vary by key student characteristics, specifically socioeconomically disadvantaged status and performance on standardized 8th grade math assessments?

Literature & Policy

High school mathematics coursetaking and college outcomes

A rich body of literature has established the connection between rigorous coursetaking in high school and educational outcomes for students. In fact, research indicates that engagement in advanced coursework or college-level classes while in high school is associated with a greater likelihood of high school graduation, increased probability of matriculating to college, better grades in college courses, and increased likelihood of earning a college degree (Adelman, 1999, 2006; Allen & Dadgar, 2012; An & Taylor, 2019; Avery et al., 2018; Chajewski et al., 2011; DiBenedetto, 2018; Evans, 2018; Horn & Kojaku, 2001; Jackson, 2014; Lee, 2002; Lee et al., 1997; Morgan & Klaric, 2007; Patrick et al., 2020; Rose & Betts, 2004; Speroni, 2011; Velasco et al., 2025; Woods et al., 2018). Importantly, research also indicates that the benefits of rigorous high school coursetaking as they relate to college outcomes are particularly strong for historically underrepresented students (An, 2013; Lee et al., 2022; Long et al., 2012).

Within this broad body of literature, high school math coursetaking has been examined closely, with findings indicating strong relationships between high school students' math enrollment and college and career outcomes. Factors in high school math coursetaking that seem to matter for college and career outcomes include the number of years of math and the types of courses. In particular, taking math during 12th grade is positively correlated with college eligibility and enrollment (Wainstein et al., 2023). Additionally, advanced math taking is associated with college attendance, including the type of college (2-year vs. 4-year) to which students have access (Byun et al., 2014; Dougherty et al., 2017; Kim et al., 2015; Long et al., 2012; Wainstein et al., 2023) as well as with an increased probability of completing college and earning a degree (Adelman, 1999, 2006; Smith et al., 2017). The importance of high school math courses extends beyond college to career outcomes, with advanced math coursetaking linked to pursuit of STEM careers and higher wages after college (Adelman, 1999, 2006; Rose & Betts, 2004).

Given the strong relationship between high school math and college and employment outcomes, much of the literature focuses on the success of various policies in increasing enrollment in high school math classes. For example, some research has explored policies related to state minimum high school graduation requirements for mathematics, with results revealing a positive impact on high school math coursetaking and later earnings for Black students and no impact for White students (Goodman, 2019). Other studies extensively investigated policies related to taking Algebra 1 in 8th grade with mixed results. In one California study, encouraging students to take Algebra 1 in 8th grade led to increased enrollments in advanced math courses in high school, especially for traditionally disadvantaged groups (McEachin et al., 2020). Another study found that positive effects of Algebra 1 in 8th grade were more pronounced among students who received additional support alongside their Algebra placement (Dee & Huffaker, 2026). However, broader acceleration of California students to Algebra in 8th grade led to negative effects on math test scores in high school, especially in large districts (Domina et al., 2015) and among traditionally underserved student subgroups (Clotfelter et al., 2015). Additionally, research indicates that students who were poorly prepared for Algebra in 8th grade were unlikely to perform better upon repeating the course in high school (Finkelstein et al., 2012).

Beyond high school graduation requirements and early acceleration, research also explores *which* advanced math courses are best for students. In a pilot program that expanded access to

advanced math in Denmark, the addition of more advanced math tracks was associated with positive college and labor market outcomes (Joensen & Nielsen, 2009). A 2025 Fordham report argues that students taking AP Statistics instead of AP Calculus graduate from college at similar rates and are likely to make about the same amount of money. However, students in AP Statistics are less likely to enroll at selective post-secondary institutions or to major in STEM fields. While the gap in advanced math coursetaking between White and Asian and other students has grown, some evidence indicates that policy nudges may encourage advanced math coursetaking for disadvantaged high school students in the California context (Avery & Goodman, 2022; Giari et al., 2025).

It is important to consider the methods employed in existing research, as students who enroll in more years of high school math or in higher level math courses are likely systematically different from those who do not—in prior achievement, postsecondary aspirations, family resources, and access to information and guidance. As such researchers cannot simply compare the outcomes of students who took a certain course (or a certain amount of math) with the outcomes of students who did not take a course (or a certain amount of math) in order to determine the effect of the course. Any observed divergence in the outcomes of these two groups is a combination of the effect of taking the course, if any, and the effect of the differences in the background of the two groups of students. Several prior papers have addressed these selection issues by using propensity score matching to restrict comparisons of students who take a course to otherwise observably similar students (Byun et al., 2014; Wainstein et al., 2023).

Moreover, many characteristics that increase the likelihood of selecting advanced coursework also independently predict college enrollment, degree completion, and even labor market success. A number of other papers argue that certain changes in policies or practices that shape course options are “natural” experiments and can be used to circumvent these selection issues. For example, Aughinbaugh (2012) included fixed effects models to control for unobservable family level effects and found that advanced math was associated with increased college enrollment. Rose and Betts (2004) and Altonji (1995) used an instrumental variable strategy to investigate this relationship. Goodman (2019) used an event-study model to examine the impact of changes to state minimum high school graduation requirements for mathematics.

Whatever the methods, the evidence appears clear. When controlling for observable characteristics, advanced math coursetaking in high school has a positive effect on subsequent outcomes, particularly for historically underserved students.

High school math coursetaking: A California context

In light of the importance of mathematics for postsecondary access and success, it is critical to consider the current policy landscape surrounding high school mathematics in California. California adopted the Common Core State Standards in 2010, which outline standards for mathematics instruction in the state. The Mathematics Framework for California Public Schools (Math Framework), adopted in 2023, guides educators, parents, and publishers in implementing the Common Core math standards. While much of the framework centers on pedagogy, the Math Framework also provides guidance on the types and sequencing of middle school and high school math courses, including traditional mathematics pathways (Algebra 1, Geometry, Algebra 2, Precalculus) and integrated math pathways (Integrated Math 1, Math 2, Math 3, Precalculus). The Math Framework also recommends that students have a variety of math courses available to them to meet their needs, including a strong pathway to Calculus for those intending to major in STEM fields and courses like statistics for those who plan to major in social science. The Math Framework further notes that courses like statistics should be designed so they may also lead to postsecondary education or careers in STEM fields.

In addition to clear standards about what math content students should learn in high school, California requires that students complete two years of math, including a course (or courses) equivalent to Algebra 1 or Integrated Math 1 to earn a high school diploma. Compared to most other states, California requires fewer math courses to earn a high school diploma. Only Montana and Maine also require only two years of mathematics, with a majority of states requiring three, and 19 states requiring four years of mathematics (Gao et al., 2017; Peltzman et al., 2025). However, local school districts in California may require additional years of mathematics to graduate, and many do, with some districts requiring up to four years of math (Gao et al., 2017).

Beyond high school graduation, mathematics courses play an important role in college access across the state. Admissions requirements for the California State University (CSU) and University of California (UC) systems require applicants to take and pass (with a C or better) 15 high school

courses—known as the A-G courses. Among those requirements are three years of high school math, including a course equivalent to Algebra 2.¹ In 2022, 54% of graduates statewide met all of the criteria for A-G (Kurlaender et al., 2026).²

There are also potential admission benefits to enrolling in four years of mathematics. First, while it is not required at California public universities, both the CSU and the UC recommend that students take a fourth year of math.³ The CSU considered a proposal to add a fourth year of quantitative reasoning (often fulfilled by a math course) as a requirement in 2019, but abandoned the proposal in 2022.⁴ However, almost all students (96.8%) who meet A-G requirements and apply to or attend a CSU take four years of quantitative reasoning coursework (Sepanik et. al, 2022).

Advanced mathematics courses such as Precalculus, Calculus, and AP Statistics can also specifically benefit students who are considering a major in STEM fields in college. Recently, the Intersegmental Committee of the Academic Senates (ICAS)—a joint committee of academic senate members from the California Community Colleges (CCC), CSU, and UC—published a position paper outlining the recommended math preparation for six broad groups of majors, including recommendations about the math courses students should take their senior year of high school (ICAS, 2025). They recommend Precalculus and Calculus for students thinking of majoring in Data Sciences, Statistics, Physics, Chemistry, Engineering, Mathematics, and Computer Sciences. In addition, admission to some CSU and UC campuses and programs of study can be competitive, and high school math course completion and performance may be used as a signal of college readiness and institutional fit. Admissions officers report that they believe students who take Calculus while in high school are more likely to succeed in college (Anderson & Burdman, 2022; Burdman et. al., 2024).

¹ The full set of high school courses required for admissions eligibility at CSU or UC campuses are known as the A-G Requirements and include courses in English language arts, social science/history, math, science, performing arts, and approved electives. Students must pass courses with a grade of C or better to be eligible. Area C outlines the math requirements. For more information see:

<https://admission.universityofcalifornia.edu/admission-requirements/first-year-requirements/subject-requirement-a-g.html>

² The rate of A-G completion cited here may differ from other publicly reported rates due to differences in sample construction.

