FAQs for STEM Calculus Pathway Placement and Initial Enrollment

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This FAQ contains responses to questions submitted during the CCCCO/MMAP webinars on March 4, 2024, and March 7, 2024. Hundreds of questions were submitted. To streamline the FAQ, similar questions were combined. Some questions about the statewide research are answered with clarity and detail in the statewide report and are not addressed here, e.g., sample size, definition of throughput, identification of math courses, etc. For additional assistance, email your question to AB705@cccco.edu.

Resources

CCCCO Guidance

ESLEI 24-15 CCCCO guidance memo for STEM Calculus Pathway Placement

Statewide Research reports

Preparatory Courses and STEM Calculus Completion: Implications of AB 1705 – statewide analysis with definitions, descriptive charts and extensive descriptive tables in appendices

Technical Appendices – detailed methodology and multivariate regression

Compliance Form

Does the signature page flow to signatories (like adobe sign) or does the college facilitate copy & pasting signatures (grouped question): Can this form be serially signed, or do all of these people have to be in the same room at once?

The Equitable Placement and Completion: AB 1705 STEM Calculus Pathway Certification form does not require each signatory to sign and submit signatures in tandem (at the same time). In the event a signatory receives an error message on the form after inputting their signature, the signatory should select the "Submit" button to complete their individual signature submission; the signatory information will be saved. When the next signatory logs in using their college's unique link, they will provide their signature and should then also select the "Submit" button to complete their individual signature submission. After all signatories have completed their respective signature certification form fields, the college will receive a confirmation email from our database system, Alchemer, that contains a PDF copy of the certification form responses. In the event your institution does not receive confirmation, please ensure the certification form is complete and then ask your institution's CEO to check spam folders for the confirmation email before contacting AB705@cccco.edu for a copy.

What happens if a college is out of compliance?

CA Ed. Code 78213 (l) says that the CCCCO can require a college or district to adopt a placement and enrollment practice:

"(l) The Chancellor's Office of the California Community Colleges may require a community college or community college district to change or adopt a placement policy or practice identified by the chancellor's office to ensure that a community college or community college district's placement and enrollment of students into mathematics, English, and ESL is consistent with the requirements of this section."

If a college is out of compliance, the first course of action would be a consultation with CCCCO leadership to help with compliance. If an audit finds the college out of compliance, the college could have to pay back any FTES from courses that were out of compliance. In addition, SEA funding is contingent on implementation of CA Ed. Code 78213 (AB 1705). In Ed. Code 78222 on SEA funding, section (b)(3) says:

(b) As a condition of the receipt of funds for purposes of this section, a district shall comply with all of the following: … (3) Adopt and implement placement and enrollment policies consistent with the requirements of Section 78213.

AB 1705 Clarifications and Definitions

How do colleges demonstrate the benefit of transfer-level math preparatory courses for STEM Calculus 1 under AB 1705? [Related question: What are the standards for full validation?]

AB 1705 uses the word "benefit" to describe preparatory courses in the STEM Calculus pathway that meet all three standards (CA. Ed. Code 78213 (f)(1)):

1. The student is highly unlikely to succeed in the first STEM calculus course without the additional transfer-level preparation.
2. The enrollment will improve the student's probability of completing the first STEM calculus course as compared to if the student started directly in the first STEM Calculus course.
3. The enrollment will improve the student's persistence to and completion of the second calculus course in the STEM program, if a second calculus course is required.

Is throughput in the law? Do we have to use throughput as our local metric?

Throughput is a term used to describe an analysis of the rates at which students successfully complete a course or courses within a given timeframe. AB 1705 requires that initial enrollment maximizes the probability that a student completes transfer-level coursework in English and math for their program. Throughput assesses that, connecting initial math enrollment with completion of math coursework that satisfies a student's degree or transfer program requirements. . Throughput has been used since 2018 for all AB 705 and AB 1705 validation studies. The data submission template for this round of validations also uses throughput.

Does AB 1705 allow two preparatory courses before the first STEM calculus course?

CA. Ed. Code 78213 (f)(1) limits colleges to two transfer-level courses in preparing students for the first STEM calculus course, but colleges must also provide evidence that the courses in the sequence meet the three standards stated in (f)(1) by July 1, 2024.

If a preparatory course in the STEM Calculus pathway is not validated, can it still be offered?

California Education Code 78213 mandates standards for placement and initial enrollment into math and English coursework but does not dictate what courses can and cannot be offered. The intent of the legislature, as stated in 78213.5, is that community colleges "place and enroll students into transfer-level mathematics or English coursework that satisfies a requirement of the student's intended certificate or associate degree or a requirement for transfer within their intended major." If the preparatory course in the STEM Calculus pathway satisfies a requirement for a non-STEM program or a CTE program, e.g. a college algebra requirement for ultrasound tech program or a trigonometry course for a local surveying program, the student can be placed and enrolled in that course.

If a student is not in a major that requires precalculus, can they still take it?

Students can take precalculus if it is required for their major. Students should start in math coursework that maximizes their likelihood of completing

quantitative reasoning requirements for their program of study. For students who take math to meet general education requirements, completion is likely maximized by Liberal Arts math or statistics.

AB 1705 says that courses that are not validated “cannot be recommended or required,” so we can still offer those courses, right?

If transfer-level preparatory courses are not validated, (1) the college shall not require or recommend the preparatory course to students in the program (per 78213 (e) and (f)), and (2) the U.S. high school graduate (or the equivalent) shall be placed and enrolled into courses that satisfy a requirement for their program when they begin coursework in English or math/quantitative reasoning (per 78213 (i)).

AB 1705 does not mandate which courses can and cannot be offered. Instead, it mandates placement and enrollment standards that ensure that students are best positioned to complete the math requirements for their program, degree or for transfer within their major. For example, consider a trigonometry course. A contextualized trigonometry course may be required for a local surveying program and therefore, would not need to be validated. Students in the surveying program enrolled in the course are satisfying a program requirement. A trigonometry course that currently serves as preparation for STEM calculus must be validated if STEM students are to be enrolled in that course after July 1, 2025, because trigonometry does not satisfy a course requirement for the STEM program. If the trigonometry course is not validated for the STEM program, the STEM student begins in calculus, with concurrent support as an option (or as a requirement if the student is in the Lowest STEM Placement group.)

Where does AB 1705 contain unit limitations?

In Education Code 78213(k), concurrent support is described as “low unit,” which the CCCCO has defined as two or fewer units. Limitations on units for transfer-level coursework are part of AB 1111, the common course numbering initiative.

