A Proposal to Modify First Year Admission Requirements for the California State University

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Summary

As the largest and most diverse four-year public university system in the nation, the California State University (CSU) is committed to completely eliminating equity gaps – the gaps between degree attainment for students from historically underrepresented communities and their peers – at all levels of the university. One of the greatest hurdles to college degree attainment is a student's level of academic preparation for college-level coursework upon entry.

Quantitative reasoning skills represent one of the greatest disparities among incoming college students. Too often, quantitative reasoning preparation disparities in PK-12 schools exacerbate equity gaps that follow students to college and influence their academic and career options. Students with additional quantitative reasoning preparation in high school – in every region of the country and across all ethnic groups – experience greater success in college. This preparation also prepares students for the workforce, regardless of their field of interest.

The CSU's ability to produce a greater number of diverse college graduates prepared for a range of professions is not only important for individual students but also for the future of California. This ability determines who participates in high-paying industries and influences the strength of our democracy.

Improving student success and closing equity gaps across a large university system requires courageous leadership and bold action that advances the mission of the institution. The proposal outlined in this item will help achieve educational equity by ensuring that a greater number of students from all backgrounds arrive at the CSU better prepared for a diverse range of majors and career paths. The goal is to expand access and equity for all students to achieve their personal and professional goals rather than limiting their opportunities at the point of college admission because of limited preparation for particular majors during high school.

The CSU is recommending that graduating high school students, beginning with the entering first-year class of 2026, be required to complete one additional course of quantitative reasoning to meet the minimum qualifications for CSU first year admission. It will be possible for students to fulfill this requirement through high school coursework in mathematics, science or an elective course with a quantitative reasoning foundation. Students may also meet the requirement with a range of qualifying Career and Technical Education courses or with appropriate dual enrollment courses at a local community college. Students who would otherwise be CSU eligible, but are unable to meet this requirement because of resource limitations at their high school, will be provided an exemption during the initial implementation of the requirement. This practice is consistent with prior phase-in processes of "a-g" course requirements for admission.

The proposed implementation term is fall 2026 to ensure ample time for planning, communication and capacity building, particularly at high schools that currently have fewer course options. The CSU will continue to collaborate with PK-12 districts in every region of the state – building on decades-long partnerships – to expand curricular offerings in subjects that align with this requirement. To support successful implementation, the CSU has committed an additional $10 million over the next four years to its Mathematics and Science Teacher Initiative, including growth in enrollment in teacher education programs, and will continue to expand the co-development of transitional courses currently offered at more than 160 high schools across the state.

This information item includes the official proposal to modify first-year admission requirements for the CSU. This proposal will be presented as an action item during the November 2019 meeting.

Background

All 23 CSU campuses are recognized as being among the top universities in the nation for creating opportunities for students to improve their lives, according to multiple social mobility indices. The CSU's longstanding commitment to access remains unwavering today. However, earning a college degree – not simply being admitted – is what positions students to transform their lives.

Since the 1950s, educators have examined the level of high school preparation required for admission to postsecondary institutions. In 1981, noting that many CSU students were taking fewer traditional college preparatory courses and that the courses ill-equipped students for university study, the Board of Trustees modified first-time, first-year student eligibility requirements to include preparatory study in English and mathematics. A 1984 CSU Taskforce on Entry-level Math Skills recognized the importance of progressive preparation writing: "Today all students, not just those who major in technical fields, need to enter the CSU having mastered arithmetic as well as elementary algebra and geometry. More and more majors require mathematics courses."

During that same period, the board requested that a comprehensive pattern of college preparatory subjects be developed as a requirement for admission requirement. In 1988, amidst controversy and opposition, the board implemented a 15-unit high school college preparatory course pattern requirement for first-time, first-year students. Today, those courses are commonly known as "a-g" requirements that establish minimum eligibility for the CSU.

The current 'a-g' requirements for CSU admission have remained unchanged for more than 20 years. Yet, the preparation needed to be successful in a range of degree programs, the workforce and virtually every aspect of life has changed for this generation of students.

Recognizing the incongruence in admission criteria and college readiness, the Academic Senate of the CSU created a task force in 2014, to examine academic preparation and quantitative reasoning. The task force included, among others, then-Lieutenant Governor Gavin Newsom and former California Department of Education Deputy Superintendent Keric Ashley. After two years of extensive consultation and investigation, one of the four recommendations was to revise quantitative reasoning requirements for CSU admission. The recommendation called for a "revised policy that evaluates the general quantitative reasoning ability of students entering and graduating from the CSU."

At the same time, nearly one-third of regularly admitted CSU students were arriving underprepared for college-level mathematics and quantitative reasoning courses. These students were relegated to non-credit developmental education courses costing them additional money, lengthening the time to earn a degree and essentially excluding them from many science, technology, engineering and mathematics (STEM) degree programs. These students were disproportionately African American and Latinx.

One-in-four students who were assigned to developmental education courses did not return for their second year. Only 10 percent earned a degree in four years and fewer than half graduated within six years. In response to these findings the CSU Office of the Chancellor issued Executive Order 1110 in August 2017. It addressed three main issues: a) it changed the way the CSU assessed students at entry and placed them in first-year courses; b) it strengthened the Early Start Program to allow students who need additional support to earn credit in the summer before their first term; and c) it discontinued stand-alone developmental education courses.

While the first year of Executive Order 1110 implementation has shown positive outcomes for students, the policy was not intended to be the sole counterbalance for students arriving underprepared for various college-level quantitative reasoning courses. The CSU's commitment is to meet students where they are and work to systematically increase the level of academic preparation and college-readiness for all incoming students.

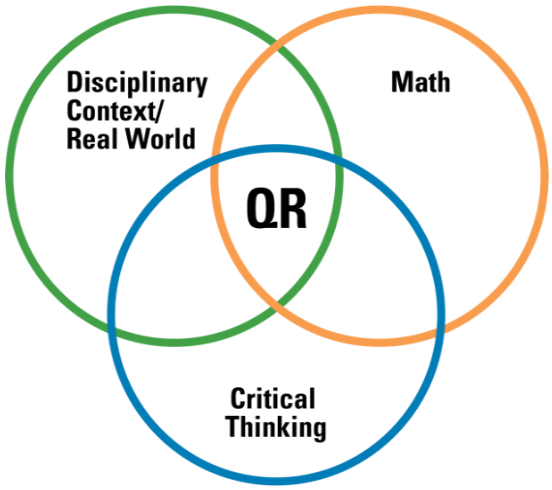
The proposed quantitative reasoning admission requirement is a progressive step in ensuring equity and authentic access for all CSU students. The proposal is not intended to curtail access or change the composition of the CSU student population. Instead, it is intended to ensure that all

students who enter the CSU are prepared to be successful in their coursework so that they may participate in a range of majors and career fields.

Defining Quantitative Reasoning

Quantitative reasoning is the ability to think and reason intelligently about measurement, dimensions, design, capacity or probability in the real world. The National Council of Teachers of Mathematics defines quantitative reasoning as:

> …the developed ability to analyze quantitative information and to determine which skills and procedures can be applied to a particular problem to arrive at a solution. Quantitative reasoning, both generally and for assessment purposes, has an essential problem-solving focus. It includes the following six capabilities: reading and understanding information given in various formats; interpreting quantitative information and drawing inferences from it; solving problems using arithmetic, algebraic, geometric, or statistical methods; estimating answers and checking for reasonableness; communicating quantitative information; and recognizing the limitations of mathematical or statistical methods.



The ASCSU Quantitative Reasoning Task Force also proposed a general definition for quantitative reasoning:

> "The ability to reason quantitatively is a stable combination of skills and practices involving: (i) the ability to read, comprehend, interpret, and communicate quantitative information in various contexts in a variety of formats; (ii) the ability to reason with and make inferences from quantitative information in order to solve problems arising in personal, civic, and professional contexts;(iii) the ability to use quantitative methods

> to assess the reasonableness of proposed solutions to quantitative problems; and (iv) the ability to recognize the limits of quantitative methods."

One common misconception is that quantitative reasoning skills are explicitly or exclusively taught in all mathematics classes. While the ability to reason quantitatively utilizes mathematical skills for calculation, deriving real-world meaning and the application of findings are equally important. Quantitative reasoning extends beyond the ability to follow a mathematical procedure without error or memorizing a formula. It invites students to think critically about problems in real-life contexts and intelligently develop and test solutions.

Quantitative reasoning is necessary to be a valued employee and an educated citizen in modern society. Planning for retirement, interpreting sports statistics, understanding economic forecasts, analyzing political arguments and making investment decisions all require strong quantitative reasoning skills. Critical thinking about quantitative data is increasingly necessary in many occupations, particularly for careers in STEM fields.

Proposal to Require Additional Course in Quantitative Reasoning

The CSU is recommending that incoming high school students, beginning with the entering first-year class of 2026, be required to complete one additional course in quantitative reasoning in high school to meet the minimum eligibility for CSU admission as a first-year student. The proposal strongly recommends that the additional quantitative reasoning course be completed during the senior year of high school. No changes are proposed for transfer admission eligibility.

