



## Will AB 1705 Lead to Stronger and More Equitable Calculus Completion for the Business Major?

### Summary

This year California community colleges will take another step in the last mile of placement and remediation reforms mandated by Assembly Bill 705 (Irwin 2017).

[AB 705](#) set standards for evaluating long-standing college policies that barred most students, and disproportionately students of color, from access to introductory general education courses in English and math, courses that are required for a university degree. The standards motivated extensive state and local research that consistently revealed the shortcomings of a system that underestimated the capacity of its students to succeed. As a result of this research, the law required colleges to change placement practices and discontinue remedial prerequisites that held students back. In the first year of mandatory implementation, an unprecedented number and percentage of students completed transfer-level general education requirements in English and math. For Black and Hispanic students, one-year transfer-level math completion more than doubled (fall 2015 vs. fall 2019), exceeding the completion rates of Whites pre-reform. However, because all racial groups experienced large gains, equity gaps remained.

Persistent equity gaps and uneven math implementation prompted another round of legislation. [AB 1705](#), sister legislation to AB 705, went into effect in January 2023. AB 1705 ensures that students with an academic goal begin in coursework that gives them the best chance of completing not only introductory general education requirements in English and math but also gateway math courses for majors that require more math. The law mandates that U.S. high school graduates begin in gateway math courses associated with their major but allows exceptions if prerequisites to gateway courses improve students' progress.

With the new focus on gateway math courses within math intensive majors comes a focus on calculus. Colleges have long-standing placement policies for calculus that sideline most students into prerequisites, like college algebra or precalculus, that do not satisfy requirements for math heavy degrees in business or STEM. Does this practice help or hinder students' progress in completing lower division requirements for the business or STEM degree? This is the next area of investigation for the state's colleges, with a July 2023 deadline for business programs and a July 2024 deadline for STEM programs.

In light of AB 1705 mandates, this report examines how prerequisite requirements, corequisite options, and the discontinuation of remedial math are currently impacting equitable access to and completion of calculus for the business major. This analysis suggests that opportunities exist throughout California's community colleges for increasing the volume and diversity of students making progress toward a business degree by addressing AB 1705 prerequisite validation requirements.

### Findings

- Access to business calculus is inconsistent across colleges.
- Concurrent support is better than preparatory coursework at improving business calculus completion for students deemed “not calculus ready.”
- Colleges serving a large share of the state's Black and/or Hispanic students are more likely to restrict access to business calculus and less likely to offer concurrent support.
- Access to business calculus varies widely within and across regions.

## Background

Signed into law in 2022, Assembly Bill 1705 (Irwin, Medina) strengthens placement and remediation reforms mandated in 2017 by AB 705 (Irwin). Under AB 705, California community colleges must give students access to courses that give them the best chance of completing general education requirements in English and math for a baccalaureate degree. In the language of AB 705, placement must “maximize the probability” that students complete transfer-level math and English within a year of enrolling in the discipline.

Under AB 705, the “maximize the probability of completion” standard drove extensive state and local research into the efficacy of remedial prerequisites that historically barred most students from introductory transfer-level courses in math and English. These studies consistently show that students are more likely to complete introductory transfer-level courses if they start in those courses and bypass remedial prerequisites. For example, in fall 2020, 64% of students starting in a transfer-level math course completed it within a year, compared to 15% of students starting in intermediate algebra, or a similar remedial course. For students deemed underprepared, corequisite support linked to a transfer-level course produced stronger and more equitable outcomes than remedial prerequisites ([PPIC 2020](#)). Take for example, students who struggled in high school. Of those with a high school GPA below 2.3, 39% completed transfer-level math if they started in that course with corequisite support, compared to 8% who started in intermediate algebra (fall 2020-spring 2021, [State Chancellor’s Transfer-level Completion Dashboard](#)). The same patterns occur in English.

*The “maximize the probability of completion” standard transformed the California community college system.*

Under the “maximize the probability of completion” standard, the percentage of students starting in transfer-level math increased from 26% in fall 2015 to 82% in fall 2021. By minimizing access barriers to transfer-level math, the community college system doubled transfer-level math completion, with the largest relative gains for [Black and Hispanic](#) students. When the data is further disaggregated, it is evident how severely past policies hampered students’ progress and underestimated their abilities. Every student group has achieved substantial completion gains, including [low-income](#) students, students with [disabilities](#), [STEM](#) students with weaker math preparation, [students over the age of 35](#), [foster youth](#), and [veterans](#). For most of these groups, one-year completion of transfer-level math doubled.