³ UC freshman admissions page:

<https://admission.universityofcalifornia.edu/admission-requirements/first-year-requirements/subject-requirement-a-g.html>

CSU freshman admissions page:

https://www.calstate.edu/apply/freshman/getting_into_the_csu/pages/admission-requirements.aspx

⁴ <https://edsources.org/2022/csu-will-abandon-proposal-to-create-fourth-year-math-requirement-for-admission/681359>

Recent research by the authors, and published by Policy Analysis for California Education (PACE) in April 2026, focuses on mathematics coursetaking patterns among California public high school students (Dykeman et al., 2026) as well as the role of high schools in mathematics course enrollment (Larson et al., 2026). Using student-level and school-level data for eight recent statewide cohorts of high school completers, we found that despite the association with high school graduation, college access, and degree completion, almost 30% of 12th grade students in 2024 did not enroll in a math class, a trend fairly consistent across socioeconomic background and gender subgroups. Moreover, at least one in five students of every racial/ethnic subgroup were not enrolling in a math class their senior year. Further, many of those that did enroll in math in 12th grade were not enrolled in advanced coursework. In fact, over the past decade, enrollment in Precalculus and Calculus has declined. At the same time, enrollment in Non-AP Statistics has grown, though not enough to fully offset the decline in Precalculus and Calculus enrollment (Dykeman et al., 2026).

We also found that schools play a substantial role in the differences observed in mathematics enrollment among students (Larson et al., 2026). In fact, controlling for student demographic characteristics, about 17.5% of the total variance in 12th grade math enrollment for the 2024 cohort was explained by differences between schools. One way schools shape these differences is through the mathematics courses they offer. For example, while courses like Algebra 2 or its equivalent are universally offered, the percentage of schools offering statistics has increased rapidly over the past decade, rising from 43% in 2015 to 63% by 2024, consistent with the growth of student enrollment in statistics courses across the state. Additionally, conditional on student demographic characteristics, 10.8% of calculus enrollment and 13.1% of AP Statistics enrollment was explained by differences between schools.

Lastly, in a complementary report, *High School Coursetaking in California: A Primer* from Getting Down to Facts, we highlight the extent to which students enroll in advanced math while investigating the relationship between advanced math coursetaking and college attendance and how that relationship varies by student subgroups (Kurlaender et al., 2026). About 40% of 2022 students took an advanced math course—defined in Kurlaender et al. (2026) as Precalculus, Trigonometry, or Calculus—during high school but that rate varied substantively across groups. Asian and Filipino students were much more likely to enroll in advanced math courses than their Hispanic, Black, and

American Indian peers. Female students were also more likely to enroll in advanced math than males, and students who were not socioeconomically disadvantaged (SED) and those who were English proficient were more likely to enroll in advanced math than their peers who were SED or English learners. Differences in coursetaking likely matter, as advanced math courses are positively associated with college enrollment. About 74% of students who took Algebra 2 (or its equivalent) and 85% of students who took Precalculus or equivalent enrolled in college. For all subgroups of students, the probability of attending college for those taking Algebra 2 or Precalculus was higher than those who did not take the courses, in part due to the fact that Algebra 2 is a requirement for admissions to California's public 4-year universities. Importantly, among student subgroups with lower likelihood of attending college in general—male students, SED students, English learners—participation in and completion of college and career preparatory coursework was associated with a larger difference in probability of attending college than it was for student subgroups with a higher unconditional probability of college attendance—female students, non-SED students, and English proficient students, respectively.

This study will extend these results, drawing on the most recent data available to estimate how the number of years of math taken in high school and enrollment in a given math course is associated with college enrollment. Considering persistent disparities in math enrollment across the state, this work aims to contribute evidence on the role of math in students' educational journeys, informing efforts to increase and diversify math pathways in high school.

Data & Methods

This study focuses on the connection between high school math enrollment and college enrollment for the California public high school class of 2022. Data on student demographics, academic achievement, and course enrollment are drawn from the California Department of Education (CDE) and then merged to data on college enrollment for all students from the National Student Clearinghouse (NSC).

Information from CDE comes from three separate data files. Socioeconomically disadvantaged status, race/ethnicity, gender, and school of primary enrollment are drawn from the California Longitudinal Pupil Achievement Data System (CALPADS) 2021-2022 Cumulative Enrollment file.

Information on 8th grade standardized test performance comes from the California Assessment of Students Performance and Progress (CAASPP) student-level data file for the 2017-2018 academic year. Finally, course enrollment data are from the CALPADS Course Completion files for the 2018-2019 through 2021-2022 academic years.

The CALPADS Course Completion data include course-by-term data for public high school students. Each course in the data is identified using its state course code which reflects the curriculum content of the course. We use these state course codes to sort math courses into 7 categories: Less than Algebra 2 (or Less than Integrated Math 3); Algebra 2 (or Integrated Math 3); Precalculus or Trigonometry;⁵ Calculus;⁶ Non-AP Statistics (includes Non-AP Statistics and Data Science courses); AP Statistics;⁷ and Other (including advanced Calculus courses, International Baccalaureate courses, Integrated Math 4, QRAT, TQR, and mathematics dual enrollment for high school credit).⁸ We also track which students are not enrolled in any math courses. These categories reflect those utilized in Dykeman et al. (2026) with minor adjustments.

This student-level coursetaking and demographic data is then merged with college enrollment data from the NSC. The NSC reports the specific college of enrollment for individual students at over 95% of institutions of higher education in the United States (Dynarski et al., 2013). This study examines three college outcomes (any college enrollment, enrollment in a 2-year college,⁹ and enrollment in a 4-year college) in the 16 months following 2022 high school graduation.¹⁰

⁵ AP Precalculus was not available for the 2022 high school graduation cohort. It was first introduced in 2023-24.

⁶ Includes Calculus AB, Calculus BC, and other Calculus courses. We do not disaggregate AP Calculus from other Calculus courses due to small cell sizes and the fact that they all have similar prerequisites.

⁷ We disaggregate Non-AP Statistics from AP Statistics due to the wide variety of Non-AP Statistics curricula and how they are viewed by college admissions officers (Burdman et al., 2024).

⁸ The Quantitative Reasoning with Advanced Math Topics (QRAT) and Transition to Quantitative Reasoning (TQR) courses were developed by high school educators in conjunction with faculty at 4-year California Universities to serve as alternative 12th grade math courses beyond the traditional Precalculus or statistics options. International Baccalaureate (IB) courses in the “Other” category include IB Higher Level and Standard Level coursework.

⁹ Results for the 2-year college outcomes are available in the Appendix.

¹⁰ Any College enrollment includes enrollment in any US college or university in the NSC data. In our data, 2-year colleges are mostly comprised of California Community Colleges, but also include some 2-year private California Universities and 2-year out-of-state colleges. The 4-year colleges in the sample are primarily California State Universities (CSU) and University of California (UC) but also include nonprofit California private 4-year schools like Stanford, and for-profit private and out-of-state universities. Students only enrolled for summer or winter intersession terms within 16 months of graduation are not counted as having enrolled in college.

Sample

This study examines the census of 12th graders enrolled in California public schools as of April 15th, 2022. The sample is limited to students who enrolled at a California public school for a full 4-years and who are included in each of the 2018-2019 through 2021-2022 Course Completion files. Additional sample restrictions include coverage in one of the 2020-2021, 2021-2022, or 2022-2023 CALPADS College and Career Readiness Indicator (CCI) accountability cohorts, as well as inclusion in the 2022 CALPADS High School Completer data file. The final analytical sample includes 344,852 students.

Outcomes

In this report we examine two key measures of college enrollment: any college going overall (inclusive of 2-year and 4-year institutions) and 4-year college enrollment.¹¹

In California about 68% of students enroll in college within 16 months of graduation. About 35% of high school graduates go to 2-year colleges while 33% go to 4-year colleges (see Table A1 in the Appendix). Nearly all of the California high school graduates who matriculate to a 2-year college enroll in the California Community College system, a network of 116 open-access colleges. Graduates who matriculate to 4-year colleges attend a wide array of in-state and out-of-state colleges, as well as public and private institutions. Across all types of colleges, admission requirements and rates vary. All of these college enrollments are captured in our “any college” enrollment measure, where we investigate the relationship between high school math coursetaking and enrollment in any type of college.