The CSU is proposing to expand the 'a-g' requirements that determine minimal eligibility for CSU admission by requiring the completion of an additional course in quantitative reasoning that could be fulfilled from area 'c – mathematics,' area 'd – laboratory science' or a quantitative reasoning course from area 'g – college preparatory elective.' Such college preparatory courses in area 'g' could include computer science, coding, finance and Career and Technical Education courses with quantitative reasoning content. Students can satisfy this requirement with course-taking beginning in middle school.

As shown in the charts on the next page, under the CSU proposal, the area 'c – mathematics' requirement will not change. It is recommended that area 'g – college preparatory elective' be expanded from one to two courses to include an additional course in quantitative reasoning selected from area 'c – mathematics', area 'd – laboratory science', or a quantitative reasoning course from area 'g – college preparatory elective.' The objective of this change is that students take the next appropriate quantitative reasoning course to strengthen fluency and preparation for college-level coursework.

Existing CSU College Preparatory Course Requirements for First Year Admission

Area	Subject	Courses
a.	**History and Social Science** (including 1 year of U.S. history or 1 semester of U.S. history and 1 semester of civics or American government AND 1 year of social science)	2
b.	**English** (4 years of college preparatory English composition and literature)	4
c.	**Mathematics** (4 years recommended) including Algebra I, Geometry, Algebra II, or higher mathematics (take one each year)	3
d.	**Laboratory Science** (including 1 biological science and 1 physical science)	2
e.	**Language Other Than English** (2 years of the same language; American Sign Language is applicable - See below about a possible waiver of this requirement)	2
f.	**Visual and Performing Arts** (dance, drama or theater, music, or visual art)	1
g.	**College Preparatory Elective** (additional year chosen from the University of California "a-g" list)	1
Total Required Courses		**15**

Proposed CSU College Preparatory Course Requirements for First Year Admission
(The proposed change is indicated in red.)

Area	Subject	Courses
a.	**History and Social Science** (including 1 year of U.S. history or 1 semester of U.S. history and 1 semester of civics or American government AND 1 year of social science)	2
b.	**English** (4 years of college preparatory English composition and literature)	4
c.	**Mathematics** (including Algebra I, Geometry, Algebra II, or higher mathematics or a comparable integrated pathway; take one each year)	3
d.	**Laboratory Science** (including 1 biological science and 1 physical science)	2
e.	**Language Other Than English** (2 years of the same language; American Sign Language is applicable - See below about a possible waiver of this requirement)	2
f.	**Visual and Performing Arts** (dance, drama or theater, music, or visual art)	1
g.	**College Preparatory Elective** (1 year selected from "c – mathematics", "d – laboratory science", or a quantitative reasoning course from the "g – college preparatory elective" areas AND 1 additional year chosen from the University of California "a-g" list)	2
Total Required Courses		**16**

In fall 2018, new CSU first-year students enrolled having completed an average of 20.7 'a-g' courses—20.2 and 20.6 for African American and Latinx students, respectively. This demonstrates students' ability to exceed the minimum number of courses required for admission. Incoming students are also exceeding the minimum number of courses in each subject area—mathematics, laboratory science, language other than English, visual and performing arts, and college preparatory electives. This proposal is intended to ensure that the distribution of those courses includes additional quantitative reasoning preparation to support postsecondary success.

The University of California (UC) maintains the database of approved 'a-g' college preparatory courses submitted by public and private high schools. Similar to previous enhancements to support the review and identification of Career and Technical Education courses for the CSU, modifications will be made to the database to more clearly identify qualifying high school courses that satisfy the requirement.

Exemptions and Commitment to Do No Harm

The proposal is designed to improve the level of preparation of incoming students, not create a barrier to the CSU. During the development of this proposal, the CSU has maintained a commitment to avoid placing an undue hardship on students who are unable to fulfill the new requirement because of limited course offerings in their high school.

Despite the multiple pathways available to meet the requirement and the CSU's commitment to support capacity building over the next six years, the university acknowledges that some students may experience unique circumstances requiring an exemption. The CSU will provide an exemption for any student, who is otherwise eligible, who cannot fulfill the new requirement due to lack of resources and/or course availability at their high school. The CSU may also grant exceptions for preparation determined to be comparable.

To facilitate this process, the CSU will seek a working partnership with the UC and the California Department of Education (CDE) to classify schools with limited qualifying course offerings related to the implementation of this proposal in 2026. This will help automate the exemption for students applying from these schools, significantly reducing the need for individual students to "seek out" such a waiver. School course offerings and waiver request information will be catalogued to more effectively target support with the expectation that, as with the initial implementation of 'a-g' requirements, waivers will be phased-out over time. The existing admission by exception policies already codified in Title 5 will remain.

Preparation in Quantitative Reasoning Matters for College Success

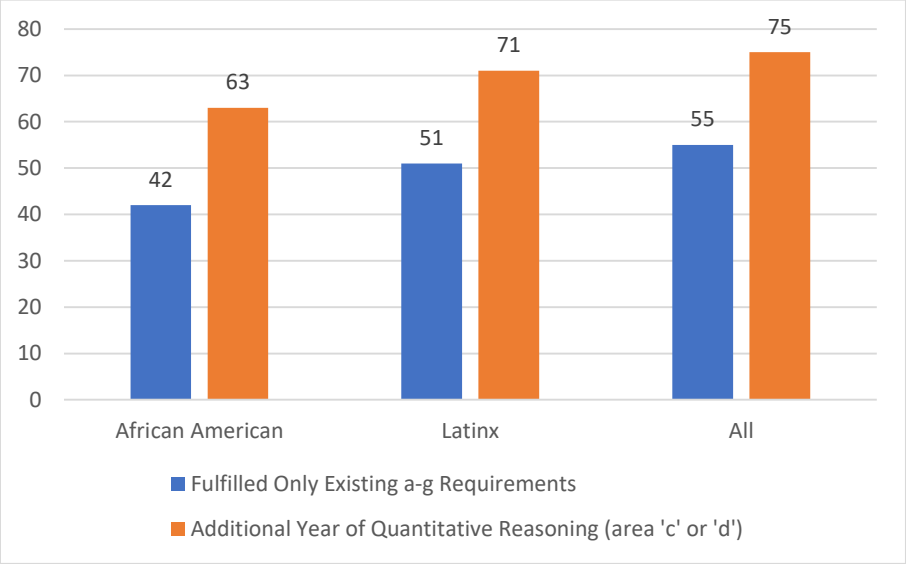
CSU-specific data and a growing body of national research suggest that additional quantitative reasoning preparation is associated with improved outcomes in college.

CSU Data

The data in this section reflect outcomes for students who have taken an additional quantitative reasoning course (as measured in area ‘c-mathematics’ or ‘d-laboratory science’) in high school prior to enrolling in the CSU.

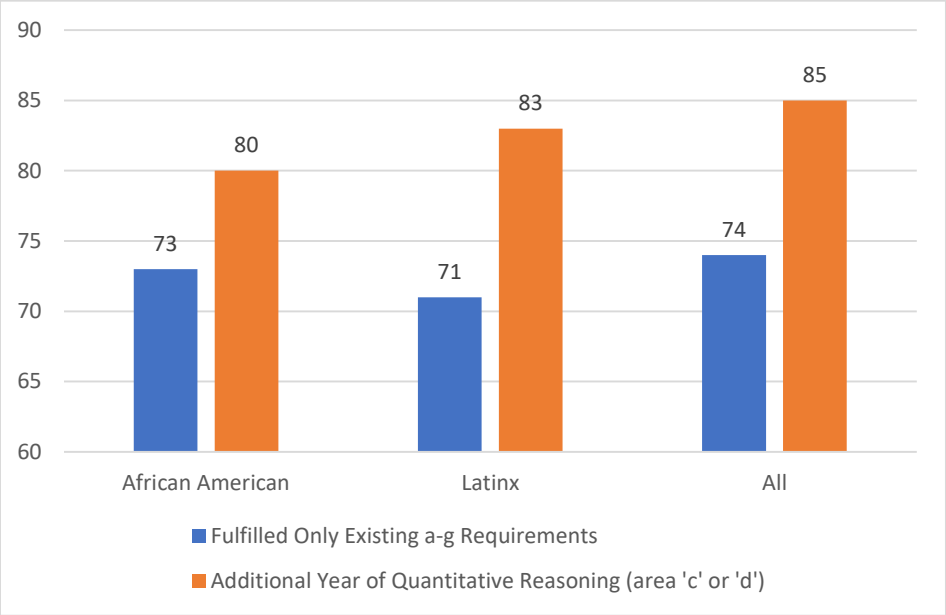
Successful Completion of the Quantitative Reasoning General Education Requirement

Additional quantitative reasoning preparation in high school dramatically increases the likelihood that a CSU student will complete the quantitative reasoning (Subarea B4) general education requirement during their first year—a significant student success milestone associated with degree completion. A review of fall 2018 first-year CSU student data indicates that students with an additional course of quantitative reasoning (from areas ‘c’ or ‘d’) had a 20 percentage point higher pass rate in Subarea B4 compared to peers with less preparation. This is consistent across all ethnic groups, including African American and Latinx students.