The new law, AB 1705, extends the “maximize the probability of completion” standard to gateway English or math courses within a major. Now under scrutiny are transfer-level prerequisites that bar students from beginning gateway coursework in their major. This will mainly (perhaps exclusively) affect business and STEM programs where transfer-level prerequisites to calculus, such as college algebra or precalculus, do not satisfy lower division requirements for the business or STEM degree. Tens of thousands of students with aspirations in calculus-based majors are sidelined every year into college algebra, a course with a statewide average pass rate of 40%. Within three semesters, only 15% will complete calculus. Does this prerequisite maximize the probability that a student completes calculus? Would they be even less likely to pass calculus without it? These are the questions that colleges will investigate this year and next year as AB 1705 deadlines approach.

Up first are non-STEM programs, like business. By July 2023, AB 1705 requires colleges to validate prerequisites to gateway courses in non-STEM programs. Colleges must show (1) that students who start in the prerequisite are highly unlikely to succeed in the gateway course without the prerequisite, and (2) that students are more likely to complete the gateway course within a year if they start in prerequisite course compared to similar students who bypass the prerequisite and start directly in the gateway course. After July 2024, colleges can no longer require or recommend prerequisites that are not validated as

improving completion of the gateway course, and they cannot place or enroll U.S. high school graduates into those courses.

This report examines the potential impact of AB 1705 in creating more equitable access to, and completion of, a gateway course (business calculus) in one program of study (the transferable associate of science in Business.)

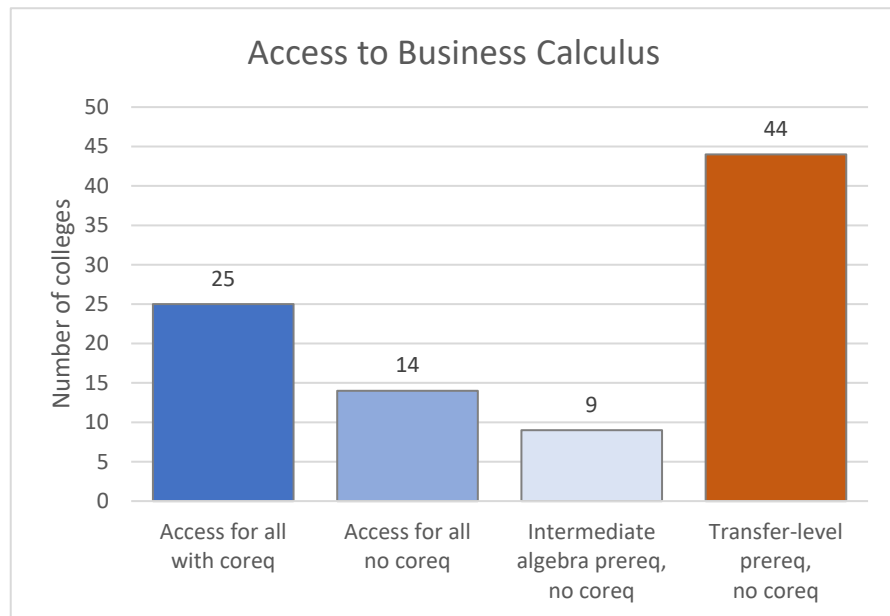
## Findings

### → Access to business calculus is inconsistent across colleges.

Ninety-two colleges offer business calculus as an option for meeting the math requirements of an associate degree for transfer in business ([AS-T Business 2.0](#)). At all 92 colleges, the course has the same learning goals and content and is certified as equivalent to [Math 140](#) under the Course Identification Numbering System (C-ID). This certification requires an intermediate algebra prerequisite but also lists a college algebra course as an advisory.

Access to business calculus is inconsistent across colleges because of varying policies on prerequisites. About half of the colleges offering business calculus (44 colleges) have a transfer-level prerequisite (usually college algebra or precalculus); the other half (48) have a lower-level prerequisite of intermediate algebra (aka high school Algebra 2); of these, 39 “access for all” colleges ensure that business students enroll directly in calculus by offering corequisite remediation (25 colleges) or no longer offering intermediate algebra (14 colleges).