Can we offer precalculus courses, so long as we have a disclaimer in the course description or use some other method of notifying STEM students that the course is optional and does not improve their chances of completing calc?

If transfer-level preparatory courses are not validated, (1) the college shall not require or recommend the preparatory course to students in the program (per 78213 (e) and (f)), and (2) the U.S. high school graduate (or the equivalent) shall be placed and enrolled into courses that satisfy a requirement for their program when they begin coursework in English or math/quantitative reasoning (per 78213 (i)).

Per (e) and (f), for both transfer-level mathematics or English coursework in general, and for transfer-level course sequences prior to STEM Calculus 1 for STEM pathways specifically, when colleges cannot verify (per AB 1705 standards) their current course and course sequences, colleges cannot "recommend or require students to enroll in that course", and shall notify students who continue to enroll in the course that it is optional and does not improve their chances of completing calculus for their STEM program.

To ensure compliance with 78213(i), i.e., ensure that students are not enrolled in unvalidated preparatory courses, colleges must implement some mechanism to ensure that enrollments are restricted to students for whom the course satisfies a transfer requirement for their program, or to students identified in 78213(j).

STEM Calculus Pathway Placement Rules

These placement rules pertain only to students who require STEM Calculus 1 for their program or major. STEM students who need applied calculus for their major should begin in that course per previous AB 1705 validation efforts (Education Code §78213 (e)). STEM students who also need Statistics for their program or major may begin in that course, but when they start on the STEM Calculus Pathway, the following rules apply.

STEM Calculus Pathway Placement	**Placement and Enrollment in the STEM Calculus Pathway (Only for STEM Students in Majors that Require STEM Calculus 1)**

For All Students	● By July 1, 2025, all students pursuing STEM programs ***must be given access to STEM calculus*** (with or without concurrent support). Students cannot be denied access to STEM Calculus 1 after July 1, 2025, unless the college has full validation status, as defined below. ● As of July 1, 2025, concurrent support in the form of a corequisite or an enhanced STEM Calculus 1 course, of no more than two additional units, ***must be available as an option*** but can only be required for Lowest Placement students (defined below).
Higher STEM Placement HSGPA>2.6 AND Passed high school Trigonometry, Precalculus, or Calculus with a C or better	At all colleges, the placement and initial enrollment for STEM students in the higher STEM placement band is STEM Calculus 1. Low unit (2 or fewer units) corequisite course or enhancement to STEM Calculus 1 may be recommended to students but not required.
Lowest STEM Placement HSGPA<=2.6 OR Did not pass high school Trigonometry, Precalculus, or Calculus with a C or better	At all colleges, except those with full validation status, students in the Lowest STEM placement band must be given the option to begin in one of the following: (1) STEM Calculus 1 (2) STEM Calculus 1 with 2 or fewer units of attached support (3) An optional preparatory course with interim approval or an innovative preparatory course but not both. At colleges with full validation status, students in the Lowest STEM placement band can be placed and enrolled into the validated preparatory course.

I understand “Passed high school Trigonometry, Precalculus, or Calculus with a C or better” as “passed one of these”. I understand “Did not pass high school Trigonometry, Precalculus, or Calculus with a C or better” as “did not pass any of these”. Correct?

> Yes, that is correct.

Does our college have to allow access to STEM Calculus 1 for all students regardless of high school math preparation or high school GPA?

> Yes, unless the college has full validation status for a preparatory course.

What if a STEM student does not need STEM Calculus 1 for their program or major?

> The STEM Calculus Pathway Placement rules only pertain to students who require STEM Calculus 1 for their program of study.

If placement rules pertain only to students who require STEM Calc1, then can colleges use student majors in the placement process?

> Yes, many colleges use meta majors or majors in the placement process to guide students to the right math option for their major.

What if a STEM student only needs applied calculus for their major?

> If a students’ major requires applied calculus, they should begin in that course per previous AB 1705 validation efforts (Education Code §78213 (e)).

What if a STEM student needs Statistics for their program or major?

> STEM students who also need Statistics for their program or major may begin in that course, but when they start on the STEM Calculus Pathway, the STEM Calculus Pathway Placement Rules apply.

What is the definition of Lowest STEM Placement students?

Students who have a high school GPA less than or equal to 2.6 or students who have not passed high school Trigonometry, Precalculus, or Calculus with a C or better.

Why is a lowest placement group defined?

The AB 1705 placement and enrollment standards for the first STEM calculus course require colleges to identify students who are highly unlikely to succeed when starting math in the first STEM calculus course and then show that this group has higher probability of completing calculus if they start in a preparatory course. The Lowest STEM Placement group was defined to examine the implications of AB 1705 standards for STEM students with weaker high school math preparation and performance.

Why does the Lowest STEM Placement group include high school GPA? Doesn't this mean that students who passed high school precalculus or trigonometry are in the Lowest STEM Placement group?

Yes. The Lowest STEM Placement group includes a subset of students with HSGPA less than 2.6 who passed HS Precalculus or Trigonometry. This is because of findings in the multivariate regression analyses done for the statewide report. In that analysis HSGPA (not HS math preparation) had the highest odds ratio for positive association with STEM Calculus completion. In the decision tree analysis, the two most important predictors of STEM Calculus 1 completion were starting level in the CCC STEM Calculus pathway and high school GPA. Level of high school math preparation was a distant 3rd in importance as a predictor and did not make meaningful contributions to the predictive model. Because these findings were supported by previous research, HSGPA was included in the definition of STEM Placement. For more detail, see the technical appendices, Preparatory Pathways and STEM Calculus Completion: Implications of the AB 1705 Standards, Technical Appendices, February 2024

What is STEM Calculus 1?

STEM Calculus 1 is a shorthand for the reference in AB 1705 to "the first STEM calculus course" (Ed. Code 78213 Section(f)). STEM Calculus 1 is a course equivalent to C-ID Math 210, 211 or the first half of Math 900S.

What is STEM Calculus 2?

STEM Calculus 2 is shorthand for the reference in AB 1705 to “the second STEM calculus course” (Ed. Code 78213 Section(f)). STEM Calculus 2 is a course equivalent to Math 220, Math 221, or the second half of a Math 900S.

What is a validated preparatory course?