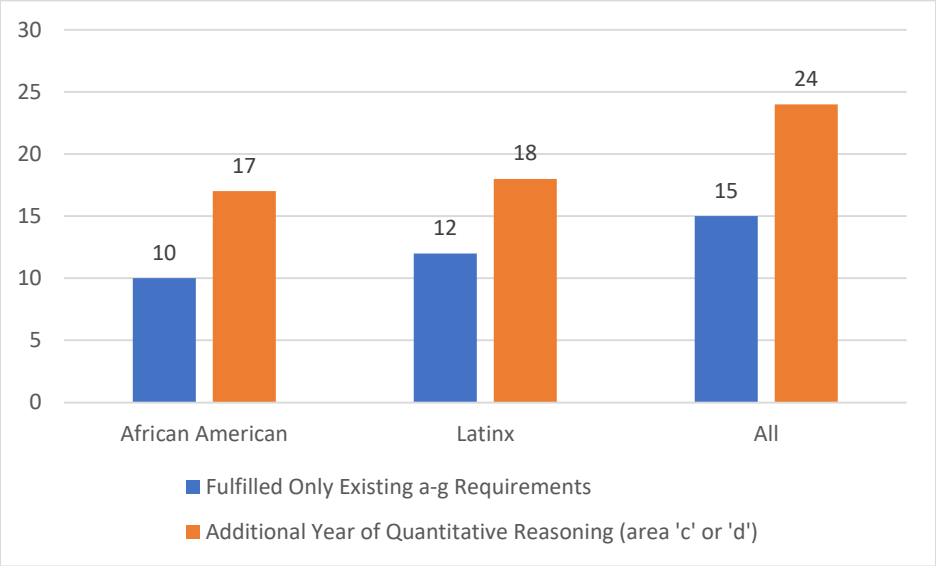
First-Year Retention

Students taking an additional quantitative reasoning course in high school are more likely to return for their second year of college. As shown below, 85 percent of CSU students who took an additional quantitative reasoning course (from areas ‘c’ or ‘d’) in high school returned for their second college year at the CSU, compared to 74 percent who only fulfilled the existing ‘a-g’ requirements. This is consistent across all ethnic groups, including African American and Latinx students.

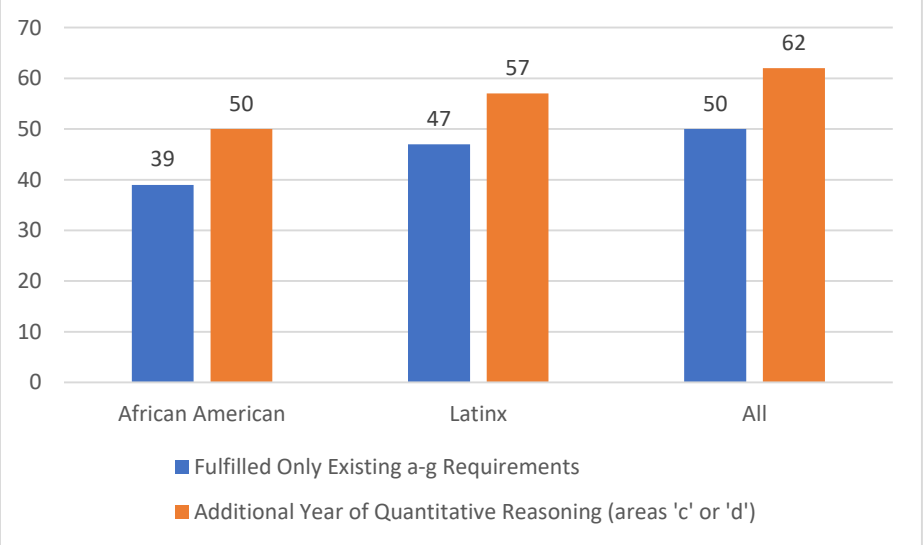


4- and 6-Year Graduation

Taking an additional quantitative reasoning course in high school is also linked to improved 4- and 6-year college graduation rates. As shown in the chart below, there is a seven percentage point difference in the 4-year graduation rate for CSU African American students – and a six percentage point difference for Latinx students – who took an additional quantitative reasoning course in high school (from areas 'c' or 'd') versus those who fulfilled only the existing 'a-g' requirements.



The chart below shows that 6-year graduation rates are also higher for all CSU students – including African American and Latinx students – who receive additional quantitative reasoning preparation in high school (as measured from areas 'c' or 'd').



National Data

National data also support the relationship between increased quantitative reasoning preparation and college success. More than a decade ago, Clif Adleman – a researcher and policy analyst at the U.S. Department of Education for more than 30 years – examined the association between high school mathematics course taking and college completion. He wrote:

> "The Toolbox Revisited is a data essay that follows a nationally representative cohort of students from high school into postsecondary education and asks what aspects of their formal schooling contribute to completing a bachelor's degree by their mid-20s. The universe of students is confined to those who attended a four-year college at any time, thus including students who started out in other types of institutions, particularly community colleges. The core question is not about basic 'access' to higher education. It is not about persistence to the second term or the second year following postsecondary entry. It is about completion of academic credentials—the culmination of opportunity, guidance, choice, effort, and commitment."

Adleman's findings on the association between high school mathematics course taking and college completion (not simply admission) are shown below:

Highest Mathematics Course Completed in High School	Percentage of College Students Who Completed a Bachelor's Degree
Calculus	81.6
Pre-Calculus	73.7
Trigonometry	65.1
Algebra II	44.4
Geometry	28.5
Algebra I	11.9
Pre-Algebra	5.1

In 2014, a Policy Analysis for California Education (PACE) brief examined course-taking patterns of community college-bound students and verified Adelman's 2005 research. The findings indicated that *not* taking a mathematics course in 12th grade was a significant predictor of not being college ready. The policy brief found that "all other factors being equal, students who took no mathematics in Grade 12 were 58 percent more likely to place 2-levels below [readiness] than into college-level mathematics." The brief also corroborated Adelman's 2006 findings that every class beyond high school Algebra II increased the probability of a student earning a bachelor's degree.

The College Board, the organization that administers the SAT, found that high school seniors who take four or more years of mathematics have higher scores on college admission tests. Students who took four years of mathematics in high school averaged 518 in the mathematics section of the SAT, and for those who took more than four years of mathematics they averaged 572.

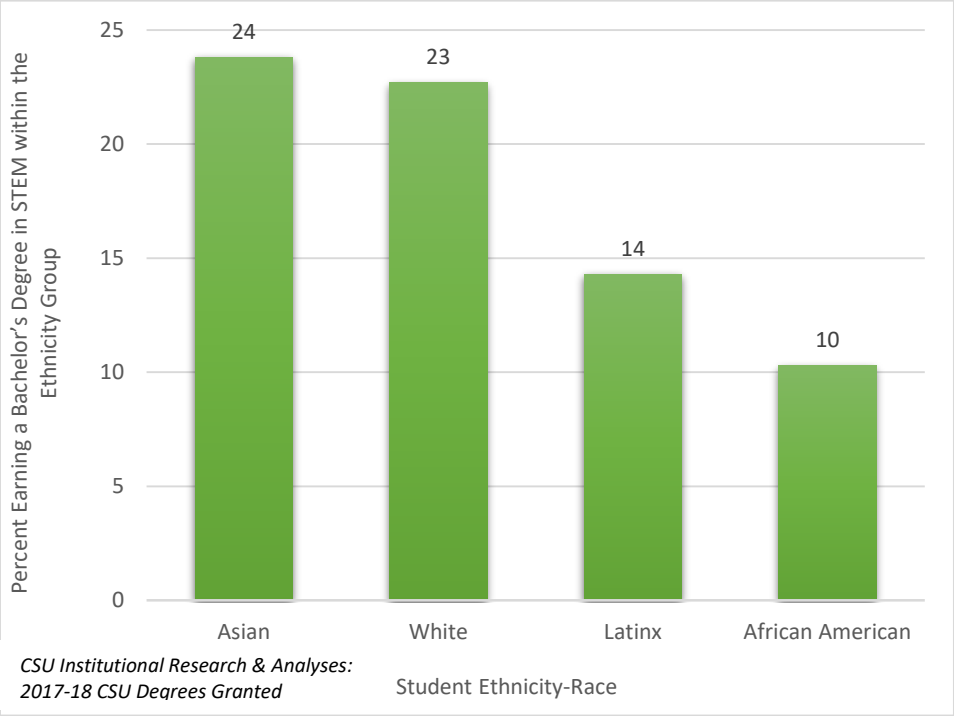
In addition, analysis from the ACT demonstrated a similar finding based on ACT student scores. Students who took four years of mathematics demonstrated higher percentages of proficiency levels in mathematics on the ACT exam (62 percent) than students who took fewer than four years of mathematics (16 percent).