*Business students with the same academic preparation are deemed “calculus ready” at some colleges and not others. Corequisite support is available at 25 of 92 colleges offering business calculus.*



At colleges offering a corequisite, all students deemed underprepared for business calculus can take the calculus course if they co-enroll in a support course or in a section of the calculus course enhanced with embedded algebra remediation. At colleges with a corequisite option in fall 2022, about 41% of business calculus sections were linked to support. At some colleges, co-enrollment into a supported section was mandatory for some students.

At colleges with an intermediate algebra prerequisite, 14 no longer offered intermediate algebra in fall 2022, which means that all business majors who aspired to take business calculus had direct access to the course, even though no corequisite was offered. In general, community colleges in California are phasing

out the intermediate algebra course because they have not been able to validate its effectiveness as a prerequisite under standards set by AB 705. State and local studies consistently show that even students with the weakest high school performance are more likely to complete transfer-level math if they begin in a transfer-level course, and their progress is hampered by taking remedial courses like intermediate algebra ([MMAP 2021](#)).

For colleges with a college algebra or precalculus prerequisite, these courses are often part of required preparation for both business and STEM calculus. At these colleges, an analysis of fall 2022 class schedules revealed many sections of college algebra and precalculus relative to sections of calculus, which suggests that most students who aspire to take calculus for their program begin in college algebra or precalculus, courses that do not satisfy course requirements for a business or STEM major. This adds an extra semester of prerequisite coursework, anywhere from 3 to 6 additional units, which delays students' progress in their program or may completely deter them from pursuing the major.

Algebra prerequisites are often seen as a door to a business or STEM degree for students with weaker math preparation. With this line of reasoning, prerequisites protect students who are deemed "not calculus ready" from failing calculus by diverting them into a course in which they can be successful as they build their skills. However, this view is not supported by a large statewide [study](#) of students transitioning from California high schools into California community colleges post AB 705. In that study, students who did not take, or did not pass, a course above Algebra 2 (or the equivalent) in high school started in various levels and types of math at the community college. For those starting in some form of calculus (n=476), 41% passed calculus, which is higher than the 38% pass rate for those who started in some form of precalculus, which includes colleges algebra (n=4842). These students would be considered "underprepared" for calculus given the traditional math sequence, yet they fared better in the calculus course than in preparatory courses for calculus. In addition, students with this same level of high school preparation who took statistics as their first college math course had a similar pass rate of 42% (n=22,276). Traditional views of readiness do not explain these results. Other factors are at play.

*If the goal is to open the door to a business or STEM degree for students with weaker math preparation, prerequisites to calculus are not the way to go.*

This data challenges a common view that underlies prerequisite structures, namely, *if you don't know A, you can't learn B*. It is this view that presumes harm to students who skip rungs in the traditional curricular ladder, and it is this view that leads to incredulity about broadening access to calculus for students currently diverted into prerequisites. But AB 1705 requires colleges to follow the data. Colleges must validate the efficacy of prerequisites to gateway courses for a college degree. In the case of the business degree, colleges will need to show (1) that students enrolled in a college algebra or precalculus prerequisite are highly unlikely to succeed in business calculus without the prerequisite, AND (2) that the students who start in the prerequisite are more likely to persist into, and complete, calculus when compared to similar students who skipped that rung in the ladder and started directly in calculus. This data suggests that college algebra and precalculus may fail the test.

**“Significant progress has been made, but it is clear that additional work remains to ensure that students in California are not enrolling in courses that delay their success and add unnecessary costs.”**

– Assemblymember Jacqui Irwin, author of AB 705 and AB 1705

→ **Concurrent support is better than preparatory coursework at improving business calculus completion for students deemed “not calculus ready.”**

According to the latest public data available, a corequisite in lieu of a prerequisite, tripled business calculus completion for students deemed “not calculus ready” in fall 2019 at the first 8 colleges offering the corequisite. That year, 57% of students starting in corequisite course linked to business calculus completed the calculus course, compared to an average of 16% of students beginning in an intermediate algebra prerequisite at those colleges pre-reform<sup>1</sup>. Given the predictable patterns of attrition in a sequence, replacing an intermediate algebra prerequisite with a college algebra or precalculus prerequisite is likely to yield similar results. A statewide study found that only 15% of business and STEM (BSTEM) students who began in college algebra completed some form of calculus after three semesters. For BSTEM students starting in some form of applied calculus, 64% completed the calculus course within a year ([PPIC 2021](#)).