A validated preparatory course meets all three requirements of the law (Ed. Code 78213 Section(f)(1)). Validated status is based on data submitted by July 1, 2024 or on data provided by the CO in the individualized college reports as part of validation efforts in spring 2024. If verified by the CCCCO, the college can continue to place and enroll the Lowest STEM Placement group into the validated course or courses per 78213 (j)(8) with no additional validation required at this time. Enrollments must be restricted to the Lowest STEM Placement group or to other groups defined in 78213 (j). Students with higher placement levels must begin in STEM Calculus 1 per 78213 (i).

Why is 15% used as the cut-off for the “highly unlikely to succeed”?

The term “highly unlikely,” without a numerical definition, has been part of long-standing Title 5 regulations pertaining to the establishment of prerequisites by California community colleges (CA Education Code 55003 (d)(2)). AB 705 and AB 1705 also use the term without quantifying it. Common perceptions of the term suggest that events occurring less than 10-15% of the time are considered highly unlikely in common usage (see for example, Measuring Perceptions of Uncertainty, 2017). The statistical significance of highly unlikely events is often less than 5%. The 15% was chosen as a liberal definition to facilitate the operationalization of AB 1705 standards for local validation efforts.

What is interim approval?

In ESLEI 15-24, interim approval is for an existing preparatory course or courses in the college’s STEM Calculus pathway that does not meet all 3 standards of the law §78213(f)(1). This option requires local data to demonstrate STEM Calculus 1 throughput in two years is 50% or greater for Lowest Placement Students starting in the course, either through the analysis provided by the Chancellor’s Office in the college’s report or data submitted through the Data Submission Template, submitted by July 1, 2024. If interim approval is granted, colleges choosing this option will implement the STEM Calculus Pathway Placement rules with the interim course option for Lowest STEM Placement students (see the

placement rules table above). Interim courses will undergo additional validation by July 1, 2027, and must achieve full validation status in order to continue as a placement and enrollment option beyond July 1, 2027 (i.e., the course will need to meet all three standards described §78213(f)(1).

How long is the interim approval period?

The interim period is July 1, 2025, through July 1, 2027. Colleges will be required to validate interim courses using a one-year throughput comparison, per Ed. Code 78213 (c), in fall 2027.

How was 50% established as the throughput benchmark for interim approval?

The 50% benchmark comes from an analysis of calculus completion rates (two-year throughput) for Lowest STEM Placement students who started in STEM Calculus 1. It is the 25th percentile of their calculus completion rates across 80 colleges where they began in STEM Calculus 1 during the academic years 2017-2018, 2018-2019 and 2019-2020. Note that in more recent cohorts post AB 705 (2019-2020, 2020-2021, and Fall 2021), the 50% benchmark is the 10th percentile. (At 95 out of 106 colleges enrolling some Lowest STEM Placement students directly into STEM Calculus 1, more than 50% of this group successfully completed STEM Calculus 1 in two-years.)

My college got interim approval to keep precalculus, but we also have a separate co-req course for precalculus. Can we still keep the co-req for precalculus with this interim approval for the 2025-2027 school years?

Yes, if your college already had a corequisite support course associated with a course with interim approval, your college can continue to offer the corequisite as part of the interim approval.

What is an innovative preparatory course?

A newly designed or redesigned transfer-level preparatory course that is one-level below STEM Calculus 1, no more than 4-units, and open to all Lowest STEM Placement students. Students successful in an innovative preparatory course are eligible for STEM Calculus 1. Lowest Placement students will have the option to start in STEM Calculus 1 or the innovative preparatory course offered during the two-year innovation period (Fall 2025-Spring 2027) as described in the STEM Calculus Placement Rules.

Innovative preparatory courses cannot be required or recommended per 78213 (f)(2) but can be combined with low unit (2 or fewer units) corequisite or enhanced support. Innovative courses will require additional validation and must meet AB 1705 standards by July 1, 2027. Students with higher placement levels must begin in STEM Calculus 1 per 78213 (i).

If our college did not attempt to validate data, are we still allowed to allow students to enroll in courses below Calculus for those whose major requires Calculus prior to Fall 2025?

Yes. The law does not require changes to placement and enrollment until July 1, 2025.

How long is the innovation period?

The innovation period is July 1, 2025, through July 1, 2027. Colleges will be required to validate innovative courses using a one-year throughput comparison, per Ed. Code 78213 (c), in fall 2027.

How is Option D, Innovative Course, different from offering a Pre-Calculus course? Will this course need to be transferable or articulated or would it exist only as a local course? Do we have to add the Innovative Course as a prerequisite to our Calculus course? Won't that affect articulation of our Calculus course?

The ASCCC is working with the CCCCO and transfer partners to expedite the development of a C-ID descriptor for this course and to ensure its transferability. As to including it as a prerequisite on the Calculus course, some colleges are opting for a more general description of prerequisites on their course outlines, per guidance from UCOP, that does not list prerequisite course titles. For example, instead of the prerequisite being Math 10 Precalculus, the prerequisite is "precalculus or AB 1705 placement."

Can we place a student into the "innovative course" and have it be required prior to taking Calc 1? Or is the "innovative course" only an option for students?

The innovation period is July 1, 2025 through July 1, 2027. The innovative course is only an option for Lowest STEM Placement students during that time frame. It

cannot be required and enrollment must be restricted to the Lowest STEM Placement group.

Does the “innovative course” have any requirements such as: credit versus noncredit, transferable or not, etc.?

There are no other requirements than those listed in ESLEI 24-15: (1) no more than four units, (2) open access, (3) successful students are eligible for calculus.

If you received interim approval for a precalc course, what are the requirements for full validation? Is it enough to remain at the 50% throughput level within two years? [Related question] If a college is given interim course approval from the data that was provided and we submit for option b, will that be a guarantee of validation or do we need to have a backup plan?

Interim approval for a preparatory course is good through July 1, 2027. It does not guarantee full validation status in the future. A fully validated course must meet all three standards described in the law (CA Ed. Code 78213 (f)).

Can we create a two semester Calc I pathway? Calc IA and Calc 1B?

No, unless you are on the quarter system.

Can a department do Option A while one or two instructors pilot an innovative course via Option D?

Colleges must choose one option of the four. The options are mutually exclusive.

If a college selects option A, and this leads to data showing that students are highly unlikely to succeed, would colleges be then able to apply to return to requiring a pre-req for the bottom band?

Yes, this is a possibility.

How many colleges are eligible for Option B as a result of confirmation by the CO analysis?

None.

If the “highly unlikely” threshold of 15% isn’t being met, does it make sense to try to create an innovative course (Option D)? Even if that throughput is higher?