We consider 4-year college enrollment as a separate outcome, as 4-year colleges typically have stricter eligibility requirements and some have competitive admissions. About two-thirds of California high school graduates who attend a 4-year college do so at the state’s public institutions: the California State University (CSU) and University of California (UC). These colleges have similar admissions requirements when it comes to high school course taking; these requirements are known as the A-G course requirements and include 3 years of math (with a grade C or better) and at least Algebra 2 or Integrated Math 3. Moreover, both the CSU and UC systems recommend four years of math for freshman applicants. Admissions rates vary across individual campuses in both systems. For

¹¹ We also examine the specific relationship between high school coursetaking and 2-year college enrollment separately, but those results are not included in the main paper and should be interpreted with caution. See the Appendix for details.

example, about 77% of California residents who apply to a UC campus are admitted to at least one UC campus, with admit rates ranging from 96% at UC Merced to 10% at UCLA.¹² California State Universities are more open access, with 96% of California resident freshmen applicants admitted, but rates range across the 23 campuses, from 96% at CSU Stanislaus to 26% at Cal Poly San Luis Obispo.¹³ Other private and out-of-state 4-year institutions have varying levels of competitive admissions and entrance requirements.

Student Subgroups

We explore differences in high school math coursetaking and college enrollment for two key student subgroups: socioeconomically disadvantaged status and prior academic performance. Results by race/ethnicity and English learner status can be found in the appendix. Socioeconomic disadvantage (SED) is a category defined by CDE for students who are either eligible for subsidized lunch or who do not have a parent or guardian who graduated from high school. Prior academic performance is measured by students' 8th grade scale scores on their Smarter Balanced Assessments Consortium (SBAC) assessments in math and English Language Arts (ELA).¹⁴ For each test (math and ELA) students' scores can be categorized as meeting one of four performance levels: Standard Not Met, Standard Nearly Met, Standard Met, and Standard Exceeded. We use these performance levels on the math assessment to disaggregate many of our results. Race/ethnicity are defined by the eight categories provided by the CDE: American Indian, Asian, Black, Filipino, Hispanic, Pacific Islander, White, and two or more races or ethnicities. English learner status is also provided by the CDE and is measured on April 15, 2022.¹⁵ Table A1 in the Appendix includes descriptive statistics on the analytic sample.

¹² 2025 Data From University of California Information Center:

<https://www.universityofcalifornia.edu/about-us/information-center/freshman-admissions-summary>

¹³ 2025 Data from CSU Data Dashboards

https://tableau.calstate.edu/views/Application_withsystemwide/AppAdmitEnroll?iframeSizedToWindow=true&%3Aembed=y&%3AshowAppBanner=false&%3Adisplay_count=no&%3Arender=true&%3AshowVizHome=no&%3Aorigin=viz_share_link

¹⁴ For more information about the SBAC, please see: <<https://www.cde.ca.gov/ta/tg/sa/sbacsummative.asp>>

¹⁵ Given this designation during senior year, English learners in our sample are likely recent newcomers to the U.S. or long-term English learners, though that information is unavailable in these data files. We acknowledge that many more students graduating from California public high schools were identified as English learners at some point in their educational trajectories and that further research is necessary to better understand the educational outcomes of students who were ever English learners.

Methods

While observing high school math enrollment and college outcomes is straightforward, credibly documenting that any given high school outcome causes a college outcome is much more difficult. High school math course-taking decisions and college-going are jointly determined. Students' math classes may affect their likelihood of applying to, being accepted into, and enrolling in college. At the same time, students' college aspirations, the knowledge and information to which they have access, and their prior educational experiences all affect the math classes they take. When we observe that students who take more and/or higher levels of math are more likely to go to college, we cannot know how much of this effect is caused by the math classes improving student outcomes and how much is caused by students who want to go (or are advised to go) to college choosing to take more math. Instead of attempting to identify a causal link, this study carefully considers the associative relationship between high school math and college enrollment. For each set of descriptive statistics, we highlight important findings and discuss likely explanations for these relationships.

The results below are primarily derived from regression analysis to study the differences in college enrollment patterns across students who take different high school math courses. These analyses regress one of the college enrollment outcomes—enrollment in any college (both 2- and 4-year), enrollment in 2-year college,¹⁶ and enrollment in 4-year college—on indicators representing measures of high school math coursetaking under study (i.e. how much or what type of math to take), a set of student-level demographic controls, and school fixed effects. Results from these regressions are presented in the Figures below; accompanying significance tests are available in the Appendix.

Results

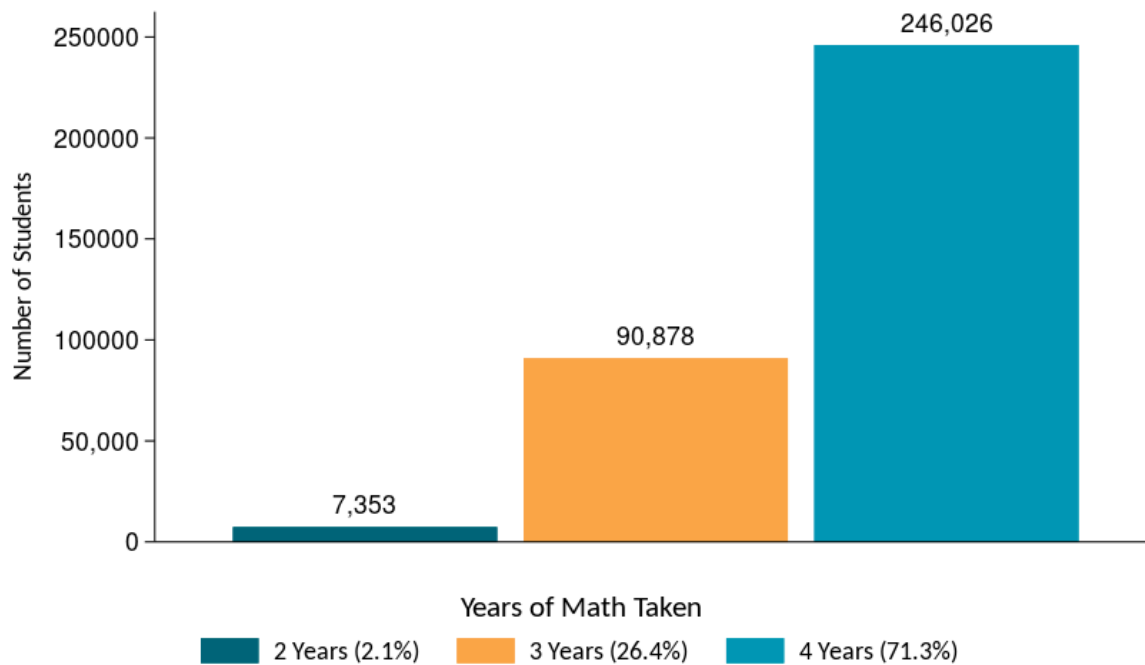
How much math? Differences in college enrollment by the number of years of high school math

Nearly all (97.7%) students who completed high school statewide in 2022 took more than the two years of math required for graduation. In fact, 71.3% of high school completers took a full four

¹⁶ Results for 2-year college enrollment can be found in the appendix.

years of math, while 26.4% took 3 years and only 2.1% took two years.¹⁷ This is important information as policy discussions have, at times, focused on raising the graduation requirements to include more years of math and/or align with the A-G course requirements. Evidence indicates that there may not be a need for a revision to the statewide graduation requirements in regard to math, as nearly all students exceeded this threshold whether as a result of local policies, college admissions requirements, or personal choice.

Figure 1. Years of math taken by California high school completers in 2022



Note. 595 students (0.2%) took less than 2 years of math before completing high school.

Generally, student enrollment in more years of math is associated with greater likelihood of college attendance. In our sample, 68.2% of high school graduates attended college within 16 months,¹⁸ 34.8% of high school graduates enrolled in a 2-year college while 33.4% (or 49% of high

¹⁷ It is important to note that our sample restrictions (only students who completed high school, have 4-years of coursetaking data, and are included in the College/Career Indicator accountability data) potentially disproportionately exclude those who take only a few years of math. In our sample, 0.2% of students take fewer than two years of math; these students likely have specialized learning needs.

¹⁸ This number is higher than the 2021-2022 16-month college going rate of 62% reported by the CDE <<https://dq.cde.ca.gov/dataquest/>>. College going rates are sensitive to who is included in the sample. The CDE includes all

school graduates who attend college) attended a 4-year college or university. Nearly 70.9% of students who took four years of math enrolled in college, compared to 58.1% of students who took three or fewer years of math (See Figure 2).¹⁹ The number of years of math appears to matter more for 4-year college enrollment, with 38.2% of students who took four years of math during high school enrolling in a 4-year college compared to 20.1% of students who took three years of math or less.