*Every system is perfectly designed to get the outcomes it gets....*

***Why is attrition inevitable in a prerequisite model?***

In a two-course sequence, students face three exit points. For example, if 50% pass the prerequisite, and 70% of that group persist into the gateway course, and 75% pass the gateway course, only 26% of the original group completes the gateway course ( $0.50 \times 0.70 \times 0.75 = 0.26$ ). Impressive gains in the pass rate for the first course will improve completion but not to acceptable levels. For example, suppose a department overhauls the first course with embedded tutoring, new curricula, and improved pedagogy, and first pass rate increases from 50% to 70%. The result of this herculean effort only increases the completion rate of the gateway course from 26% to 37% ( $0.70 \times 0.70 \times 0.75 = 0.37$ ). The corequisite model resolves the exit point problem.

The relative success of the calculus corequisite model shows that the way in which remediation is structured makes a difference. A calculus corequisite model also welcomes business students into the major with a course taught in the context of business applications, a course that counts toward their business degree. There is no stigma in needing help with algebra because algebra remediation is intentionally integrated, and there is more instructional time for individualized help. By contrast, a college algebra or precalculus prerequisite sidelines students into a decontextualized course where the application to business is unclear, and the course does not count toward requirements for the business degree. This may result in students disengaging in the course and not passing. But this also may lead to capable students disengaging from the major altogether. Studies of attrition in university STEM programs suggest that passing a prerequisite to calculus does not motivate students to continue into calculus. In short, capable students change their majors. For example, in a [study](#) at Texas Tech university, 1/3 of students who earned a B or better in precalculus did not enroll in calculus. In an Arizona State University [study](#), 65% of declared life science majors who earned a C or better in precalculus did not persist into the calculus; this was also true for 55% of declared physical science majors and 38% of declared engineering majors. Similar patterns emerged in a [study](#) of students taking college algebra at universities in Nebraska and Illinois.

This is further evidence that prerequisites to business calculus may deter the progress of capable students who seek a business degree and may therefore be difficult to validate under AB 1705.

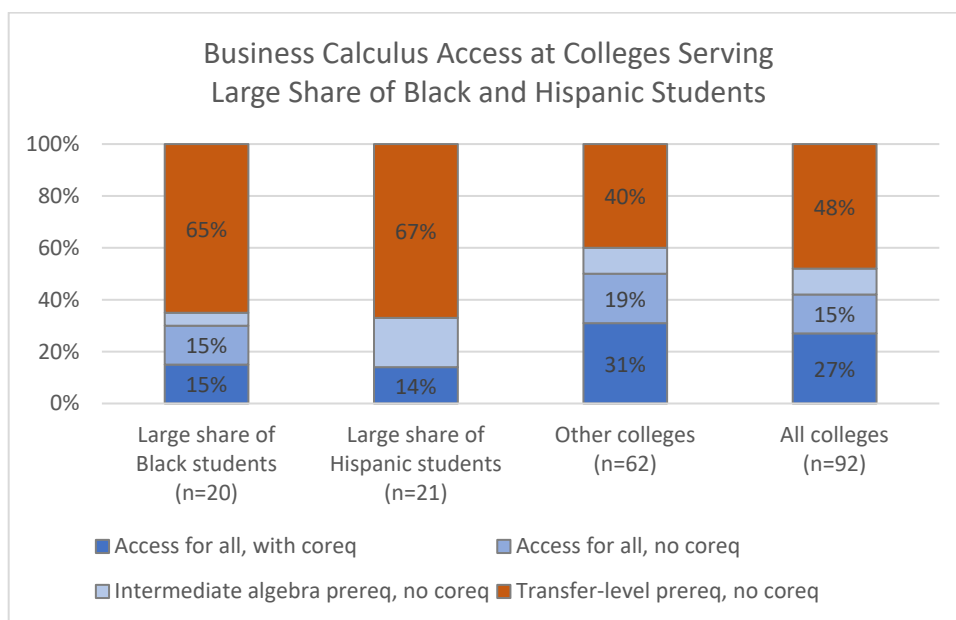
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<sup>1</sup> Data is from the [Basic Skills Cohort Tracker](#). The 16% throughput is the average of the throughput at the eight colleges for students starting in intermediate algebra in fall 2015 and tracked through spring 2016. Throughput = (intermediate algebra pass rate) x (persistence rate into any transfer-level math) x (business calculus pass rate). In 2015, intermediate algebra was a prerequisite to almost all transfer-level math courses, but few of the students who started in that course progressed to business calculus. Of the 2591 students starting in intermediate algebra in fall 2015 across the 8 colleges, 1693 passed; but only 65 persisted into business calculus, with 34 of 65 (52%) passing business calculus.