Overall, the research on mathematics and quantitative reasoning course taking in high school and college success is clear. Additional mathematics and quantitative reasoning preparation in high school better prepares students to pursue a multitude of pathways once they begin their postsecondary studies. The national findings are consistent and present across all ethnic groups with sample sizes large enough to cancel selection biases or notions that the outcomes are simply correlational.

A list of other relevant studies can be found in attachment A.

Data Related to Disparities in STEM

Based on current trends in quantitative reasoning preparation, it not surprising that persistent disparities exist at the CSU for students seeking degrees in STEM, despite progress in closing equity gaps. In 2017-18, 24 percent of students who self-identified as Asian and 23 percent who identified as white earned a baccalaureate degree in a STEM field. However, only 14 percent of Latinx students and 10 percent of African American students earned a similar degree. These data are reflected in the graph below.



This problem is not unique to the CSU. As noted in a 2017 Brookings Institute national report examining quantitative reasoning disparities beginning in middle school, "STEM college graduates are predominantly white or Asian, a pattern that has persisted for years despite historically high black and Hispanic college attendance and completion rates."

The equity gap continues into the workplace despite the fact that careers in STEM have grown dramatically. According to a 2018 report by Pew Research Center, since 1990, STEM employment has grown 79 percent (from 9.7 million to 17.3 million). The report authors write "STEM jobs have relatively high earnings compared with many non-STEM jobs, and the earnings gap persists even after controlling for educational attainment. Among workers with similar education, STEM workers earn significantly more, on average, than non-STEM workers."

In the Pew Research Center report, the authors find that "Black and Hispanic workers continue to be underrepresented in the STEM workforce. Blacks make up 11% of the U.S. workforce overall

but represent 9% of STEM workers, while the Latinx community comprises 16% of the U.S. workforce but only 7% of STEM workers."

CSU-specific data and a growing body of national research are clear that mathematics and quantitative reasoning preparation matter for college success and that the disparities in preparation can follow students across sectors, limiting their opportunities.

Many Institutions Have Already Moved to Address Quantitative Reasoning Preparation

Recognizing the need to improve preparation for postsecondary success, many universities now require additional mathematics and quantitative reasoning preparation. States with at least one university that have such a requirement include:

- Arizona
- Colorado
- Florida
- Georgia
- Indiana
- Louisiana
- Maryland
- Massachusetts
- Minnesota
- North Carolina
- Tennessee
- Texas
- Virginia
- Wisconsin
- Wyoming

In 2006, North Carolina began requiring at least four years of mathematics for admission to any of its 15 public universities. Meanwhile, students seeking admission to the Twin Cities, Duluth, Morris and Rochester campuses of the University of Minnesota are required to have taken four years of mathematics in high school. The university system enacted this admission change in 2015 as a result of "university research [that] has shown that completing four years of math enhances student success in college. Grade point averages and graduation rates at the University of Minnesota are higher for students who have taken four years of math."

Effective in 2015, students in Maryland were required to complete four years of mathematics in high school for entry to any of the state's public universities, and those who complete Algebra II prior to their final year must complete the four-year mathematics requirement by taking a course or courses that utilize non-trivial algebra. Maryland is the home of Bowie State University, Morgan State University, Coppin State University and University of Maryland Eastern Shore – four historically black universities – dispelling the notion that such a requirement harms historically underserved student of color. The University of Maryland Baltimore County (UMBC) has become a national model for preparing African American STEM graduates. UMBC's undergraduate admissions requirements are shown in the figure below:

Additionally, in 2016, both the Massachusetts State University and the University of Massachusetts systems began requiring entering students to complete four years of mathematics, including one course during the final year of high school.

California PK-12 School Districts

Many California school districts have graduation requirements that align with the CSU proposal. Every student graduating from those districts has already fulfilled the quantitative reasoning requirement. While not an exhaustive list, examples include:

- San Diego Unified
- Long Beach Unified
- Elk Grove Unified
- Fresno Unified
- San Bernardino City Unified
- Oakland Unified
- Stockton Unified (beginning in 2023)
- La Cañada (beginning in 2021)
- Rocklin Unified
- Lake Elsinore Unified
- Murrieta Valley Unified
- Perris Union
- San Jacinto Unified

Long Beach Unified School District

The Long Beach Unified School District (LBUSD) – where 70 percent of students are from households below the federal poverty level and 86 percent are non-white – increased the quantitative reasoning requirement six years ago to improve college readiness. Prior to changing the requirement, just 39 percent of students met the 'a-g' requirements for admission to the CSU. Today, 56 percent of students meet the 'a-g' requirements, and the district's African American and Latinx students graduate at higher percentages compared to their peers in the county and across the state. Despite early opposition to the change and concern that underserved students would be disadvantaged, the outcomes have demonstrated the opposite. Students of color in LBUSD are graduating and attending college at higher rates due to increased quantitative reasoning preparation.

San Diego Unified School District

In 2011, the San Diego Unified School District Board of Education adopted new, more rigorous graduation requirements that align with the district's mission. The district is the second largest in California with more than 124,000 students, of which 23 percent are English Language Learners, 59 percent qualify for free or reduced lunch and 77 percent are non-white. The new requirements include specific high school courses that are aligned to the minimum subject-area course requirements for CSU and UC admission and are aligned to the California Next Generation Science Standards.

The high school graduating class of 2016 was the first class required to meet the new graduation requirements, which include three years of science (one year of life science, one year of physical science and one additional year of science coursework). Since adopting the new requirements, the percentage of graduates completing all 'a-g' requirements in the district has increased 10 percentage points over five years, from 46 percent in 2013 to 56 percent in 2018.

PK-12 Institutions in Other States

Recognizing the importance and power of quantitative reasoning preparation, a growing number of states now require four years of quantitative reasoning courses for a high school diploma:

- Alabama
- Arkansas
- Connecticut
- District of Columbia
- Florida
- Georgia
- Louisiana
- Maryland
- New Mexico

Five states go further, requiring four years of quantitative reasoning in high school and specifying that students take a course during the senior year to minimize skills gaps:

- Delaware
- Michigan
- Ohio
- Tennessee
- West Virginia

Charts detailing the requirements for each state are included as attachment B.

Understanding and Building Capacity with California School Districts

Given the CSU's longstanding partnerships with school districts across the state, there is a working knowledge of existing capacity disparities and regional variations. Data from the 'a-g' database indicate that 99.7 percent (or 1,448 of 1,453) of California comprehensive high schools offer a course that would satisfy the proposed quantitative reasoning requirement.

Still, CSU staff acknowledge the concerns about sufficient access to qualifying courses. A preliminary analysis of approved 2019-20 'a-g' courses provides a clearer picture of course accessibility to meet the proposed requirement:

- Select charter schools with low enrollments presently have the least capacity. In many cases these schools currently recommend students complete online courses or community college courses if they are seeking to satisfy the 'a-g" requirements. Several have since closed or have only recently begun enrolling students.
  - Five schools with 136 students combined earning their diploma (2017-18) currently do not offer courses that would meet the proposed requirement.
  - Six schools, two with 56 students earning a diploma (2017-18) and four charter schools with 112 students earning their diploma (2017-18), had only area 'c-mathematics' courses that would meet the proposed requirement.
  - Seven schools, one with fewer than 10 students earning their diploma (2017-18) and six charter schools with a combined 89 students earning their diploma (2017-18), had only one area 'd' or 'g' course that would meet the proposed requirement.
- The remaining 1,435 schools offer multiple courses to satisfy the proposed requirement.

The table below summarizes these findings:

Method to Meet Proposed Requirement	**Charter School**		**Not a Charter School**		**Grand Total**	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Can meet with area 'c' course or 2 or more courses from areas 'd' or 'g'	380	89.8%	1,018	98.8%	1,398	96.2%
Can meet with area 'c' course or 1 area 'g' course	3	0.7%	2	0.2%	5	0.3%
Can meet with area 'c' course or 1 area 'd' course	11	2.6%	4	0.4%	15	1.0%
Can only meet with 2 or more courses from areas 'd' or 'g'	14	3.3%	3	0.3%	17	1.2%
Can only meet with an area 'c' course	4	0.9%	2	0.2%	6	0.4%
Can only be met with 1 course in areas 'd' or 'g'	6	1.4%	1	0.1%	7	0.5%
Does not meet proposed requirement	5	1.2%	--	--	5	0.3%
Grand Total	423	100%	1,030	100%	1,453	100%

In other school contexts, ample course offerings are available, but student course-taking behavior may need to be examined. Preliminary assessment of CSU fall 2018 first-time student data (through a review of high school course-taking behavior in areas 'c-mathematics' and 'd-laboratory science') identified the districts (shown below) that have 20 or more students who entered the CSU not having met the proposed standard and where the overall percentage of students meeting the requirement was well below the average (91 percent).