Although additional years of math may increase the likelihood of college enrollment, the observed differences in college attendance between students who took three years or less of math in high school and students who took four years cannot be fully attributed to the differences in years of math taken. Many factors affect students' probabilities of enrolling in college. Although we cannot account for each factor that plays a role, we can control for students' prior academic performance on 8th grade assessments, the high school attended, and a number of demographic characteristics (race, socioeconomic status, and gender). In this manner, we ensure that we are comparing students exposed to similar conditions and with similar background characteristics when investigating the relationship between high school math coursetaking and the probability of attending college. Figure 2 illustrates the importance of controlling for these variables. When we include the control variables listed above, the probability that students who took four years of math in high school attend college shrinks to 70%, while the probability that students who took three years or less enroll in college grows to 63.4%, leading to an almost 50% reduction in the difference in college attendance between the two groups—from a 12.8 percentage point difference to a 6.6 percentage point difference.

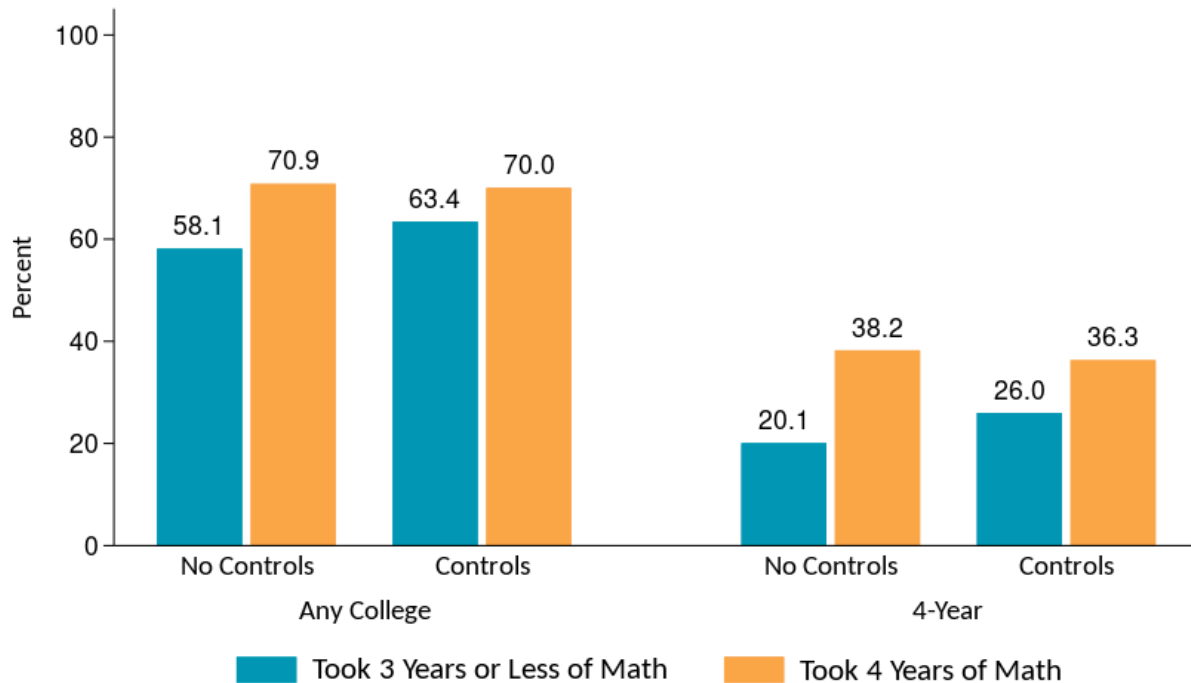
The gap in 4-year college-going rates between students who took three and four years of math is about 40% smaller after adjusting for student demographic characteristics, 8th grade SBAC scores, and school attended, with 36.3% of students who took four years of math and 26% of students who took three years of math or less likely to enroll in a 4-year college. Going forward, we only report results that are adjusted for these student characteristics.²⁰ Significance testing between estimates of college enrollment for different groups presented in the figures are available in the Appendix.

high school completers in their calculations. Although we started with the population of all high school completers, for our analytical sample, we excluded students who did not have four years of course-taking data. We further excluded students not in the 2020-21, 2021-22, or 2022-23 accountability files to make the results comparable to Larson et al (2016).

¹⁹ Due to the small numbers of students who took less than three years of math, we divide students into two groups, those who took four years of math and those who took three years or less, for the remainder of our investigation about the relationship between years of high school math and college enrollment.

²⁰ Unadjusted estimates are available from the authors on request.

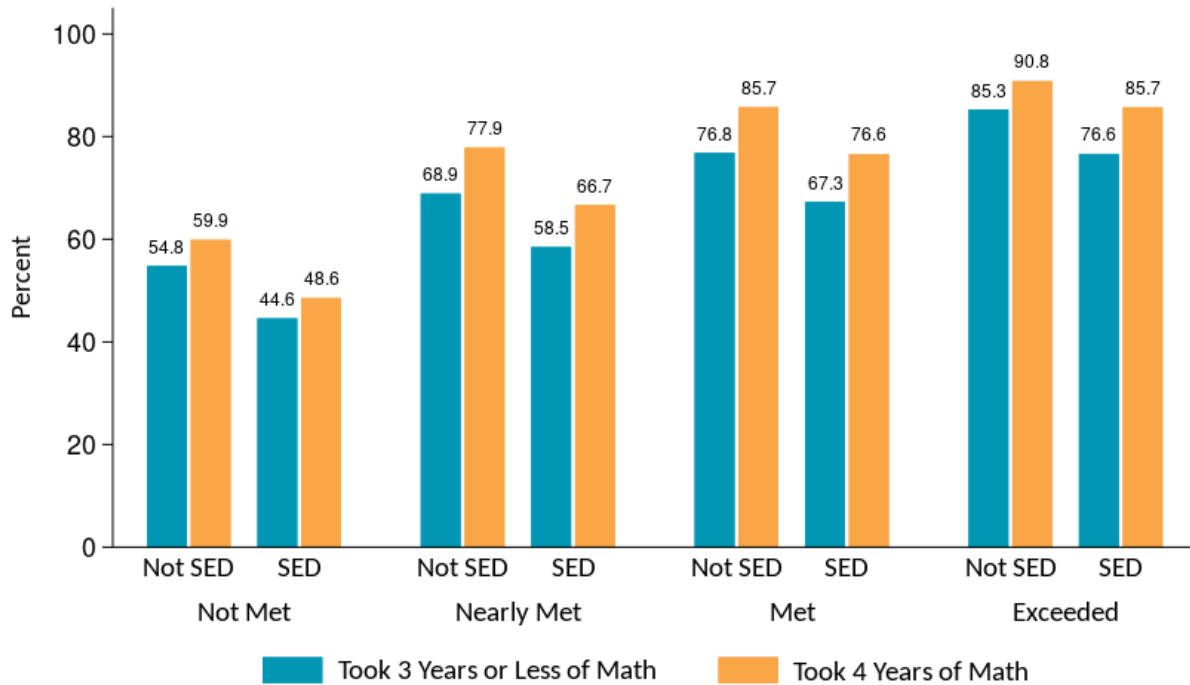
Figure 2. College enrollment by years of math coursetaking in high school



Note. Predicted probabilities are derived from the model: $y_i = \alpha d_i + x_i' b + \varepsilon_i$, where $d_i = 1$ if student i took 4-years of math and zero otherwise and x_i' is a vector of student characteristics that is empty when the model has no controls. Models with controls include gender, race/ethnicity, SED status, math and ELA scale scores on the 8th grade SBAC, and school fixed effects. The results from significance testing between groups are available in the Appendix.

In general, the relationship between the number of years of math and the likelihood of college attendance is consistent across key subgroups of students. Figure 3 shows that irrespective of SED or prior performance, students who took four years of math were more likely to attend college than students who took three or fewer years of math. Figure 3 also reveals other noteworthy patterns: students with higher prior academic achievement (i.e., 8th grade standardized assessments) were more likely to attend college, on average, than students with lower performance, regardless of the number of years of math in high school. Additionally, students who were not socioeconomically disadvantaged were more likely to attend college than their SED peers. Even with these differences, among students with similar SED status and 8th grade performance levels, students who took four years of math were more likely to attend college.