→ **Colleges serving a large share of the state’s Black and/or Hispanic students are more likely to restrict access to business calculus and less likely to offer concurrent support.**

Colleges with the largest concentrations of Black and/or Hispanic students tend to have the most restrictive access to business calculus.<sup>2</sup> These colleges are

- *More likely to require a transfer-level prerequisite, such as college algebra or precalculus*  
College algebra and precalculus are higher-level prerequisites than required for certification by the state’s Course Identification Numbering System (c-id.net). In the group of colleges serving a large share of the state’s Black students, 65% had a transfer-level prerequisite, compared to 67% of colleges serving a large share of the state’s Hispanic students and only 40% of other colleges.
- *Less likely to ensure that business majors are mainstreamed into business calculus<sup>3</sup>*  
In the group of colleges serving a large share of the state’s Black students, 30% mainstream all business majors into business calculus, compared to 14% of colleges serving a large share of the state’s Hispanic students and 50% of other colleges.
- *Less likely to offer corequisite support for business calculus*  
Only 15% of those with large Black student populations and 14% of those with large Hispanic student populations offered this more effective form of support for students deemed “not calculus ready,” compared to 31% of other colleges.



These patterns are reminiscent of the inequity in access to transfer-level math that persisted throughout the implementation of AB 705 (CAP 2022, CAP 2020). Colleges serving a large share of the state’s Black and Hispanic students were more likely to continue policies and practices that resulted in students enrolling in remedial math prerequisites. This continued in the face of consistent state and local evidence

<sup>2</sup> Large share of Black students = at least 1.5% of the state’s Black community college students (at least 1,850 Black students) attend the college. Large share of Hispanic students = at least 1.25% of the state’s Hispanic community college students (at least 12,690 Hispanic students) attend the college. Because Hispanic students are more evenly distributed across the state’s colleges, the benchmark for “larger share” is lower to generate a sample of 20-25 colleges.

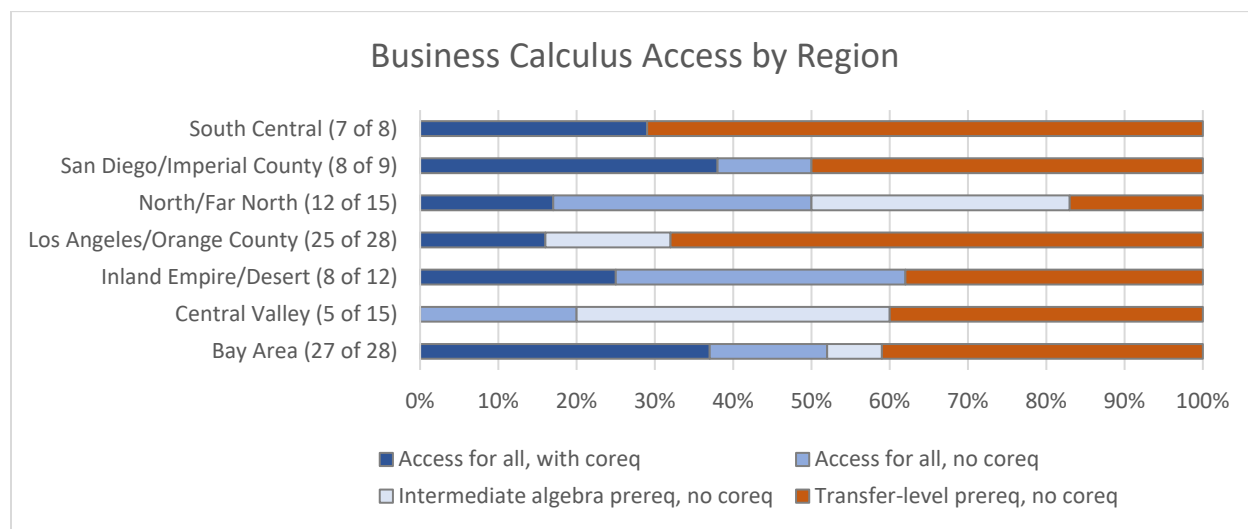
<sup>3</sup> These colleges are labeled “access for all” in the graph because they either offer a corequisite to business calculus or they have an intermediate algebra prerequisite but no longer offer intermediate algebra.