- Baldwin Park Unified
- Calexico Unified
- Central Unified
- Central Union High
- Chico Unified
- Coachella Valley Unified
- Delano Joint Union High
- Kern County Office of Education
- Kern High
- Lodi Unified
- Manteca Unified
- Merced Union High
- Oceanside Unified
- Salinas Union High
- San Gabriel Unified
- San Juan Unified
- Santa Rosa High
- Turlock Unified
- Visalia Unified
- Wasco Union High
- Washington Unified

These districts account for one in fourteen of new fall 2018 enrollees from California public high schools while also accounting for one in six students who would not have met the proposed standard. The CSU recognizes it will need to work closely with these districts to build capacity and/or change course-taking behavior. Additionally, individual schools from large districts not listed above have also been identified as needing support

To be clear, the proposed requirement will likely lead to limited changes in some high schools over the next six years to provide adequate curricular and advisement capacity for students. The CSU is committed to working with all districts to meet this challenge.

CDE Data Sharing Agreement and Study

On August 29, 2019, the CSU finalized a new data sharing agreement with the CDE to jointly gain a better understanding of 'a-g' course outcomes for CSU applicants. There are two important notes regarding this data sharing agreement. First, the agreement, as negotiated over the past four months, limits data accessibility to CSU applicants. It does not include the universe of California high school students. However, given the vast number of CSU applicants each year and their geographic and demographic diversity, these data reflect college-bound students across the state and the high schools they attend. Second, the assessment of existing data is historical—a view of the landscape as things were or as students behaved under the existing 'a-g' requirements. These data do not account for projected increases in course offerings over the next six years or changes in advising and course-taking behavior that would occur as a result of the proposed requirement being adopted.

The joint study will provide a longitudinal lens of course-taking trends for CSU applicants and the qualifying courses offered across high schools allowing the CSU to more precisely estimate the effects of the proposed change to 'a-g' criteria on previous cohorts. The cooperative study will examine:

- The number of admitted CSU students who already meet the proposed requirement without changes in course-taking;
- The number of qualifying courses at high schools; and
- Variations in course-taking behavior by race and ethnicity.

The joint study will help the CSU better understand the interaction of the important variables to more precisely identify schools for targeted support. Additionally, data will provide the CSU a better understanding of how California public high school students' preparation for admission affects baccalaureate performance, major selection, and student success outcomes.

The CSU Mathematics and Science Teacher Initiative (MSTI)

The CSU is committed to increasing its annual production of credentialed teachers in STEM fields. Since 2005, the California legislature has provided ongoing support to the CSU's Mathematics and Science Teacher Initiative (MSTI), preparing mathematics and science teachers today and developing the next generation of California's STEM teacher-leaders. This work encompasses many components, including:

- Recruiting new students;
- Developing new credential pathways;
- Providing financial support to attract outstanding candidates and facilitate credential completion;
- Ensuring program alignment with California community colleges;
- Developing partnerships with federal agencies, laboratories and industry leaders; and
- Identifying the most successful approaches across the CSU system.

MSTI has enabled the CSU to increase its annual preparation of mathematics and science teachers from 700 to approximately 1000. Through its recently announced commitment of an additional $10 million investment over the next four years, the CSU is committed to doubling the number of mathematics, science and computer science teachers prepared at the university.

It is particularly noteworthy that the mathematics and science teachers prepared by CSU campuses often go on to teach in the state's high-need schools where 25 percent or more students come from families in poverty and mathematics achievement rates are significantly below statewide averages. As a result, these new mathematics and science teachers are contributing markedly to reducing the disparities in access to qualified teachers that have been found in the state for the past three decades and that have contributed to continued equity gaps in these fields.

The California Mathematics Readiness Challenge Initiative (CMRCI)

The CSU will continue collaborating with school districts and PK-12 schools that need assistance developing qualifying courses. Since 2016, the staff at the CSU Center for the Advancement of Instruction in Quantitative Reasoning (CAIQR) have been working with the CDE and PK-12 and community college partners to develop a "bridge" or transitional course from high school to higher education through the California Mathematics Readiness Challenge Initiative (CMRCI). Transitional mathematics, defined as courses or curriculum needed to successfully transition to college-level mathematics, is crucial for student success. Analogous to the development of the Expository Reading and Writing Course (ERWC) for English language arts, five CMRCI sites (four at CSU campuses, one at a UC campus) are working with more than 150 high schools to offer such courses. In addition, CSU Northridge is currently offering a transitional mathematics course developed with the Los Angeles Unified School District.

The table below lists the current transitional courses developed at each CSU site, the number of school districts and schools at which the course is currently being taught, and the approximate number of students participating. Currently, more than 10,000 students are enrolled in a CSU transitional course.

CSU Campus and Course Title	**Districts**	**Schools**	**Students** (approximate)
CSU Monterey Bay: *Transition to College Level Mathematics*	5	8	197
CSU Northridge: *Transition to College Mathematics and Statistics*	1	48	2,131
CSU Sacramento: *Quantitative Reasoning with Advanced Math Topics*	20	52	4,293
CSU San Bernardino; Cal Poly Pomona; CSU Long Beach; San José State *Mathematical Reasoning with Connections*	20	48	2,963
San Diego State: *Discrete Mathematics for Pre-College Students*	1	12	1,204
Totals	**47**	**168**	**10,788**

These courses are approved in area 'c' of the 'a-g' requirements. The CSU will continue to partner with school districts to ensure that an ample supply of courses are available by 2026, the proposed implementation year, in the schools where they are most needed. Further, the CAIQR is assisting and supporting school districts in building their capacities of qualified teachers to teach these courses.

Descriptions of the CMRCI bridge courses are provided in attachment C.

The ERWC Model for Capacity Building

The CSU envisions using a capacity-building framework for quantitative reasoning modeled on its work in reading and writing. The CSU's Center for the Advancement of Reading and Writing (CAR/W), in partnership with California's county offices of education, supports curricular development and integration, professional development for teachers and administrators and evaluation frameworks. High school English language arts teachers have the opportunity to register for a four-day workshop to become an ERWC-certified instructor, at no cost for registration or materials. A council of CSU faculty representatives and an advisory board made up of faculty and public stakeholders provide direction for the center's activities.

The CSU is utilizing a parallel approach in supporting capacity development across California, centered in the CAIQR and leveraging the existing CMRCI bridge course pilot programs that currently operate in 168 high schools. The university will be expanding these efforts to include the schools and districts identified as most in need of capacity-building support.

Proposed Title 5 Revision

A modification of first year admission requirements for the CSU would necessitate revisions to two sections of Title 5. The proposed amendments are included below and would be presented for board action in conjunction with this proposal to modify first year admission requirements for the CSU.

Title 5. Education
Division 5. Board of Trustees of the California State Universities
Chapter 1. California State University
Subchapter 3. Admission Requirements
Article 4. Admission as First-Time Freshman
5 CCR § 40753

§ 40753. Applicants Who Are California Residents or Graduates of a California High School.

(a) A graduate of a California high school or a high school graduate who is a resident may be admitted to a campus as a first-time freshman if

(1) the graduate's eligibility index is equal to or greater than that minimum eligibility index, as determined by the Chancellor, required to limit eligibility to that one-third of California high school graduates which has the greatest probability of academic success in the California State University, and

(2) for admissions prior to fall term ~~2003~~ 2026, the graduate has completed satisfactorily a comprehensive pattern of college preparatory subjects to include at least

four years of English, three years of mathematics, two years of history or social science, two years of laboratory science, two years of foreign language, one year of visual and performing arts, and one year of electives from any combination of English, mathematics, social science, history, laboratory science, foreign language, visual and performing arts, CSU-approved career technical education courses, and other fields of study determined by the Chancellor to be appropriate preparation for California State University study. ~~four years of English, three years of mathematics, one year of United States history or United States history and government, one year of laboratory science, two years of foreign language, one year of visual and performing arts, and three years of electives from any combination of English, mathematics, social science, history, laboratory science, foreign language, visual and performing arts, and other fields of study determined by the Chancellor to be appropriate preparation for California State University study. A graduate who qualifies for admission under subdivision (a)(1) and who has completed at least ten of the courses in the comprehensive pattern of this subdivision may be admitted on condition that the graduate completes the work identified by the Chancellor or designee at the time of the graduate's admission as necessary to remove the coursework deficiency within the first two years of the graduate's baccalaureate studies. The Chancellor shall implement the comprehensive pattern of college preparatory subject requirements and in so implementing shall make every effort to avoid undue hardship during the phasing in of these requirements and shall determine satisfactory completion of the requirements and may grant exceptions for preparation determined by the Chancellor to be equivalent.~~

(3) commencing with admissions for the fall term ~~2003~~ 2026, the graduate has completed satisfactorily the comprehensive pattern of college preparatory subjects defined in Section 40601. The Chancellor shall implement the comprehensive pattern of college preparatory subject requirements and in so implementing shall make every effort to avoid undue hardship during the phasing in of these requirements and shall determine satisfactory completion of the requirements and may grant exceptions for preparation determined by the Chancellor to be equivalent.

(b) This section shall not apply to an applicant who is eligible for admission as a first-time freshman pursuant to Section 40755.

Note: Authority cited: Section 89030, Education Code. Reference: Section 89030, Education Code.

Title 5. Education
Division 5. Board of Trustees of the California State Universities
Chapter 1. California State University
Subchapter 3. Admission Requirements
Article 4. Admission as First-Time Freshman
5 CCR § 40754

§ 40754. Applicants Who Are Neither California Residents nor Graduates of a California High School.