Figure 3. Any college enrollment (2- and 4-year) by years of high school math, academic proficiency level in 8th grade math, and SED status

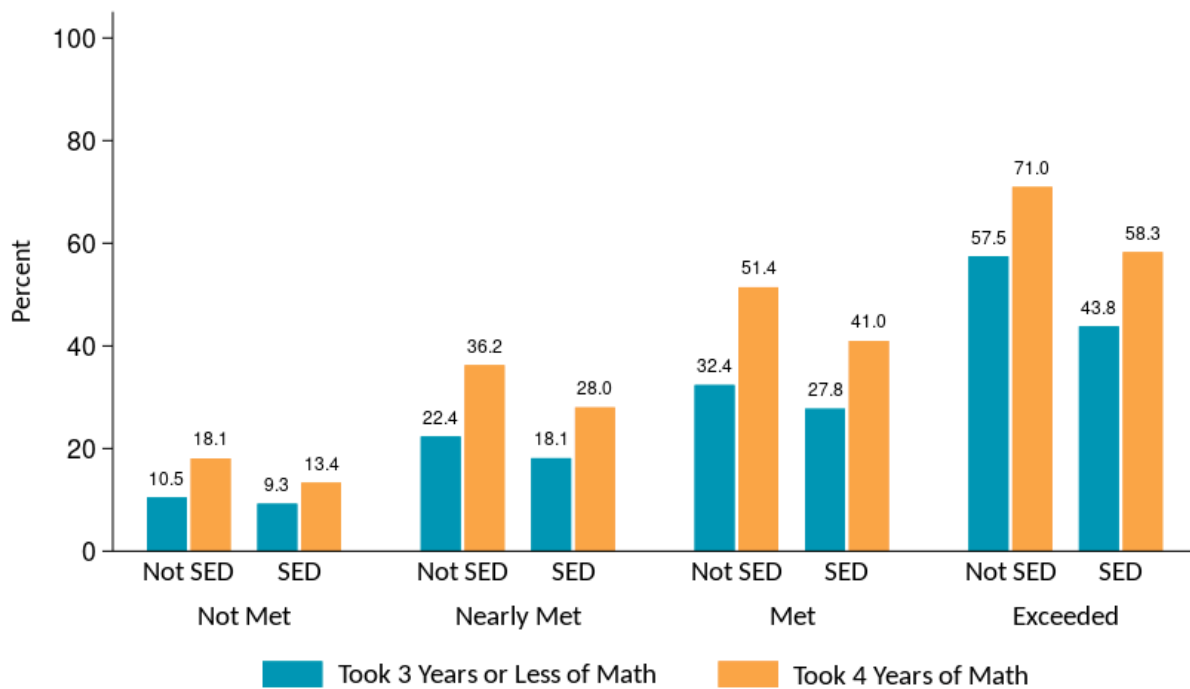


Note. Predicted probabilities are derived from the model: $y_i = \alpha d_i + x_i' b + \varepsilon_i$, where $d_i = 1$ if student i took 4-years of math and zero otherwise and x_i' is a vector of student characteristics including gender, race/ethnicity, SED, math and ELA scale scores on the 8th grade SBAC, and school fixed effects. The results from significance testing between groups are available in the Appendix.

The relationship between the number of years of math coursetaking and college enrollment is more pronounced for 4-year college enrollment. Just as we observed with overall college enrollment, SED students and those who scored lower on the 8th grade assessment were less likely to attend a 4-year college, while non-SED students and those who *met* or *exceeded* state standards were more likely to attend. Importantly, among non-SED students, the increased likelihood of 4-year college attendance for students who took four years of math compared to those who took three or fewer is greater for students who *met* the math standards on the 8th grade SBAC than for students demonstrating either lower or higher levels of performance. This is likely due to the fact that students who exceeded standards were quite likely to go to 4-year college irrespective of the amount of math they took. The students who met the standards, being less likely to attend 4-year college on average, had a larger potential change in likelihood of attendance. Among SED students, the increased likelihood

of 4-year college attendance is larger with each proficiency level on the 8th grade math SBAC; the increased likelihood of attending 4-year college when taking four years of high school math, compared to three or fewer years, is about 4 percentage points for SED students who did not meet the math standards, 10 percentage points for those who nearly met the standards, 13 percentage points for those who met standards, and 15 percentage points for those who exceeded the standards. Importantly, the gaps in 4-year college enrollment (Figure 4) are much larger between students that took four years of math and those that took three or fewer years of math compared to the gaps for any college enrollment (2- and 4-year) (Figure 3).

Figure 4. 4-year college enrollment by years of high school math, academic proficiency level in 8th grade math, and SED status



Note.

Predicted probabilities are derived from the model: $y_i = \alpha d_i + x_i' b + \varepsilon_i$, where $d_i = 1$ if student i took 4-years of math and zero otherwise and x_i' is a vector of student characteristics including gender, race/ethnicity, SED, math and ELA scale scores on the 8th grade SBAC, and school fixed effects. 246,026 students take 4-years of math out of a sample of 344,852. The results from significance testing between groups are available in the Appendix.

How far in math? Differences in college enrollment by highest level of math taken in high school

In addition to the number of years in which students engage in math coursetaking, the types of math courses in which students enroll also matter for postsecondary attendance. Results generally show that, among students who took Algebra 2 or its equivalent,²¹ students who then enrolled in advanced math courses were more likely to attend college (including both 2 and 4-year), and more likely to attend a 4-year college, than students who took no further math after Algebra 2 (Figure 5). The differences between any college enrollment and 4-year college enrollment are captured by 2-year college enrollment (for specific regression results with 2-year college enrollment outcomes see the Appendix).

On average, students who did not take additional math after reaching Algebra 2 had a 65.2% probability of attending college but were relatively unlikely to attend a 4-year college (23.3%). Students enrolled in non-AP Statistics, AP Statistics, Precalculus, and Calculus were very likely to attend college, and more likely to attend a 4-year college. Specifically, students who took non-AP Statistics, AP Statistics, and Precalculus, and/or Calculus were about 9 to 19 percentage points more likely to attend college compared to taking no additional math after reaching Algebra 2, once we controlled for student demographic characteristics and schools.

Compared to higher level math courses, Precalculus and non-AP Statistics provided less of an advantage in 4-year college enrollment. Students who enrolled in non-AP Statistics or Precalculus as their highest course were only 12.7 or 19.3 percentage points, respectively, more likely to enroll in a 4-year college than students who stopped at Algebra 2, whereas those who took AP Statistics (31.3 percentage points) or Calculus (38.4 percentage points) were substantially more likely to enroll. Some students enrolled in two or more courses after Algebra 2, a pattern associated with an even greater advantage than enrolling in one post-Algebra 2 course. The most popular pathways included AP Statistics and Calculus (a 43% advantage over zero additional courses), non-AP Statistics and Calculus (33.5% advantage), and non-AP Statistics and Precalculus (22.4% advantage).

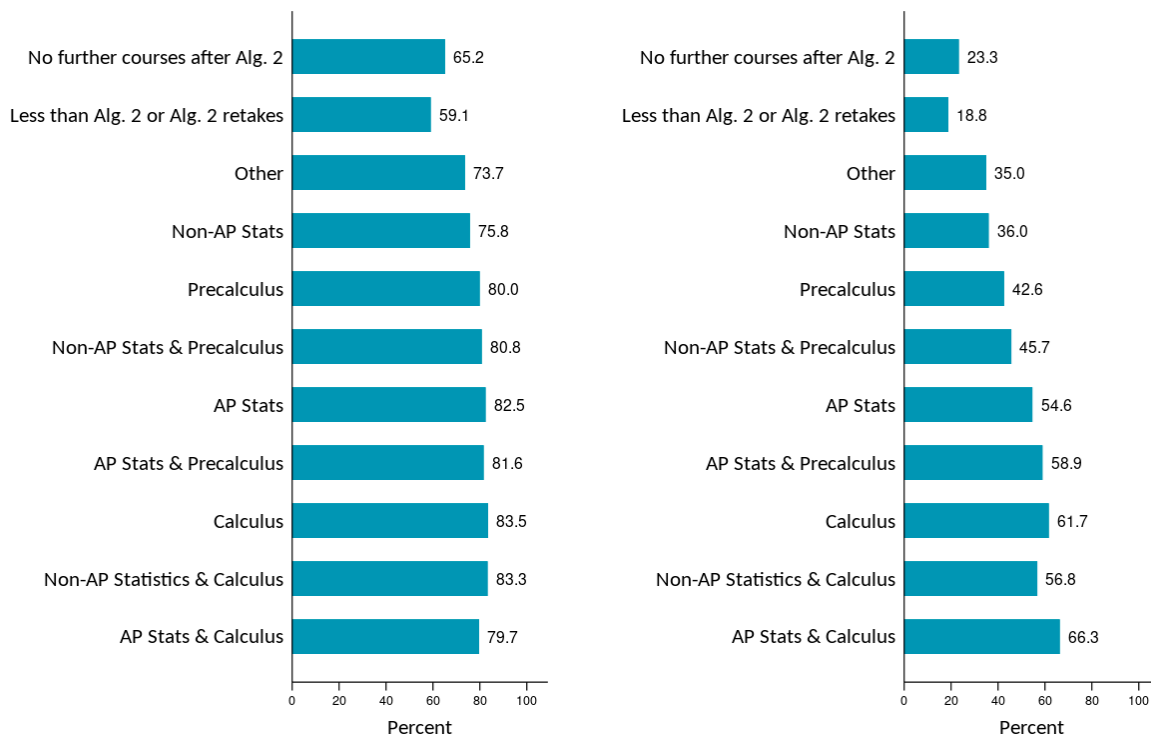
²¹ In this analysis we don't distinguish between students who completed the Algebra pathway (Algebra 1, Geometry, Algebra 2) or the Integrated pathway (Integrated Math 1, Math 2, Math 3), as both pathways satisfy the state graduation requirement as well as the A-G requirements (assuming the correct number of courses and grades in those courses were met) and allow students to engage in the same advanced math coursework.