that remedial math prerequisites hampered students' progress, with disproportionate impact for students of color ([PPIC 2021](#), [PPIC 2020](#), [CAP 2021](#)).

AB 1705 requires colleges to validate that their placement policies and practices do not hold students back. Preliminary evidence suggests that many students who begin in prerequisite courses, such as college algebra or precalculus, never complete a gateway calculus course, and that they could succeed in calculus if they started there with corequisite support. The law addresses many of the issues that led to uneven and inequitable implementation of its sister legislation, AB 705, so this time around the state may make progress in addressing equity gaps.

→ **Access to business calculus varies widely within and across regions.**

Access to business calculus is inconsistent across geographic regions. In some regions of the state, more than half of the colleges that offer business calculus ensure that all business students are mainstreamed into the calculus course, either with or without corequisite support (North/Far North and the Inland Empire/Desert region). In other regions, it is the reverse. More than half of the colleges that offer business calculus restrict access by requiring students to take college algebra or precalculus first (South-Central Coast region and Los Angeles/Orange counties,). Because these prerequisites do not satisfy the associate degree for transfer in business, these colleges have added additional coursework and units to the path to a business degree. Perhaps more serious is the fact that this policy may be deterring many students from a business degree, given the low statewide pass rate for college algebra ([PPIC 2020](#)).



Colleges within a region can also have very different prerequisite policies. For example, seven colleges in the South-Central region offer business calculus. Two mainstream business majors into the calculus course with corequisite support as an option. At the other five colleges in the region, business majors must clear a college algebra or precalculus hurdle first. Variation in prerequisite policies within a region is often explained by district policies, which are locally determined. For example, there are many college districts in the Bay Area. The three colleges in the Peralta Community College District that offer business calculus have the same precalculus prerequisite. Across the bay, all three colleges in the San Mateo Community College District ensure direct access to business calculus by offering a corequisite and all three discontinued intermediate algebra in fall 2022.

Community college students often choose to attend their local college because work and family obligations keep them close to home. A student with an interest in business may be deemed “calculus ready” at one college but not at another. Access to corequisite support may be available or it may not be.

When geographic inequity in access to effective programs is present, zipcode may determine whether a student successfully completes a gateway course and continues to pursue their interest in business.

For a program's gateway courses, AB 1705 is a completion-by-design law. Colleges with placement and prerequisite policies that impede students' progress will need to make changes.

## Conclusion

AB 1705 was passed in 2022 to address uneven and inequitable implementation of AB 705. AB 1705 ensures that students with an academic goal begin in coursework that gives them the best chance of completing not only introductory general education requirements in English and math but also gateway math courses for majors that require more math. The law does not dictate curricula or prerequisites; instead, it sets standards by which colleges evaluate the effectiveness of their placement and prerequisite policies.

The state Chancellor's office notified colleges of the July 2023 deadline for AB 1705's prerequisite validation requirements for non-STEM programs in a [memo](#) released in December 2022. Because of this impending deadline, this report examined how prerequisite requirements, corequisite options, and the discontinuation of remedial math are currently impacting equitable access to and completion of calculus for the business major. This analysis suggests that opportunities exist throughout California's community colleges for increasing the volume and diversity of students making progress toward a business degree by addressing AB 1705 prerequisite validation requirements for business calculus.