> If the “highly unlikely” threshold is met in the future and the innovative course has higher throughput, then it is possible for the innovative course to achieve full validation status.

If no students exist in the first validation criterion (e.g., no students in the lowest level enrolled directly in calculus), how can criteria 2 and 3 be validated against that control group?

> In this case, your college would not have the data for full validation status at this time, but interim status might still be an option.

If our report says, “Based on this analysis, this report does not support validation approval status or interim approval status for any preparatory course currently offered by your college in the STEM Calculus pathway.” What are the choices we have?

> Your college can choose Option A, Option D, or submit a local analysis using the data submission template if the findings support validated status (Option B1) or interim approval status (Option C1).

Is the only way to continue to enroll students into PreCalc or Trig after July 1, 2025 by submitting data under Options B or C?

> Yes, that is correct.

So even the LOWEST level must be given access to Calculus but can have the OPTION of an innovative course?

> Yes, that is correct.

Can you please clarify, if we were to select option A, can students still elect to self-enroll in a STEM preparatory course as long as we don't require or recommend it?

> No, colleges choosing Option A are discontinuing preparatory courses and offering concurrent support instead.

If a college selects option B or C but is ultimately not approved for validation, will they then have the opportunity to change to option D and pursue the innovative course at that time.

> Colleges should know ahead of time if their data supports full validation status (Option B) or interim approval (Option C). If your data does not meet the criteria, then do not submit data and, instead, choose Option D.

As a follow up to the last question, if our summer session starts prior to July 1, 2025 and ends after, are we allowed to offer 'pre-calculus' classes in summer 2025?

> Yes.

In the higher STEM placement, can a student opt to take the Prep Calculus course (option D)?

> The innovative course that is part of Option D is only an option for Lowest STEM Placement students. After July 1, 2025, STEM students in the higher STEM placement band should begin in Calculus 1, with the option of concurrent support.

Data Submissions

What do you do when your college/district does not have the resources to provide us with the data we need?

> The RP Group is providing technical assistance to assist local institutional research offices. Submit a request through AB705@cccco.edu.

We have two different STEM Calc 1 courses (Calc 1 and Calculus for Life Sciences). The data looks different for those courses. Do we submit different validations?

> Yes, the data submission template includes additional tabs to accommodate different courses.

Can our college choose different years: 2020-21, 2021-22, Fall 2022, basically one year after the State analysis period, due to insufficient HS data in 2019 or years before in our local data?

> Yes, the data submission template allows colleges to specify academic terms or years or terms starting in Fall 2019.

On the data submission template do we have the option to identify specific programs rather than using a blanket TOP code? We may have programs under a TOP where one has a calc requirement and one does not.

> In the data submission template, indicate the six-digit TOP code categories (SM02 or SS02) associated with the programs on which you are reporting. Please submit a question to AB705@cccco.edu if you need additional individualized technical assistance on this issue.

For validation are we allowed to separate out the students below 2.6 gpa by level of math completed?

> The data submission template provides a uniform definition of Lowest STEM Placement students to be used across colleges. If your local analysis determines that a subset of the Lowest STEM Placement group meets the three standards for validation of preparatory coursework, your college may submit that additional analysis by July 1, 2024 to AB705@cccco.edu for evaluation.

What should we do if our new 'pre-calculus' pathway is less than two years old and the throughput data won't be available in time?

> The CCCCO is adhering to legislatively mandated timelines; therefore, the validation period is not being extended. One option is to use a one-year timeframe in your data submission or to choose Option A or D in the compliance form, which do not require data submission.

Is there any possibility for an extension of the July 1, 2024 timeline? Our research office is understaffed.

> The CCCCO is adhering to legislatively mandated timelines, so the validation period is not being extended. However, the RPGroup is providing technical assistance to assist local institutional research offices. Please submit a request through AB705@cccco.edu.

I am confused about the data for STEM Calculus I start. If we have NO students in this category, how do we validate our placement policy?

> In this case, your college does not have the data to meet all three standards required for full validation. However, your college can still complete the data submission template for your preparatory course(s) to apply for interim approval. Implementing an innovative course is also an option and does not require data submission.

If we have done our own validation study by directly placing students who have not taken Pre-calc into STEM Calc 1 with support, will this be accepted as a backup for the excel report you provided for us to complete?

> Your college must complete the data submission template provided by the CCCCO to validate preparatory courses. Students in the Lowest STEM Placement group who begin in STEM Calculus 1, either with or without support, should be included in the column “Calculus 1 Start.” If your local analysis uses a subset of the Lowest STEM Placement group and shows that placement of this group into preparatory coursework meets the three standards for validation, your college may submit that additional analysis to AB705@cccco.edu for evaluation.

College-level Reports

What is the purpose of the college-level reports provided with the memo?

> Each college received with the memorandum a report based on their local data that addresses the same three questions investigated in the statewide analysis. The local reports can be used to help colleges decide their next steps in the process to achieve compliance with AB 1705. Colleges may choose to follow the findings in their local report and forgo data submission.

To whom was the college-specific report sent? CEO? CIO? Lead researcher? Other?

> The ESLEI 24-15 memo, the college specific data report, and the data submission template, along with a college's unique link to access the STEM Pathways certification form was sent to the CEO, CIO, CSSO and AS President at each institution College leadership was asked to ensure that relevant faculty, students, administrators, and staff leaders are fully informed and respond promptly to any actions and requests for information outlined in the attached memo and college specific data report. Please reach out to the college executive leadership to obtain access to the college specific report and other related materials.

Who do we contact if we were sent the wrong College report?

> Please email AB705@cccco.edu if you have received the incorrect college report.

Our college data included our NON-STEM College Algebra course which is not a pathway to Calculus. How do we correct this?

> Please email AB705@cccco.edu if your college would like a corrected version of the college report. Alternatively, your college can correct this through the local data submission if omitting this course changes the conclusions in the college report.

In the college report, is Calculus for Biology considered STEM Calc 1? It has only an intermediate algebra and Trigonometry prereq, which is not the same as STEM Calc 1.

> STEM Calculus 1 is a course equivalent to C-ID Math 210, 211 or the first half of Math 900S. The analysis did not include applied calculus courses. In your college report, Table 5 contains the list of courses used in the analysis. Validation of prerequisites for applied calculus courses occurred in 2023.

All of our Allied Health majors are placed in the Biological Sciences degree which has a STEM top code. So, these students take College Algebra for the sole purpose of meeting a Chem prerequisite. So these students are included in our throughput data?