Interestingly, students who took Algebra 2 (or its equivalent) a second time, or a course that is generally less advanced than Algebra 2, were moderately less likely to attend college than those who took no math after Algebra 2. This could highlight a limitation with simply looking at course enrollment data, as it doesn't account for how students performed in their coursework. Students who retook Algebra 2 likely did not perform well in their first attempt or may have found the course difficult enough to enroll in a math class that didn't require Algebra 2 as a prerequisite.

Figure 5. Probability of college enrollment by math coursetaking beyond Algebra 2

Any college enrollment (2- and 4-year)

4-year college enrollment



Note. Predicted probabilities are derived from the model: $y_i = \sum \alpha_{ji} d_{ji} + x_i' b + \varepsilon_i$, where $d_{ji} = 1$ if student i 's highest math course post Algebra 2 was course j and zero otherwise, and x_i' is a vector of student characteristics including gender, race/ethnicity, SED, math and ELA scale scores on the 8th grade SBAC, and school fixed effects. To be included in the sample a student had to have enrolled in Algebra 2 by the 11th grade. The results from significance testing between groups are available in the Appendix.

The relationship between higher levels of math coursetaking and college enrollment is more pronounced for SED students compared to their non-SED counterparts. We illustrate these differences

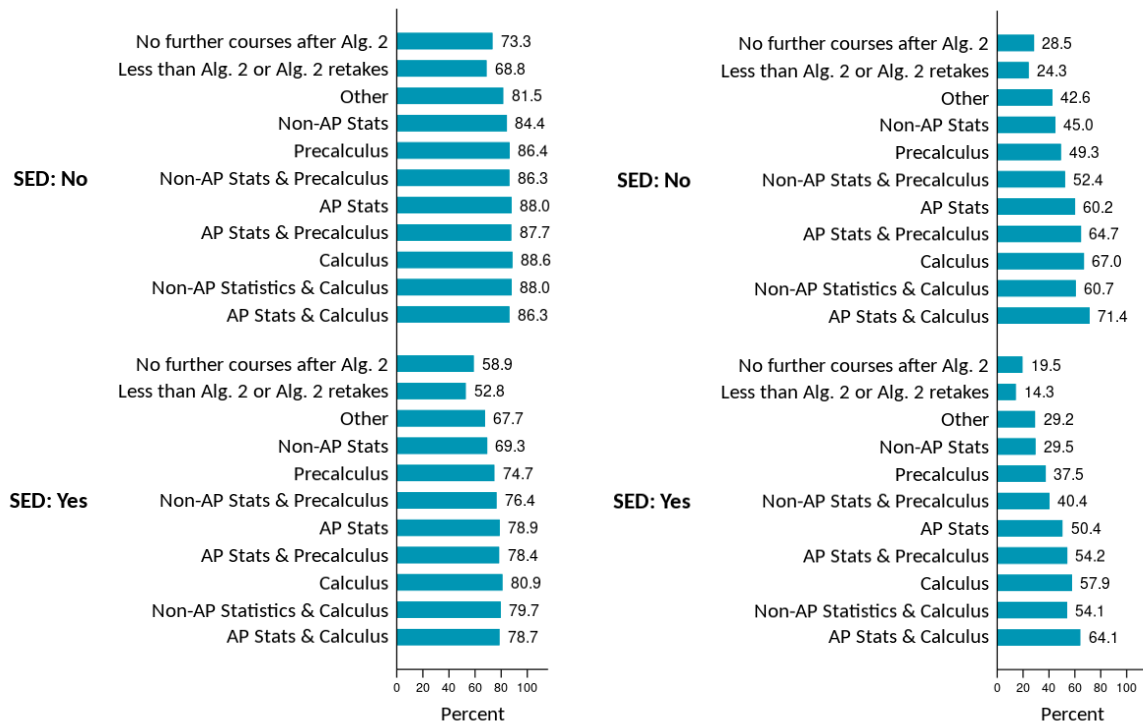
in Figure 6. Overall, it is clear that SED students were generally less likely to attend college than their non-SED peers in all levels of math courses. For enrollment in any math course beyond Algebra 2, students who were SED had, on average, between a 67.7% and 78.7% likelihood of enrolling in college, whereas students who were not SED had between an 81.5% and 88.6% likelihood of enrolling in college. Importantly, SED students in even the highest math courses like Calculus were still a little less likely to enroll in college than non-SED students who took any of the possible math courses after Algebra 2. This is reflective of broader and persistent inequities in educational opportunities and outcomes. However, SED students taking very advanced coursework (especially AP Statistics, Calculus, and combinations of those courses with others) had a bigger advantage (relative to no additional classes) in college enrollment compared to their non-SED peers, when controlling for student demographics and schools. This may indicate the powerful potential of advanced math coursework for broadening access to postsecondary education.

In general, SED students were much less likely to enroll in a 4-year college or university than non-SED students. Among SED students, however, those who took advanced math courses were much more likely to enroll in a 4-year college compared to students with similar background characteristics and prior academic achievement that enrolled in a lower-level math course after Algebra 2. For example, SED students who enrolled in Calculus had, on average, a 57.9% chance of enrolling in a 4-year college, while SED students enrolling in non-AP Statistics had a 29.5% chance of doing so. Importantly, SED students who took the highest levels of math courses were also more likely to attend college than non-SED students who took lower levels of math. In this case, SED Calculus students had an 8.6 percentage point greater likelihood of enrolling in college than non-SED students who reached only Precalculus. While taking higher level math courses may not equalize SED and non-SED students in 4-year college enrollment, it may help close the gaps between the two groups.

Figure 6. Probability of college enrollment by SED and math coursetaking beyond Algebra 2

Any college enrollment (2- and 4-year)

4-year college enrollment



Note. Predicted probabilities are derived from the model: $y_i = \sum \alpha_{ji} d_{ji} + x_i' b + \varepsilon_i$, where $d_{ji} = 1$ if student i 's highest math course post Algebra 2 was course j and zero otherwise, and x_i' is a vector of student characteristics including gender, race/ethnicity, SED, math and ELA scale scores on the 8th grade SBAC, and school fixed effects. To be included in the sample a student had to have enrolled in Algebra 2 by the 11th grade. The results from significance testing between groups are available in the Appendix.

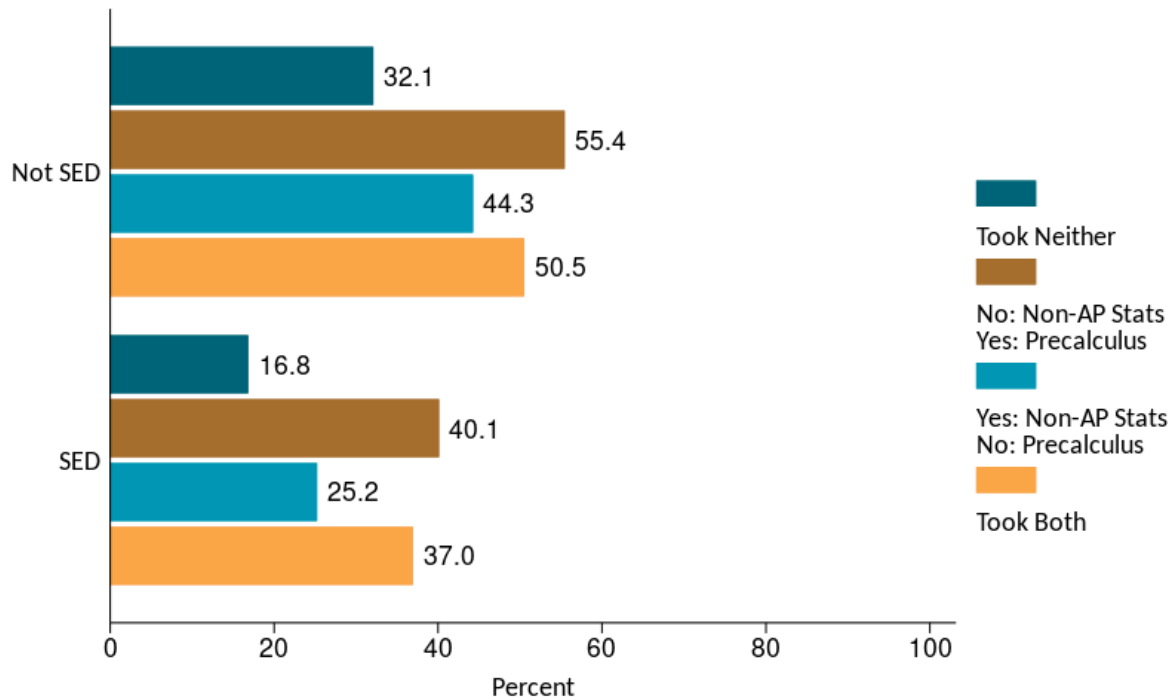
Although evidence indicates that more years of math and courses beyond Algebra 2 are associated with an increased likelihood of enrolling in college, there is much debate as to the optimal set of math classes for students to achieve their desired college outcomes. Schools often face choices about which classes to offer and how to schedule those courses, along with how to best advise students on which classes to take; students often face choices between advanced math courses. In this section, we focus on direct comparisons of three common math course options for college-bound students and their relationship to 4-year college enrollment. Figure 7 compares students who enroll in non-AP Statistics with students who enroll in Precalculus, Figure 8 illustrates the difference between

students who enroll in AP Statistics and those who take Precalculus, and Figure 9 depicts the difference between students who take AP Statistics and those who take Calculus.