(a) A high school graduate who is neither a resident nor a graduate of a California high school may be admitted to a campus as a first-time freshman if

(1) the graduate's eligibility index is equal to or greater than that minimum eligibility index, as determined by the Chancellor, which is required to limit eligibility to that on-sixth of California high school graduates which has the greatest probability of academic success in the California State University, and

(2) for admissions prior to fall term ~~2003~~ 2026, the graduate has completed satisfactorily a comprehensive pattern of college preparatory subjects to include at least four years of English, three years of mathematics, two years of history or social science, two years of laboratory science, two years of foreign language, one year of visual and performing arts, and one year of electives from any combination of English, mathematics, social science, history, laboratory science, foreign language, visual and performing arts, CSU-approved career technical education courses, and other fields of study determined by the Chancellor to be appropriate preparation for California State University study. ~~four years of English, three years of mathematics, one year of United States history or United States history and government, one year of laboratory science, two years of foreign language, one year of visual and performing arts, and three years of electives from any combination of English, mathematics, social science, history, laboratory science, foreign language, visual and performing arts, and other fields of study determined by the Chancellor to be appropriate preparation for California State University study. A graduate who qualifies for admission under subdivision (a)(1) and who has completed at least ten of the courses in the comprehensive pattern of this subdivision may be admitted on condition that the graduate completes the work identified by the Chancellor or designee at the time of the graduate's admission as necessary to remove the coursework deficiency within the first two years of the graduate's baccalaureate studies. The Chancellor shall implement the comprehensive pattern of college preparatory subject requirements and in so implementing shall make every effort to avoid undue hardship during the phasing in of these requirements and shall determine satisfactory completion of the requirements and may grant exceptions for preparation determined by the Chancellor to be equivalent.~~

(3) commencing with admissions for the fall term ~~2003~~ 2026, the graduate has completed satisfactorily the comprehensive pattern of college preparatory subjects pursuant to Section

40601. The Chancellor shall implement the comprehensive pattern of college preparatory subject requirements and in so implementing shall make every effort to avoid undue hardship during the phasing in of these requirements and shall determine satisfactory completion of the requirements and may grant exceptions for preparation determined by the Chancellor to be equivalent.

(b) This section shall not apply to an applicant who is eligible for admission as a first-time freshman pursuant to Section 40755.

Note: Authority cited: Section 89030, Education Code Reference: Section 89030, Education Code.

Title 5. Education
Division 5. Board of Trustees of the California State Universities
Chapter 1. California State University
Subchapter 3. Admission Requirements
Article 1. Construction and Definitions
5 CCR § 40601

§ 40601. Applicants Who Are California Residents or Graduates of a California High School.

The following terms, whenever used or referred to in this subchapter, shall have the following meanings, respectively, unless a different meaning appears from the context:

(a) The term "Chancellor" means the Chancellor of the California State University or designee.

(b) The term "the campus" means the campus to which application for admission is made.

(c) The term "appropriate campus authority" means the president of the campus or designee.

(d) The term "college" means:

(1) Any institution of higher learning that is accredited to offer work leading to the degree of Bachelor of Arts or to the degree of Bachelor of Science, by the applicable regional accrediting agency recognized by the United States Department of Education, except an institution which is accredited only as a "specialized institution";

(2) Any foreign institution of higher learning which, in the judgment of the Chancellor, offers course work equivalent to that offered by institutions included within subdivision (d)(1) of this section.

(e) The term “application” means the submission to the campus, by the person applying for admission, of all documents, including official transcripts of all the applicant's academic records and information that the applicant is required personally to submit, and the payment of any application fee due, pursuant to Section 41800.1.

(f) The term “eligibility index” means the number derived for admission determination, from a weighted combination of the grade point average for courses taken in the comprehensive pattern of college preparatory subjects during the final three years of high school, and the score on either the ACT or the SAT (examinations), pursuant to Title 5 section 40752 or section 40802. The weighting of grade point averages and test scores shall be determined and adjusted from time to time by the chancellor on the basis of standards defined by a California higher education eligibility study.

(g) The term “good standing at the last college attended” means that at the time of application for admission and at the time of admission, the applicant was not under disciplinary or academic suspension, dismissal, expulsion or similar action by the last college attended and was not under disciplinary suspension, dismissal, expulsion or similar action at any institution of the California State University.

(h) The term “first-time freshman” means an applicant who has earned college credit not later than the end of the summer immediately following high school graduation or an applicant who has not earned any college credit.

(i) The term “undergraduate transfer” means any person who is not a first-time freshman pursuant to Section 40601(h), and who does not hold a baccalaureate degree from any college.

(j) The term “full-time student” means any student whose program while in attendance at a college averaged twelve or more semester units per semester, or the equivalent.

(k) The term “resident” shall have the same meaning as does the same term in Section 68017 of the Education Code, and shall include all persons so treated by the provisions of that section.

(*l*) The term “unit” means a semester unit within the meaning of Section 40103, or the equivalent thereof.

(m) The term “transferable” when used in connection with college units, college credit or college work, shall mean those college units, credit or work which are determined to be acceptable (either for specific requirements or as electives) toward meeting the requirements of a baccalaureate degree. The Chancellor is authorized to establish and from time to time to revise procedures for the implementation of this subdivision.

(n) The term “comprehensive pattern of college preparatory subjects” means, in each area of study, at least four years of English, three years of mathematics, two years of history or social

science, two years of laboratory science, two years of foreign language, one year of visual and performing arts, one year of electives from any combination of mathematics, laboratory science, CSU-approved career technical education courses, and other fields of study with quantitative reasoning content determined by the Chancellor to be appropriate preparation for California State University study, and one year of electives from any combination of English, mathematics, social science, history, laboratory science, foreign language, visual and performing arts, CSU-approved career technical education courses, and other fields of study determined by the Chancellor to be appropriate preparation for California State University study.

(o) The terms "impacted campus" or "impacted programs" at any campus mean that the number of applications from eligible applicants received during the initial application filing period exceeds the number of available admission spaces.

(p) The terms "redirection" or "redirect" refer to the responsibility of each CSU campus that opens to receive new undergraduate applications for any given term to admit eligible transfer applicants with Associate Degrees for Transfer or to forward their application to another CSU campus with the capacity to admit.

Note: Authority cited: Section 89030, Education Code. Reference: Sections 89030 and 89030.5, Education Code.

Conclusion

For decades, the CSU has been at the forefront of addressing the academic preparation of prospective and current students while maintaining a commitment to authentic access to a high-quality degree. To this end, groundbreaking programs like the CSU's Early Assessment Program, established in 2003, provide prospective students, families and schools with early guidance on preparation for collegiate study and opportunities to enhance preparation in the senior year of high school. Similarly, the ERWC, now offered in more than 1,000 California high schools, provides high school seniors the opportunity to complete a fourth-year course in English language arts that was co-developed by the CSU and high school faculty to more closely align with college-level writing expectations.

Most recently, the CSU implemented new academic preparation policies associated with Executive Order 1110. These policy changes were also met with opposition, protest, critical public comments and concern about the implications for historically underserved students. Yet, the CSU's guiding question, "Is this the right thing to do for students?" remained central. One year later, the number of students passing credit-bearing courses, which count toward their degree, has increased eightfold. And, historically underrepresented students experienced the greatest gains.

Similar protest and opposition was associated with the CSU's 1988 adoption of the 'a-g' courses. But today, a record number of students are meeting the 'a-g' requirements and are eligible for study at the CSU and UC. A recent report by the Public Policy Institute of California noted that

"high school graduation rates increased from 75% in 2009–10 to 83% in 2015–16. Much of this increase has come from rising graduation rates among students of color: rates for both Latino students and African American students have increased 12 percentage points (to 80% and 73%, respectively)."

Continued progress requires action and organizational clarity regarding the true costs associated with maintaining the status quo. There is widespread agreement that students continue to deserve and need access to better preparation for college. The workforce and world have changed significantly in the last 30 years and the evidence is clear—additional quantitative reasoning preparation improves college success and access to a range of majors and career choices.

This proposal to modify first-year admission requirements to the CSU continues the progress made to ensure equity and authentic access for all CSU students. The CSU has proposed a six-year timeframe before implementation to allow for capacity-building and communication to students and families. The CSU also remains committed to access and takes seriously the responsibility to do no harm to students who may be attending schools with limited access to qualifying courses. And the university is committed to partnering with districts, schools and community organizations to build the necessary capacity for successful implementation.

Quantitative Reasoning Research Summary

Adelman, C. (2005). Executive Summary: The Toolbox Revisited: Paths to Degree Completion from High School Through College. *The Journal for Vocational Special Needs Education,28* (1), 23-30.

URL: The Toolbox Revisited: Paths to Degree Completion From High School Through College

"The academic intensity of the student's high school curriculum still counts more than anything else in precollegiate history in providing momentum toward completing a bachelor's degree. There is a quantitative theme to the curriculum story that illustrates how students cross the bridge onto and through the postsecondary landscape successfully. The highest level of mathematics reached in high school continues to be a key marker in precollegiate momentum, with the tipping point of momentum toward a bachelor's degree now firmly above Algebra 2."