> The college reports included two cohorts: (1) All Students (non-dual enrolled student with a Degree/Transfer or Undecided education goal whose first math course was a transfer-level course in the STEM calculus pathway) and (2) STEM majors (a subset of All Students). The following TOP codes were used to identify STEM majors: 1905.00, 0706.00, 0707.00, 0707.10, 0901.00, 1914.00, 1701.00, 1902.00, 0401.00, 4902.00.
>
> If your college chooses to complete the data submission template, you can address this issue by choosing a subset of the STEM TOP codes. If your local analysis changes the conclusions reached in the college report provided by the CCCCO, submit the data and choose the option in the compliance form that is supported by your local data.

How did you verify the first college math enrollment for the students in the sample? Our college report shows many students who have not completed precalculus as starting in Calculus 1 which is not possible at our college (except by the rare prerequisite challenge).

> The college reports are based on the COMIS data that your college submits to the CCCCO. In that data submission, students are assigned unique identifiers that allow researchers to identify first math course enrollment in the CCC system over time.
>
> Please note that the Lowest STEM Placement group includes students with HSGPA less than 2.6 who completed high school precalculus or trigonometry. If your college's calculus placement is based solely on completion of HS precalculus, then there may be students in the Lowest STEM Placement group starting in calculus at your college.

Can you provide access to our college-level data? We have access to MIS data, but in our data we cannot track students who start in precalculus at our college and complete calculus at another college.

> The RP Group is providing technical assistance to local research offices. Submit a request by email through AB705@cccco.edu.

Why did the individual college data have different bands than the study? Why did they use completely different years?

> The statewide analysis was conducted first and disaggregated the cohorts both by high school math preparation and also by the existing default placement rules for precalculus. The longer window mirrored the previous validation study for applied calculus. As results were vetted with ASCCC, CIOs, and others, feedback suggested that a post-AB 705 implementation time frame would be better for the college reports to reflect more recent placement reforms and curricular changes. The analysis in the college reports disaggregated cohorts using the newly developed STEM Calculus Pathway placement levels to support local validation efforts.

In the college report, it refers to first CCC math. Is that first math at our institution only, or across the CC system?

> First CCC Math is the first math enrollment for that student in the CCC system. Students who begin math in the STEM Calculus pathway at your college and complete calculus at another college are included in your college report as a completion. Students who begin math in the STEM Calculus pathway at another college and complete calculus at your college are not included in the cohort for your college report.

What do we do if our local data does not match the data sent to us? Should we talk to our district if the data seems incorrect? Specifically, the n counts seem much lower than we know based on our enrollments.

> The college reports are based on the COMIS data that your college submits to the CCCCO, so your local institutional research office will have the data. There are several reasons why the cohorts in the college report may be smaller than your course enrollments: (1) the cohort only includes students whose first math enrollment was in a STEM Calculus pathway course at your college. For example, if students start in College Algebra and then progress to Trigonometry, they will only appear in the College Algebra count. Also, if students start math at another college and then take precalculus at your college, they will not appear in your precalculus cohort; (2) the cohort is a subset of first math enrollees who reported in CCCApply their highest HS math and HS GPA. If a student did not report highest HS math nor HS GPA in CCCApply, they are not included in the cohort.

The RP Group will be providing technical assistance to support your local institutional research office in replicating the analysis in the college report for your local data submission. If the findings from your local analysis support validation status or interim approval, your college can submit the data submission template to the CCCCO for evaluation.

Do some colleges have a placement policy that gives students with lower levels of high school math access to STEM Calculus?

Students without precalculus or trigonometry could have accessed calculus through self-placement or a guided self-placement process, the college's use of GPA for placement and not high school math coursework, concurrent enrollment in a corequisite support course, prerequisite challenge processes, as well as different approaches to prerequisite verification at different colleges.

The Lowest Placement Group includes students who passed precalculus or trigonometry in high school. If they are removed, does it change the results?

During the time frame examined in the college reports (2019-2020, 2020-2021 academic years or Fall 2021), there were 2,209 students whose first CCC math course was STEM Calculus 1 and who had not completed high school trigonometry or precalculus (as reported through CCCApply.) Of the 2,209, 64% completed STEM Calculus in the two-year timeframe.

Were there any colleges statewide whose precalculus courses improved throughput to STEM Calculus I? (It might help locally if I can say that it's not just us, it's not our courses, it's the whole state needing to change.)

The answer is no for every college that had at least 10 Lowest Placement students who started directly in STEM Calculus 1. There were prevalent and consistent patterns of high rates of attrition across colleges.

What happens if in a couple of years we see lower throughput rates? Will there be another round of individual college analysis? What if the results do not replicate what you've shared?

At the end of the innovative period (after July 1, 2027), another validation will take place, as described in ESLEI 24-15 and CCCCO guidance will respond to

that research. The CCCCO is committed to data-based decision-making that supports students' progress in completing math requirements for their program of study. AB 1705 standards require that placement policies and enrollment practices in the CCC system, and at every college, ensure that STEM students begin in coursework that best positions them to complete calculus requirements for their programs.

Corequisites and Concurrent Support

Can our college require any group of students to enroll in corequisite support linked to STEM Calculus 1?

Students in the Lowest STEM Placement group can be required to enroll in low unit corequisite support or enhanced STEM Calculus 1. Corequisite support can be an option, but not required, for students in the higher STEM Calculus Placement group.

If my college offers only one Calc 1 section, with a mandatory corequisite, then all students would have to take it, not only the Lowest STEM Placement group. Would that be okay?

Enacting placement reforms for Calculus will require a shift in the class schedule away from sections of preparatory courses (College Algebra, Precalculus, Trigonometry) and toward more sections of calculus, some of which can be with support and some without, to ensure students have the options that fit the requirements of the STEM Calculus Pathway Placement Rules.

Can we offer "enhanced STEM Calculus" only? Or do we have to have two options? Calculus without support and calculus with support?

Colleges should have two options and enough sections of each to accommodate anticipated enrollment trends based on the STEM Calculus Pathway Placement rules.

Can you explain an enhanced calculus class vs. a corequisite support class?

A corequisite support course is a separate course that students take simultaneously with calculus. An enhanced calculus course embeds support into the calculus course, usually including additional units or contact time.

What is a “low unit” corequisite?

Low unit is defined as two or fewer semester units. This same definition applies to enhanced calculus courses; embedded support should be no more than two additional units.