In alignment with the findings displayed Figures 5 and 6, **enrollment in a Precalculus course is associated with a higher likelihood of 4-year college enrollment than taking a non-AP Statistics course when directly comparing the two courses.** Interestingly, while students who took both non-AP Statistics and Precalculus in high school were more likely to enroll in college than students who only took non-AP Statistics, students who took both classes had a *lower* chance of 4-year college enrollment than students who only took Precalculus (Figure 7). The explanation for these differences is not entirely clear, and likely the result of student choices, in combination with school advising and course offerings, that balance local high school graduation requirements with the demands of 4-year college admissions. Moreover, while these results suggest that Precalculus may unlock more opportunities for 4-year college attendance than non-AP Statistics, it is also possible that students who already intended to attend a 4-year college sought out Precalculus as a signal of preparation, leading to higher rates of college going among Precalculus students.

These patterns are consistent for both SED and non-SED students, though SED students had lower 4-year college-going rates than non-SED students across all course comparison groups. For example, non-SED students who took neither Precalculus nor non-AP Statistics had a 32% chance of enrolling in a 4-year college while students who took both classes were 19 percentage points more likely to enroll, at about 51%. When taking just one of the courses, SED students who took Precalculus were more likely to attend a 4-year college than those who took non-AP Statistics. Importantly, the differences in probability of 4-year college enrollment between taking non-AP Statistics, Precalculus, both, or neither were greater for SED students than for non-SED students. This may provide some important, albeit cautious evidence, that careful selection—whether that selection is the product of individual choice or school structures and practices—of high school math courses matters more for SED students than non-SED students.

Figure 7. 4-year college enrollment by SED, non-AP Statistics, and Precalculus coursetaking²²



Note. Predicted probabilities are derived from the model: $y_i = \alpha_{1i}d_{1i} + \alpha_{2i}d_{2i} + \alpha_{3i}d_{1i} * d_{2i} + x_i' b + \varepsilon_{iv}$, where $d_{1i} = 1$ if student i took Precalculus and zero otherwise, $d_{2i} = 1$ if student i took non-AP Statistics and zero otherwise, and x_i' is a vector of student characteristics including gender, race/ethnicity, SED, math and ELA scale scores on the 8th grade SBAC, and school fixed effects. The results from significance testing between groups are available in the Appendix.

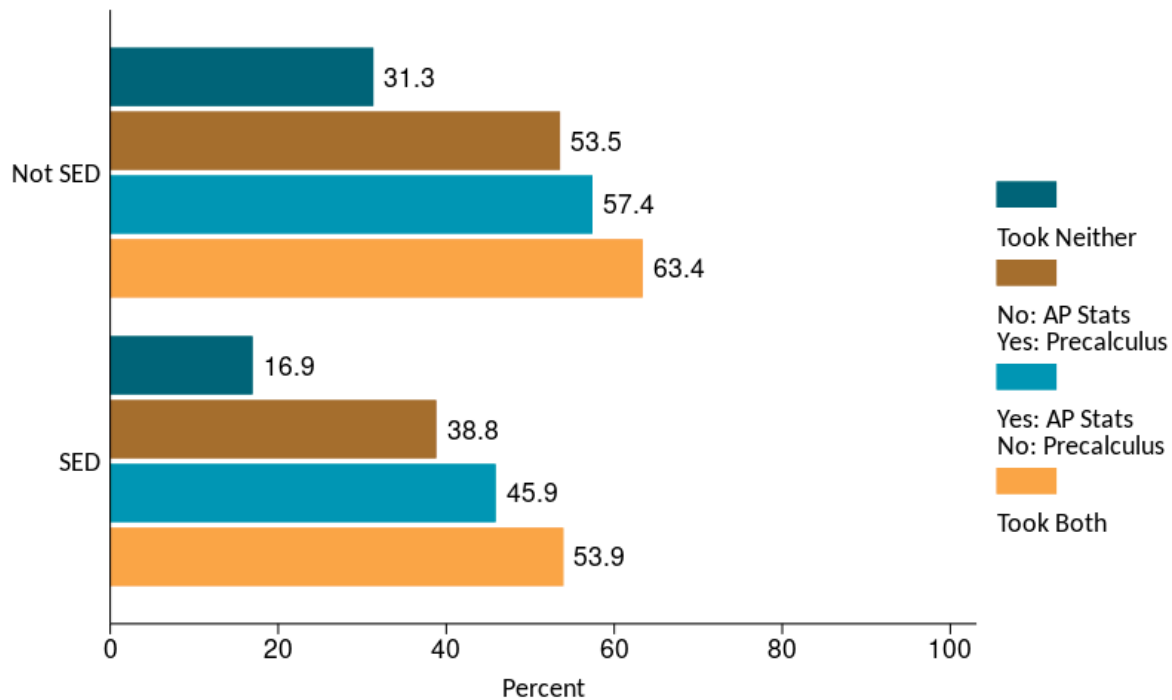
Somewhat different patterns emerge when comparing AP Statistics and Precalculus (Figure 8). In contrast to the previous comparisons, students who took both courses had the highest probability of enrolling in a 4-year college. Students who took AP Statistics but not Precalculus had the next highest probability of enrolling in a 4-year college, followed by students who only took Precalculus. Students who took neither class had the lowest likelihood of enrolling in a 4-year college. Again, caution is warranted when interpreting these comparisons; although AP Statistics and Precalculus may support students' preparation for postsecondary education and potentially pave the way for access to 4-year

²² The "Took Neither" category in Figure 7 includes enrollment in all courses other than non-AP Statistics and Precalculus and Calculus. Students who took AP Statistics are included in the "Took Neither" category, unless they also took Precalculus or non-AP Statistics at some point in high school. Students who took Calculus are included in the Precalculus category by default as Precalculus (or an equivalent course) is a necessary prerequisite for Calculus. However, not all students in the Precalculus category progressed to Calculus.

college, it is also likely that these courses are frequently taken by students who are already planning to attend a 4-year college.

The pattern is the same for SED and non-SED students. As established in previous figures, non-SED students had a greater probability of attending a 4-year college than SED students regardless of the math courses taken. Here, however, the stark reality of the differences between non-SED and SED students is quite evident. Otherwise-similar SED students who took both Precalculus and AP Statistics had a similar or lower probability of attending a 4-year college than non-SED students who took only one of these advanced courses.

Figure 8. 4-year college enrollment by SED, AP Statistics, and Precalculus coursetaking



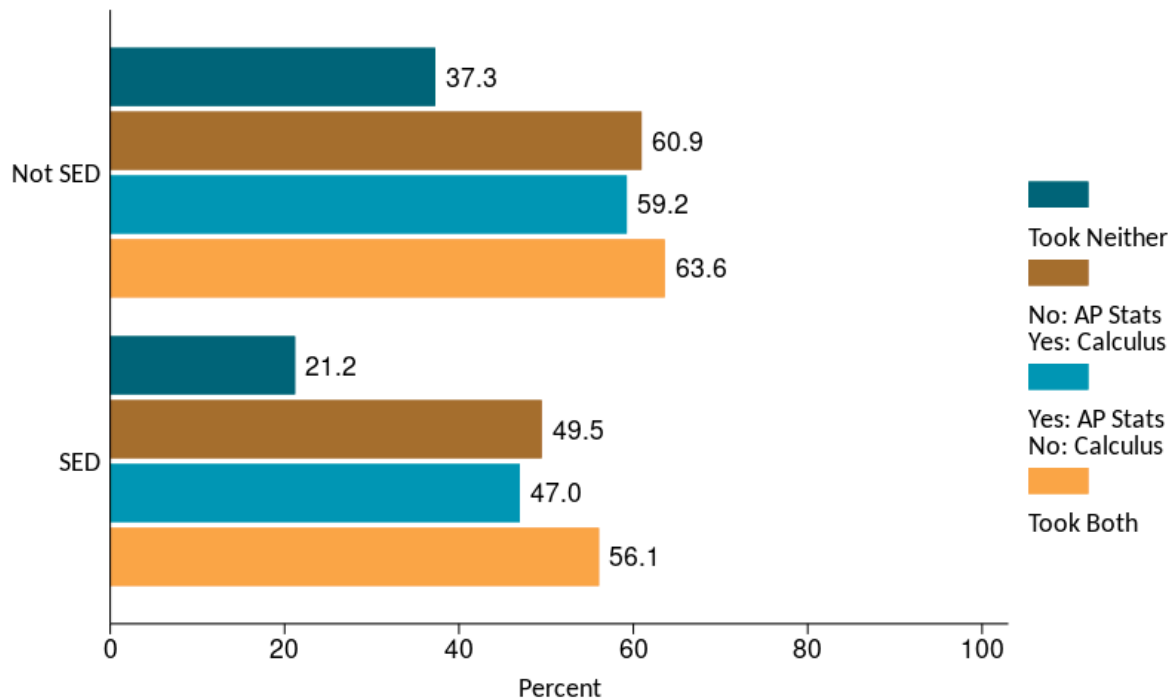
Note.