Long, M. C., Iatarola, P., & Conger, D. (2009). Explaining gaps in readiness for college level math: The role of high school courses. *Education Finance and Policy, 4*(1), 1-33.

URL: Explaining Gaps in Readiness for College-Level Math: The Role of High School Courses

"Despite increased requirements for high school graduation, almost one-third of the nation's college freshmen are unprepared for college-level math. The need for remediation is particularly high among students who are low income, Hispanic, and black. Female students are also less likely than males to be ready for college-level math. This article estimates how much of these gaps are determined by the courses that students take while in high school. Using data on students in Florida public postsecondary institutions, we find that differences among college-going students in the highest math course taken explain 28–35 percent of black, Hispanic, and poverty gaps in readiness and over three-quarters of the Asian advantage. Courses fail to explain gender gaps in readiness. Low-income, black, and Asian students also receive lower returns to math courses, suggesting differential educational quality. This analysis is valuable to policy makers and educators seeking to reduce disparities in college readiness."

Long, M. C., Conger, D., & Iatarola, P. (2012). Effects of high school course-taking on secondary and postsecondary success. ***American Educational Research Journal*****, 49(2), 285–322.**

URL: https://doi.org/10.3102/0002831211431952

"Using panel data from a census of public school students in the state of Florida, the authors examine the associations between students' high school course-taking in various subjects and their 10th-grade test scores, high school graduation, entry into postsecondary institutions, and postsecondary performance. The authors use propensity score matching (based on 8th-grade test scores, other student characteristics, and school effects) within groups of students matched on the composition of the students' course-taking in other subjects to estimate the differences in outcomes for students who take rigorous courses in a variety of subjects. The authors find substantial significant differences in outcomes for those who take rigorous courses, and these estimated effects are often larger for disadvantaged youth and students attending disadvantaged schools."

Blair, R., & Getz, A. (2011). A Brief History of the Quantitative Literacy Movement.

URL: A Brief History of the Quantitative Literacy Movement

"It has always been important for individuals to have the capacity to *do* arithmetic and algebra, however, in today's global and technological society, doing calculations is not enough. An individual's capacity to identify and understand quantitative situations, reason quantitatively, and communicate about the role mathematics plays in the world is essential. This quantitative literacy goes beyond basic computational skills. The quantitatively literate individual should be able engage in mathematics and solve quantitative problems from a wide array of authentic contexts and everyday life situations. These "habits of the mind" lead to making well-founded mathematical judgments that are useful in an individual's current and future life as a constructive, concerned, and reflective citizen. Quantitative Literacy (QL) is more than just arithmetic skills and as fundamental as language literacy."

Bozick, R., Ingels, S., & Owings, J. (2008). Mathematics Coursetaking and Achievement at the End of High School: Evidence from the Education Longitudinal Study of 2002 (ELS:2002).

URL: Mathematics Coursetaking and Achievement at the End of High School: Evidence from the Education Longitudinal Study of 2002.

"The findings show that the largest overall gains are made by students who take precalculus paired with another course during the last 2 years of high school. In terms of learning in specific content areas, the largest gains in intermediate skills such as simple operations and problem solving were made by those who followed the geometry–algebra II sequence. The largest gains in advanced skills such as derivations and making inferences from algebraic expressions were made by students who took precalculus paired with another course. The smallest gains were made by students who took one mathematics course or no mathematics courses during their last 2 years."

Elrod, S. (2014, December 19). Quantitative Reasoning: The Next "Across the Curriculum" Movement.

URL: Quantitative Reasoning: The Next "Across the Curriculum" Movement

"By one definition, quantitative reasoning (QR) is the application of basic mathematics skills, such as algebra, to the analysis and interpretation of real-world quantitative information in the context of a discipline or an interdisciplinary problem to draw conclusions that are relevant to students in their daily lives. It is not just mathematics. Carleton College, for example, views QR as "the habit of mind to consider the power and limitations of quantitative evidence in the evaluation, construction, and communication of arguments in public, professional, and personal life." The term numeracy is also used in conjunction with these skills."

Finkelstein, N., Fong, A., Tiffany-Morales, J., Shields, P., & Huang, M. (2012). College Bound in Middle School & High School? How Math Course Sequences Matter.

URL: College Bound in Middle School & High School? How Math Course Sequences Matter

"Irrespective of students' math performance, taking four years of high-school math strengthens their postsecondary opportunities. For students seeking entrance to one of California's public university systems, a fourth year of math is strongly recommended. Yet our analysis shows that slightly more than 30 percent of students in the study sample did not take math during their senior year. For those who don't study math their senior year (as well as for others who may not move directly from high school to college), having to take a college placement test after at least a year away from math can be a major deterrent to placing into a college-level math course; and students who do not do well on their placement test are likely to end up in a developmental, or remediation, math course, which yields no college credit."

Gao, N. (2016, July). College Readiness in California: A Look at Rigorous High School Course-Taking. Public Policy Institute of California.

URL: College Readiness in California: A Look at Rigorous High School Course-Taking

"In this report we look at participation and performance in rigorous high school courses among California high school students, both overall and across demographic and racial/ethnic groups. While enrollment in rigorous courses has been increasing, particularly among students who are traditionally underrepresented in higher education, a large majority of California high school students are not taking the courses that can prepare them for college. Forty-three percent of high school graduates in 2015 completed the a–g requirement, and 27 percent of high school graduates in 2013 passed an advanced placement (AP) exam. Participation in advanced math, biology, chemistry, and physics courses is also low. In particular, only 30 percent of high school juniors and seniors enrolled in Algebra II and smaller shares enrolled in chemistry (28%) and physics (10%)."

Lee, J. (2012). College for all: Gaps between desirable and actual P–12 math achievement trajectories for college readiness. *Educational Researcher*, 41(2), 43–55.

URL: https://doi.org/10.3102/0013189X11432746

"This study addresses missing links in "college for all" debates by investigating gaps between actual and desirable math achievement trajectories for students' college readiness. Linking multiple national data sets across P–16 education levels, the study estimates college readiness benchmarks separately for two-year and four-year college entrance and completion. The goals of the study are to compare performance standards, benchmarks, and norms for college readiness and to assess college readiness gaps among all students as well as gaps among racial and social subgroups. The results suggest that entrance into and completion of two-year versus four-year colleges require substantially different levels of math achievement in earlier education periods and that meeting national versus state proficiency standards leads to differences in postsecondary education outcomes and can mean the difference between bachelor's and associate's degree attainment. Persistent racial and social gaps in college readiness threaten the goal of getting all students academically ready for at least two-year college completion."

Daun-Barnett, N., & St. John, E. (2012). Constrained curriculum in high schools: The changing math standards and student achievement, high school graduation and college continuation. *Education Policy Analysis Archives, 20*, 5.

URL: http://dx.doi.org/10.14507/epaa.v20n5.2012

"Mathematics education is a critical public policy issue in the U.S. and the pressures facing students and schools are compounded by increasing expectations for college attendance after high school. In this study, we examine whether policy efforts to constrain the high school curriculum in terms of course requirements and mandatory exit exams affects three educational outcomes – test scores on SAT math, high school completion, and college continuation rates. We employ two complementary analytic methods – fixed effects and difference in differences (DID) – on panel data for all 50 states from 1990 to 2008. Our findings suggest that within states both policies may prevent some students from completing high school, particularly in the near term, but both policies appear to increase the proportion of students who continue on to college if they do graduate from high school. The DID analyses provide more support for math course requirement policies than mandatory exit exams, but the effects are modest. Both the DID and fixed effects analyses confirm the importance of school funding in the improvement of high school graduation rates and test scores."

Trusty, J., & Niles, S. (2003). High-school math courses and completion of the bachelor's degree. *Professional School Counseling, 7*(2), 99-107.

URL: http://www.jstor.org/stable/42732549

"Using a national longitudinal sample of 5,257 young people who were pursuing the bachelor's degree, we studied how credits in intensive high school mathematics courses affected their completion versus noncompletion of the degree. Finishing one unit in any of four intensive math courses more than doubled the likelihood that participants would later complete the bachelor's degree. Effects were present above and beyond the effects of background variables, including early math ability. Implications of findings are presented."

One Year Out: Findings From A National Survey Among Members Of The High School Graduating Class Of 2010 (Rep.). (2011). Washington, DC: Hart Research Associates.

URL: One Year Out: Findings From A National Survey Among Members Of The High School Graduating Class Of 2010

"Four in nine members of the class of 2010 say that based on what they know now they wish they had taken different courses in high school, with the largest proportion of these graduates saying they wish they had taken more math courses or more difficult math courses. 44% say that they wish they had taken different courses in high school. Among this group, 40% would have taken more or higher-level math courses, 37% would have taken courses that would have trained them for a specific job, and 33% would have taken more or higher-level science courses. Regrets about course selection are higher than average among students who went on to college but felt less well prepared than others at their college, students who considered dropping out or did drop out of college, and students who were required to take non-credit remedial courses once they got to college."