Can corequisite support be non-credit?

Colleges can only enroll United States (US) high school graduates (or the equivalent) who have an academic goal of credit certificate, degree, or transfer into noncredit English or math coursework if and when the student is concurrently enrolled in a transfer-level English or math/quantitative reasoning course. (source: CCCCO AB 1705 FAQ, p. 10, February 7, 2023) A non-credit support course can be offered for Calculus 1, but AB 1705 stipulates that non-credit must have “similar contact hours” to low-unit credit versions of corequisite support. In addition, students cannot be required to take a non-credit course.

Our current pathway to Calculus is two courses. How can all this content fit into a low unit corequisite support course?

Of course, it is not possible to include all of the content from two preparatory courses into a corequisite support course. The corequisite model provides instructional time for the teaching and learning of core skills that are integral to achieving the learning goals for calculus. Good corequisite design requires the identification of these core skills through backwards design from the calculus learning goals. Interdisciplinary conversations with faculty from other STEM disciplines may help math faculty in this identification of skills requisite to success in STEM courses.

Calculus 1 has a minimal amount of trigonometry, but Calculus 2 is heavier in trig. Do you also recommend optional support for calculus 2? What if other disciplines rely on trig like physics and they also want to offer a support course?

Optional support through a low unit corequisite is an option for Calculus 2 or Physics. Some colleges are already offering a 0.5-unit corequisite support course for STEM Chemistry.

Do the 2 units of concurrent support have to be transferable (w/CID)?

> Concurrent support courses are usually not transferable. There are no C-ID descriptors for concurrent support courses.

Our current calculus course already exceeds C-ID units. Can we still have a two-unit corequisite support course linked to calculus?

> Yes, a two or fewer unit corequisite support course is still an option in this case. AB 1111 implementation may result in a standardization of calculus course units to C-ID specifications, which is currently 4-units.

Can we create a ‘new’ Calc 1 course with support so it is all wrapped in one? If that is allowed, is there a cap to the TOTAL units allowed?

> Yes, an enhanced Calculus 1 course is an option, with additional units not to exceed two units above the units for the standard Calculus 1 at the college.

Advising students

What do we tell students in the higher placement group who want to take a preparatory course?

> Many students need reassurances that help counter the insecurity and uncertainty that is a natural part of starting college. This may be particularly true in math. With equity-minded and capacity-oriented messaging, share information about how the college has designed concurrent supports, such as corequisite courses, supplemental instruction, and tutoring, to help students learn or review math skills needed in calculus. Reassure them that the college has studied placement into the STEM Calculus pathway and found that students with the same level of math preparation are more likely to complete calculus if they start in calculus instead of in a preparatory course. Discuss the cost and time savings. Encourage them to connect with other STEM students through the MESA program or the math tutoring center to form or join a study group.
>
> When students ask to start in a lower course, they are expressing a desire to “start at the beginning” or to “build skills for later success,” they are not asking to start in a course that hampers their progress or derails them from their pursuit of a STEM major. When a college maintains preparatory courses prior to STEM

Calculus 1, students believe that these courses must help, otherwise why would the college offer them?

What happens to students who fail STEM Calculus 1?

Colleges should work to minimize the failure rate. Colleges should have early alert systems in place that activate wrap-around support for students who are failing calculus while the student is still enrolled in the course. Second, colleges should have mechanisms in place to proactively support students who are attempting calculus a second time after an initial failure. Support can include addressing basic needs, tutoring, mentoring, enrolling in concurrent support, or taking the course with a different instructor.

For Higher STEM Placement, if they passed Calc 1 in HS, we place them in Calc 1? I thought we were required to place them in Calc 2. (students don't repeat courses they passed in HS)

Please see the discussion of this issue in the AB 1705 Implementation Guide under Required Action #3.

Dual Enrollment

Can the traditional preparatory courses, such as College Algebra or Trigonometry, be offered as dual enrollment?

Yes, but enrollment in those courses must be restricted to dual enrollment students if the preparatory courses have not been validated per AB 1705 standards.

Articulation and C-ID

Are the CSUs and UCs aware of the changes that community colleges are making in response to AB 1705?

Leaders in the three systems of higher education are aware of recent legislation and its impact on community college math placement policies and initial math enrollment patterns. Improving community college transfer is a focus of current intersegmental initiatives, and articulation of community college coursework is integral to transfer.

Does this law apply to the CSUs or UCs?

No, AB 1705 does not apply to placement and enrollment policies in the CSU or UC system.

Should we remove prerequisites from our Calculus 1 course outlines?

The CCCCO, CSU Chancellor's Office (CSUCO), and UC Office of the President (UCOP) are aligned in their understanding of AB 705 and AB 1705, and there is agreement that community colleges have purview over determining how prerequisites are satisfied in accordance with recent legislation.

After the passage of AB 705, UC and CSU continued to require a prerequisite as part of a course outline, but the prerequisite does not need to be fulfilled by students taking that specific course. In a 2020 training, UCOP staff described prerequisites as necessary for articulation and that a prerequisite of "multiple measures placement" was sufficient. Corequisites are also allowed.

This articulation policy is consistent with the law as stated in AB 1705 in 78213.5(c)(1) which states that "community colleges shall determine the methods of fulfilling the prerequisite, whether it be through high school coursework, completion of corequisite coursework or concurrent support activity, credit by examination, credit for prior learning, or multiple measures placement into, or completion of, a course with the same or higher prerequisite."

Colleges should implement this change as they did the AB 705 changes. Colleges will need to work with their articulation officers to determine if changes to Calculus 1 course outlines are necessary. It is possible that no changes will be necessary because all students enrolling in STEM Calculus 1 under the new placement rules will either have met precalculus prerequisites through high school work (or the equivalent) or will be satisfying prerequisites by enrolling in corequisite support when in Calculus 1.

Will C-ID descriptors for STEM Calculus 1 (Math 210 and 211) change? Both courses currently have a prerequisite of precalculus or the combination of college algebra with trigonometry or the equivalent.

The C-ID descriptors have undergone modifications in recent years to align with earlier legislation, AB 705 (Placement and Developmental Education) and AB 928 (Cal-GETC). It is possible that the shift from prerequisites (prior learning

support) to corequisites (concurrent learning support) for Math 210/211 will be reflected in future updates to C-ID.