Predicted probabilities are derived from the model: $y_i = \alpha_{1i}d_{1i} + \alpha_{2i}d_{2i} + \alpha_{3i}d_{1i} * d_{2i} + x_i'b + \varepsilon_i$, where $d_{1i} = 1$ if student i took Precalculus and zero otherwise, $d_{2i} = 1$ if student i took AP Statistics and zero otherwise, and x_i' is a vector of student characteristics including gender, race/ethnicity, SED, math and ELA SBAC scale scores on the 8th grade SBAC, and school fixed effects. The results from significance testing between groups are available in the Appendix.

Students who take either (or both) AP Statistics and Calculus are more likely to enroll in a 4-year college, when compared to students who take neither class. AP Statistics students had a modestly lower chance (1.7 percentage points for non-SED and 2.5 among SED students) of attending a

4-year college than Calculus students. Notably, the difference in 4-year college attendance between students who took neither of these courses and students who took at least one was larger for SED students than for non-SED students. The reasons for the differences between SED and non-SED are uncertain, though it may be that SED students need these courses to demonstrate qualification and readiness for college more than non-SED students. It may also indicate that SED students who took AP courses had access to additional resources—beyond these advanced math courses—that support their college attendance, such as formal programs like AVID, MESA, or supports such as advising or college application guidance.

Figure 9. 4-year college enrollment by SED, AP Statistics, and Calculus coursetaking



Note. Predicted probabilities are derived from the model: $y_i = \alpha_{1i}d_{1i} + \alpha_{2i}d_{2i} + \alpha_{3i}d_{1i} * d_{2i} + x_i' b + \varepsilon_{iv}$, where $d_{1i} = 1$ if student i took Calculus and zero otherwise, $d_{2i} = 1$ if student i took AP Statistics and zero otherwise, and x_i' is a vector of student characteristics including gender, race/ethnicity, SED, math and ELA scale scores on the 8th grade SBAC, and school fixed effects. The results from significance testing between groups are available in the Appendix

Discussion & Conclusion

This study examines the relationship between high school mathematics coursetaking and college enrollment, with particular attention to enrollment at 4-year institutions. Three central findings emerge. First, more mathematics coursework is strongly associated with a higher likelihood of college enrollment in the 16 months following high school graduation. Second, the type of mathematics courses students enroll in matter substantially: advanced courses, particularly AP Statistics, Precalculus, and Calculus, are associated with markedly higher 4-year college enrollment rates relative to less advanced math courses. Third, mathematics intensity (i.e., how much and what courses) appears to be especially consequential for socioeconomically disadvantaged students, suggesting that increasing enrollment in advanced math coursework could play an important role in narrowing college enrollment gaps at 4-year institutions.

Our findings indicate a clear positive association between years of mathematics completed in high school and subsequent college enrollment. Students who complete four years of mathematics are substantially more likely to enroll in college immediately after graduation than students who complete fewer years. Moreover, the types of math courses in which students enroll matter. Advanced math courses, particularly Precalculus, AP Statistics, and Calculus, are strongly associated with college enrollment outcomes, especially 4-year enrollment, when compared to stopping at Algebra 2. On the one hand, results affirm assumptions about the relationship between Calculus and 4-year college enrollment, where students who take Calculus, with or without also taking AP Statistics, have the highest probability of attending a 4-year college. On the other hand, findings here may show that AP Statistics is gaining ground in college admissions offices, who have traditionally rated Precalculus above AP Statistics in terms of rigor (Burdman et al., 2024). As our results indicate, those enrolling in AP Statistics are more likely to attend a 4-year college than those who take Precalculus.

Although the mechanisms for the observed relationships we describe between high school math coursetaking and college enrollment are less clear, there are several plausible explanations. It may be that students who aspire to attend a 4-year college are enrolling in math courses that prepare them for college-level coursework and that provide a positive signal in the college application processes (Serna, 2020), especially at selective colleges where seats have become more limited and admissions

more competitive. It may also be that students who take more years of math and more advanced courses are gaining the skills, knowledge, and support necessary to apply to, enroll in, and potentially succeed in 4-year colleges to which they may not otherwise have access. It is also possible that something we do not measure or cannot directly observe (i.e., academic motivation, parental involvement) correlates with both enrollment in more and higher level math courses as well as college enrollment.

Whatever mechanism may be at work, evidence suggests that taking more math courses and engaging in advanced math has the potential to narrow the 4-year college enrollment gaps between SED and non-SED students. SED students generally have lower college enrollment for a range of well-documented reasons, such as financial constraints, poor academic preparation, and lack of information about college application and enrollment processes among other reasons (Kurlaender et al., 2019; Rouse, 2004). Yet, our findings indicate that the associations between advanced math and college enrollment are stronger for SED students compared to their non-SED peers. This finding is particularly important given that SED students frequently attend schools that are less likely to offer advanced or college preparatory coursework (Adelman, 1999; Carbonaro et al., 2024; Conger et al., 2009; Klopfenstein, 2004; Klugman, 2013; Moore & Slate, 2008; Ogut & Circi, 2023; Solórzano & Ornelas, 2004) and are more likely to be subject to differences in expectations, biases, and prejudices that impede access to advanced courses (Attewell & Domina, 2008; Gamoran, 1987; Iatarola et al., 2011; Oakes & Guiton, 1995). Moreover, first-generation students, many of whom are SED, often underestimate the advantages of taking advanced math courses such as Calculus (Smith Arrillaga et al., 2023). Together, findings in this paper, along with the rich body of literature about access to college preparatory coursework, demand that policymakers and educators ensure SED students have access to advanced math courses such as AP Statistics, Precalculus, and Calculus to prepare them for competitive admissions at 4-year universities and the rigor of college-level math courses once enrolled.

Even as evidence overwhelming points to the benefit of four years of high school math coursetaking and advanced math courses, enrollment in math in 12th grade and enrollment in Precalculus and Calculus is declining among California high school students (Dykeman et al., 2026; Larson et al., 2026). The reasons for these downward trends are unknown. It may be a matter of shifting expectations by high schools, institutions of higher education, or by students themselves. As

the Framework for California Mathematics suggests, students who intend to major in STEM fields may be better prepared by coursework that takes them through Calculus, while those who intend to major in social sciences or humanities could take a pathway that leads to statistics or financial algebra. These downward trends could also be driven by declining course offerings in advanced math, possibly due to staffing constraints (Tan et al., 2024). Whatever the reason, the prominent role of advanced math in college attendance, combined with the trend that fewer seniors are taking mathematics, means that fewer students have the opportunity for college enrollment and for 4-year enrollment in particular.

These findings have some important limitations. First, the results are not causal and thus should be interpreted cautiously. Moreover, we explore only proximate college enrollment outcomes and not students' longer-term college persistence and degree attainment. Future research on the connections between more and advanced math enrollment and college success, including specifically success in STEM, should be undertaken. In addition, our investigation of specific math courses is limited to courses beyond Algebra 2 or its equivalent course (e.g., Integrated Math 3). It is possible that the pathway students take to this point—a traditional pathway (Algebra 1, Geometry, Algebra 2) or an integrated pathway (Integrated Math 1, Math 2, Math 3)—has proximal impacts like whether students continue to enroll in math and which math courses they take, as well as longer-term outcomes like whether students enroll in and succeed in college. Future research should investigate whether early math pathways also play a role in each of college outcomes.

Nevertheless, our findings suggest that additional and more advanced math coursework may be an important lever for expanding access to college attainment, especially for historically underrepresented students. Future policy efforts could focus on strengthening opportunities for additional years of math enrollment through default course scheduling, partnerships with colleges for dual enrollment expansion, and through advising practices.

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