Preliminary evidence suggests that algebra and precalculus prerequisites hinder completion of business calculus. Students deemed "not calculus ready" have much better outcomes if they bypass prerequisites and receive corequisite algebra support while taking calculus. Colleges serving a large share of the state's Black and Hispanic students tend to set a higher bar for access to business calculus. They are more likely to require a transfer-level prerequisite, less likely to mainstream students into business calculus, and less likely to offer corequisite support. This inequity in access is also seen across and within geographic regions.

For the state to address uneven and inequitable access to gateway math courses for the business degree and make meaningful progress toward closing gaps in gateway course completion, this report offers the following **recommendations**:

1. Replace prerequisites with corequisite support that is tailored to the gateway course for the business degree, e.g., business calculus or finite math, and follow the principles of [good corequisite design](#).
2. Integrate instructional strategies into gateway courses that create welcoming, intellectually engaging, interactive and supportive learning environments.
3. Start business students in college-level statistics; statistics is required for the business major and may be an easier transition to college math.

In the next few months, the state Chancellor's office will release information about the \$64 million appropriated by the state legislature to support colleges in the implementation of AB 1705. As colleges discontinue ineffective prerequisites, funding may support professional training, cross-campus conversations and communities of practice that aid in the development of effective corequisite support for calculus. Business and STEM programs that redesign for targeted algebra remediation within the context of the calculus course are likely to see larger and more diverse student populations enrolling in and completing gateway calculus courses for their programs.

Thirty-nine colleges have business programs that are already AB 1705-compliant. At these colleges, all business students begin directly in business calculus, either with or without concurrent support. This



precedent suggests that the state has a ready resource in faculty at these colleges who are successfully teaching business calculus to students who in a past paradigm would be viewed as “not calculus ready.” This report ends with a window into the experiences of two such faculty.



San Mateo College math professor Michelle Beatty teaches a 5-unit applied calculus course that is open to any student who also enrolls in 1-unit of corequisite support. “The calculus course is the same, but I have time to slow down and focus on algebra issues,” says Beatty. The textbook integrates algebra review, and throughout the semester, algebra instruction occurs within the context of calculus problems related to business and other fields, instead of being front-loaded at the beginning of the course. Students receive personalized help in class by embedded tutors and by peers during collaborative activities. Outside of class, Beatty holds her office hours in the Math Resource Center, where students can also attend algebra workshops and ask questions of tutors in person or virtually. Beatty creates a welcoming environment for students who may feel nervous about starting math in the calculus course, and her students describe her as caring. “I try to be relatable and get to know my students,” says Beatty. “I try to understand what is happening in their lives and help them catch up when they get behind. I try to be flexible.”

For colleges that are replacing a prerequisite to business calculus with a corequisite, Beatty recommends forming a community of practice. “What really helped was meeting once a week with other faculty to talk about what supplemental things we could do in class for each topic. We shared materials and strategies.” She also recommends investing in embedded tutors with the caveat that it works best when both faculty and tutors participate in training.

Resources: [Corequisite course outline](#), [applied calculus course outline](#), [syllabus](#)



Agnes Marsubian is an adjunct math instructor at LA Mission College who teaches math full-time at a local high school. Before AB 705, most of LA Mission’s students had taken two remedial algebra courses at the college before Marsubian met them in her business calculus course, but now many of her students take business calculus as their first college math class. “The gap in students’ algebra skills and in their behavior as college students can be large and hard to deal with,” says Marsubian, but she has adjusted. “I use a flipped classroom approach,” where students get an introduction to new concepts and procedures through MyMathLab, and “class time is more like tutoring and group practice.” Though she also reviews some key algebra at the beginning of the course, the flipped classroom leaves time in class for addressing students’ individual needs. For Marsubian, business students benefit from a focus on business applications, with a lighter touch on theory, and they are motivated by assignments where they use technology and tools relevant to the workplace. In one assignment, students research a business topic and give a presentation as if they were in a professional job setting. She’s not convinced that the college needs to add a corequisite. “The students work hard, and they are engaged because the material is relevant to their major and their lives.”

Resources: [Syllabus](#)



This report and associated research were produced by the California Acceleration Project in February 2023. CAP is a faculty-led network that supports California’s 116 community colleges to achieve strong and equitable student outcomes in math and English courses required for a college degree. [www.AccelerationProject.org](http://www.AccelerationProject.org)