However, it may not be necessary because prerequisites can be satisfied in many ways as stated in AB 1705 in 78213.5(c)(1): “community colleges shall determine the methods of fulfilling the prerequisite, whether it be through high school coursework, completion of corequisite coursework or concurrent support activity, credit by examination, credit for prior learning, or multiple measures placement into, or completion of, a course with the same or higher prerequisite.”

What about STEM courses in other disciplines that have a college algebra, trigonometry, precalculus prerequisite?

AB 1705 and associated sections of the California Education Code pertain only to English, ESL, mathematics and quantitative reasoning coursework. However, colleges are encouraged to examine math prerequisites in other disciplines that do not satisfy course requirements for the students’ program of study, degree or transfer within the major, and to consider support options, such as low unit corequisite courses, that streamline and contextualize learning support. For example, some colleges offer 0.5-units of math support linked to a chemistry course as an option for students who have not completed the prerequisite algebra course.

In addition, colleges have many available methods of fulfilling the prerequisite, whether it be through high school coursework, completion of corequisite coursework or concurrent support activity, credit by examination, credit for prior learning, or multiple measures placement into, or completion of, a course with the same or higher prerequisite.

Can the C-ID for physics include an option for a new version of calculus for physics and engineers that is more applicable to those disciplines?

Changes to C-ID Transfer Model Curriculum and associated course descriptors are certainly important in streamlining, modernizing, and contextualizing math requirements with the goal of improving STEM degree completion. Faculty can engage and participate in a FDRG (Faculty Discipline Review Group) and engage directly with the C-ID and TMC process for their disciplines or engage in cross-collaborative review. In spring 2024. You can find more information here.

Equity and STEM

Most of our STEM students have not taken advanced math in high school or are returning students who have taken time off from school. Aren't we setting them up for failure if they don't take precalculus? Won't these changes lead to greater inequity in STEM?

Research at the state and local level consistently shows that students who began in a preparatory course below STEM Calculus 1 have much lower Calculus 1 throughput in two years when compared to students who began in Calculus 1, even when disaggregated by high school math preparation and high school GPA. Furthermore, across all demographic groups, multivariate regression analysis found that starting in a preparatory college course had the strongest negative effect on STEM Calculus 1 completion among all factors examined, stronger than high school GPA, high school math preparation, age or EOPS status. In short, preparatory college coursework prior to calculus is not an effective equity strategy for improving calculus completion rates, even for students with weaker high school math preparation or lower high school GPA.

Because the data suggest that higher and more equitable STEM calculus completion is associated with direct access to calculus, universal calculus access coupled with concurrent learning support holds promise for diversifying and increasing participation in STEM.

How is this equitable when some colleges may be able to validate precalculus and others cannot? Are these policies setting up certain groups of students to failure simply due to geographic locations?

AB 1705 requires colleges to ensure that students begin in coursework that best positions them to complete math requirements for their degree or transfer program. An approach that accomplishes this goal may be different at different colleges, which is why they can validate their local practices. The Chancelor's Office is committed to data-driven decision-making with the goal of achieving equitable placement, support, and completion of STEM calculus across the system.

What else can be done in addition to changing the calculus pathway to improve calculus outcomes, particularly for students of color?

In addition to changes to placement and support structures, a focus on the classroom is vital. Teaching matters, and in math it matters more than a student's academic preparation, according to a study of 704 transfer-level math classes in four California community colleges. This study found that the instructor effect explained more of the variation in pass rates than the student's prior academic preparation, the high school a student attended, student demographics, and course attributes (type, modality, scheduling). The study found associations between specific classroom practices/policies and improved outcomes for Black and Hispanic students. See Counting on Math Faculty | Education Equity Solutions.

Active learning: A large randomized, controlled study of active learning versus a lecture pedagogy at a Hispanic-serving institution found active learning with near-peer embedded learning assistants in STEM Calculus improved calculus success rates, improved performance on the final exam, and improved precalculus proficiency for students entering calculus with weak precalculus skills, across race and gender. See (1) The Supportive Role of Active Learning in a Calculus Course on Low Precalculus Proficiency Students, International Journal of Mathematical Education in Science and Technology, and (2) Establishing a New Standard of Care for Calculus Using Trials with Randomized Student Allocation, Science

Growth-oriented classroom cultures: In a study of California community college transfer-level English and math classrooms, growth-oriented classroom practices were associated with better classroom experience and greater academic success, with larger effect size for traditionally disadvantaged demographic groups. See Fostering Faculty Growth Culture Practices in California Community Colleges Summary Report_Shared.pdf

My department plans to do the innovative precalculus course. Obviously, persistence into calculus affects throughput. What does the research suggest for improving persistence and getting students to stay in STEM?

Science education. Increasing persistence of college students in STEM - PMC presents a persistence framework based on three pillars: learning, motivation, and professional socialization with 8 cross-cutting strategies that can be used as a blueprint for improving STEM persistence in the first year of college.

New Tracking Transfer Report: 18% of CC students complete a 4-year STEM degree in 6 years, 12% for African Americans. How does AB1705 help CC transfer students increase these 6-year completion rates for STEM degrees?

> The implications of the current research is that inequitable access to calculus and attrition in pipeline to calculus contribute to STEM program attrition. In the period of the statewide study, about 65% of STEM students who began in a preparatory course in the calculus pathway did not complete STEM Calculus in two years. AB 1705 requires colleges to ensure that students are best positioned to complete calculus requirements for their STEM programs. Improving timely calculus completion is a key component to improved STEM transfer and STEM degree attainment, according to a large three state study by the Community College Research Center.

AB 1705 Funding

Can our college use recently allocated AB 1705 funding to implement calculus corequisites and innovative courses?

> Yes, colleges are encouraged to utilize the recently allocated funding to support the implementation of AB 1705 for STEM. This can include faculty compensation to create innovative courses and to develop support courses.

Statewide Analysis Questions

Where can we find the research that informed the STEM Calculus Pathway Placement Rules?

> The statewide analysis is summarized in the report Preparatory Courses and STEM Calculus Completion: Implications of AB 1705 Standards. A technical appendix contains a more detailed methodology and the multivariate regression analyses. Both are posted on The RPGroup website here: https://rpgroup.org/RP-Projects/All-Projects/Multiple-Measures/AB705_Resources (under Evaluation).

Did the data utilized to support direct access to Calculus 1 include students who took Calculus 1 without having taken Precalculus or Trigonometry courses?