Rigor at Risk: Reaffirming Quality in the High School Core Curriculum (Rep.). (2007). Iowa City, IA: ACT.

URL: Rigor At Risk: Reaffirming Quality in the High School Core Curriculum

"Of those students who take a core mathematics curriculum, only 16 percent are ready for a credit bearing first-year College Algebra course (see Figure 4). It is not until students take one full year of additional mathematics courses beyond the core that we see more than half (62 percent) of ACT-tested students ready for college-level work in mathematics."

The Value of the Fourth Year of Mathematics (Rep.). (2013). Washington, DC: Achieve, Inc.

URL: The Value of the Fourth Year of Mathematics

"Too many students and educators view the senior year and graduation from high school as an end point, rather than one vital step along the education pipeline. Students who engage in a fourth year of math tap into and build upon their advanced analytic skills and are more likely to have better success in postsecondary course work, as they have maintained their momentum and continued to practice mathematics throughout their high school experience."

Table 1: States that Require a Minimum of Four Years of High School Mathematics/Quantitative Reasoning for a General Diploma

State	Requirement
1. Alabama	3 credits to include: Algebra I, or its equivalent; Geometry, or its equivalent; Algebra II w/Trig or Algebra II, or its equivalent. One credit from Alabama Course of Study: Mathematics or CTE/AP/IB/postsecondary equivalent courses
2. Arkansas	(1) Algebra I or First Part and Second Part Algebra I (Grades 7-8 or 8-9); (1) Geometry or First Part and Second Part Geometry (Grades 8-9 or 9-10); (1) Algebra II; (1) Fourth Math - Choice of: Advanced Topics and Modeling in Mathematics, Algebra II, Calculus, Linear Systems and Statistics, Mathematics Applications and Algorithms, Pre-Calculus, or an AP mathematics
3. Connecticut	Four credits in mathematics, including algebra I, geometry and algebra II or probability and statistics
4. Delaware	The student shall complete mathematics course work that includes no less than the equivalent of the traditional requirements of Geometry, Algebra I and Algebra II courses. The student shall complete an Algebra II or Integrated Mathematics III course as one of the Mathematics credits. During the senior year the student shall maintain a credit load each semester that earns the student at least a majority of credits that could be taken that semester. A credit in Mathematics shall be earned during the senior year.
5. District of Columbia	Must include Algebra I, Geometry and Algebra II at a minimum
6. Florida	A student must earn one credit in Algebra I and one credit in geometry. Earn one credit in Algebra II and one credit in statistics or an equally rigorous course.
7. Georgia	Four units of core credit in mathematics shall be required of all students, including Mathematics I or GPS Algebra, or its equivalent and Mathematics II or GPS Geometry, or its equivalent and Mathematics III or GPS Advanced Algebra or its equivalent. Additional core courses needed to complete four credits in mathematics must be chosen from the list of GPS/ CCGPS /AP/IB/dual enrollment designated courses.
8. Louisiana	Algebra I (1 unit); Applied Algebra I (1 unit), or Algebra I-Pt. 1 and Algebra I-Pt. 2 (2 units); The remaining units shall come from the following: Geometry or Applied Geometry; Technical Math; Medical Math; Applications in Statistics and Probability; Financial Math; Math Essentials; Algebra II; Advanced Math - Pre-Calculus; Discrete Mathematics; or course(s) developed by the LEA and approved by BESE.
9. Maryland	3 credits - 1 in Algebra/Data Analysis; 1 in Geometry; and 1 additional mathematics credit 4 credits beginning with the class of 2018
10. Michigan	Algebra I, Geometry, Algebra II, one math course in final year of high school. Under HB 4465, a student may complete Algebra II over 2 years with 2 credits awarded or over 1.5 years with 1.5 credits awarded. A pupil also may partially or fully fulfill the Algebra II requirement by completing a department-approved formal career and technical education program or curriculum, such as a program or curriculum in electronics, machining, construction, welding, engineering, computer science, or renewable energy, and in that program or curriculum successfully completing the same content as the Algebra II benchmarks assessed on the department prescribed state high school assessment, as determined by the department.
11. New Mexico	4 units of math with one unit equal to or greater than Algebra 2. 2013 and after: Four units in mathematics, of which one shall be the equivalent to or higher than the level of algebra 2, unless the parent submitted written, signed permission for the student to complete a lesser mathematics unit.
12. Ohio	Four units, which shall include one unit of algebra II or the equivalent of algebra II
13. Tennessee	4 credits, including Algebra I, II, Geometry and a fourth higher level math course. (Students must be enrolled in a mathematics course each school year.)

14. Virginia	Courses completed to satisfy this requirement shall include at least two different course selections from among: Algebra I; Geometry; Algebra, Functions and Data Analysis; Algebra II, or other mathematics courses above the level of Algebra II. The Board shall approve courses to satisfy this requirement.
15. West Virginia	Math I; Math II; Math III STEM, or Math III LA or Math III TR; Math IV or Math IV TR or Transition Mathematics for Seniors or any other fourth course option (Chart V). An AP mathematics course may be substituted for an equivalent course or any fourth course option.

Table 2: States that Require Four Years of High School Mathematics AND a Senior Year Course

State	Mathematics requirement
Delaware	The student shall complete mathematics course work that includes no less than the equivalent of the traditional requirements of Geometry, Algebra I and Algebra II courses. The student shall complete an Algebra II or Integrated Mathematics III course as one of the Mathematics credits. During the senior year the student shall maintain a credit load each semester that earns the student at least a majority of credits that could be taken that semester. A credit in Mathematics **shall be earned during the senior year**.
Michigan	Algebra I, Geometry, Algebra II, one math course in final year of high school. Under HB 4465, a student may complete Algebra II over 2 years with 2 credits awarded or over 1.5 years with 1.5 credits awarded. A pupil also may partially or fully fulfill the Algebra II requirement by completing a department-approved formal career and technical education program or curriculum, such as a program or curriculum in electronics, machining, construction, welding, engineering, computer science, or renewable energy, and in that program or curriculum successfully completing the same content as the Algebra II benchmarks assessed on the department prescribed state high school assessment, as determined by the department. The DOE shall post on its website and submit to the senate and house standing committees on education guidelines for implementation. Each **pupil must successfully complete at least 1 mathematics course during his or her final year of high school enrollment**. The bill is now Public Act 208 of 2014.
Ohio	Earn at least four units of mathematics which shall include algebra I, algebra II, geometry, and another higher-level course or **a four-year sequence of courses** which contains equivalent content.
Tennessee	4 credits, including Algebra I, II, Geometry and a fourth higher level math course. (**Students must be enrolled in a mathematics course each school year**.)
West Virginia	Math I; Math II; Math III STEM, or Math III LA or Math III TR; Math IV or Math IV TR or Transition Mathematics **for Seniors or any other fourth course option**

	(Chart V). An AP mathematics course may be substituted for an equivalent course or any fourth course option.

California State University Bridge Courses in Mathematics

The California State University (CSU) Bridge Courses were developed with grants from the California Department of Education and a federal Investing in Innovation (i3) grant. Bridge Courses were co-developed by high school mathematics teachers and CSU faculty to create a senior year course that fulfills an area 'c' admission requirement and serves as a transition to college-level mathematics and quantitative reasoning courses.

Five CSU campuses are leading the development and implementation of these courses in collaboration with their K-12 partners. The projects focus on: a) preparing teachers for rigorous mathematics instruction; b) developing innovative pedagogical practices; and c) exploring the range of quantitative reasoning content that effectively bridges K-12, community college and CSU competency expectations.

The projects help schools build capacity to increase college readiness, especially in STEM-related fields. These courses are effectively filling resource gaps and addressing course availability needs in poor districts while expanding pathways for mathematics success.

All five projects fundamentally shift the way mathematics is taught in high school, opening doors for more students to realize academic success. For example, in the Mathematics Reasoning with Connections course led by CSU San Bernardino, the curriculum emphasizes the connections between algebra, geometry, trigonometry and statistics, with a focus on deep contextual understanding. These Bridge Courses offer an opportunity for high schools to offer multiple quantitative reasoning pathways for students while responding to their diverse career interests.

The CSU is working with local school districts to build awareness about the promise of Bridge Courses throughout the state. These courses hold the potential to be developed, scaled and targeted at school districts with limited resources.

Table 1: The number of districts, schools, teachers, and students participating in C

CSU Lead: **Course Title**	**Districts**	**Schools**	**Teachers**	**Students** (approximate)
CSU Monterey Bay: Transition to College Level Mathematics	5	8	8	197
CSU Northridge: Transition to College Mathematics and Statistics Project	1	48	40	2,131
Sacramento State: Excellence in Academic Preparation	20	52	139	4,293
CSU San Bernardino: Mathematical Reasoning with Connections	20	48	74	2,963
San Diego State: Discrete Mathematics	1	12	22	1,204
Totals	**47**	**168**	**283**	**10,788**