> In the statewide study, MMAP examined a cohort of more than 37,000 STEM majors with a first math enrollment in the California Community Colleges between 2012-2013 and 2019-2020. Of these students, 31% (11,648 of 37,232) started directly in STEM Calculus 1. Of the students starting in Calculus 1, over 1,600 had not taken precalculus or trigonometry (either in high school or at a CCC) according to the data from CalPASS Plus and CCCApply.

Who is included in the cohort? Were any student populations excluded, e.g., veterans, returning students, disabled students, dually enrolled high school students?

> Dually enrolled high school students were not included in the cohort. Please see the detailed methodology for a full description of the cohort and data sources: Preparatory Pathways and STEM Calculus Completion: Implications of the AB 1705 Standards, Technical Appendices, February 2024. Updates to the appendices of the main report will include a disaggregation by special populations identified in MIS reporting, such as veterans and disabled students.

Why were summer terms excluded?

> Summer terms were excluded from the starting cohort but included for the completion cohorts. Data analysis showed that the majority of high school students in the data file started in a transfer-level math course in the STEM Calculus pathway during a summer term. In order to exclude these students, the team excluded summer starts. However, if a student completed STEM Calculus 1 in a summer term the completion is included in the throughput rate.

Does the statewide analysis only use high school transcripts from CA high schools?

> No, the high school data comes from two sources, self-reported data from the CCCApply application, where a student could have attended any high school in the US. The second source is EdResults Partnerships, CalPASS data which is actual high school data for participating California high schools. Please see the detailed methodology for information about data sources: Preparatory Pathways

and STEM Calculus Completion: Implications of the AB 1705 Standards, Technical Appendices, February 2024

What percentage of students were excluded due to incomplete high school data?

For the statewide study, 4.2% of the cohort had incomplete high school data in the analysis that disaggregated students by high school math preparation, and 1.3% of the cohort had missing high school data in the disaggregation by the default placement rules. See Tables B1 and B2 in Appendix B. The analysis included these students as a separate category in the throughput calculations, see Tables C2 and C3, E2 and E3 in the main report: Preparatory Pathways and STEM Calculus Completion: Implications of the AB 1705 Standards, February 2024.

Why was data from 2012-2018 used as these students were placed by exam and we had not collected data about all high school coursework?

The statewide study uses cohorts from 2012-2019. For the years 2012-2018, the analysis used high school transcript data obtained through CalPASS Plus. The longer window mirrored previous validation studies. The multivariate regression analysis includes a control for pre- and post-AB 705 first CCC math enrollment.

In addition, the study tracked STEM students for three years from their initial math enrollment to allow ample time for them to complete the preparatory sequence (usually two courses) and Calculus 1 and Calculus 2. The longer window allowed for more cohorts to be tracked.

If the language of AB705/1705 states we are to increase probability of success in transfer level Math in 1 year, why does this study focus on two year throughput for Calc 1?

As noted, AB 1705 requires placement and enrollment to maximize the probability of completion of math coursework that satisfies a requirement for the student's degree or program within one year of the student's first math attempt (California Education Code 78213 section (c)(1)). For one-year throughput, see Appendix C, Tables C5 and C6, in the main report. The two-year timeframe was used to accommodate the longer calculus pathways at many colleges. This approach allowed for a full examination of the full potential of a longer path to improve calculus completion.

The statewide study combines high school trigonometry and precalculus, can you tell us what happens when the two courses are separated?

For highest HS math, students with trigonometry as their highest high school math were 16% of the combined HSTrig/Precalc category (Trig: 2,188, Precal:10,977). Patterns remained consistent when HS math preparation was disaggregated by HS Trigonometry and HS Precalculus. For both groups, throughput rates (2 years) were much higher for those starting in CCC STEM Calculus versus those starting in a CCC preparatory course in the STEM calculus pathway. With direct access to STEM Calculus 1, HS Trig completers had a 3-ppt lower 2-year throughput compared to HS Precalc completers.

How many times did it take a student to complete Calculus 1?

For direct enrollees into STEM Calculus 1 who completed the calculus course in two years, at least 69% passed (C or better) on the first attempt for each level of high school math preparation. See Table C4 in the statewide analysis for more details.

Do you have data on these students in calc 2?

Yes, see page 8 and Appendix E in the main report.

How could students who did not have precalculus or trigonometry in high school get into Calculus in college?

The statewide study included years when placement methods included assessment testing as well as years when high school transcript data was used for placement. Students without precalculus or trigonometry could have accessed calculus through prior placement testing, more recent self-placement or guided self-placement processes, the college's use of GPA for placement and not high school math coursework, concurrent enrollment in a corequisite course, prerequisite challenge processes, as well as different levels of prerequisite verification at different colleges.

Were students who started in Calculus without taking a precalculus or trigonometry course spread evenly throughout the time frame of the study or where they were clustered in the later years as pilot programs sprung up around alternative placement avenues?

> In the statewide study, there were 1,634 STEM students who started in Calculus 1 who were coded with a high school math preparation level below precalculus or trigonometry. The number increased each year of the study, from 74 in 2012-2013 to 386 in 2019-2020.

How large was the group of students who had at most geometry and passed Calculus? Were they concentrated at one college or during one year?

> There were 230 STEM students in the cohort who started in Calculus and had high school math preparation of at most geometry, according to the CalPASS Plus data or CCCApply. They were spread across 73 colleges with no apparent district or regional pattern. The number of students in this group has increased slightly over time, from 10 in 2012-2013 to 48 in 2018-2019 and 36 in 2019-2020.
>
> The “at most geometry” group (n=2,868) was less than 7.7% of the entire cohort used in the study, with 92% of STEM students with this level of high school math preparation starting in preparatory college courses. Even though it was a small group, their completion outcomes followed the same trends as all other disaggregated groups.

Does the analysis include students who dropped the class before census?

> No, colleges do not report pre-census enrollments to CCCCO. This data may be available locally.

Did the data include students who started in Calc I, failed, then took Precalc, passed, and then went back and passed Calc. 1? How often did this occur?

> Of the 9,100 students who started in STEM Calculus 1 and eventually completed within two years, 1,796 (19.7%) were not successful in their first attempt. Of the students who were unsuccessful in their first attempt, 92% persevered and re-enrolled in STEM Calculus 1 and passed within two years (1,649 of 1,796=92%).

The remaining 8% (147 students) transitioned to a lower level and completed a STEM Calculus 1 pathway course en route to completing STEM Calculus 1 in 2 years.

Aren't there many extraneous and confounding variables in this study, e.g., self-selection bias, other factors that affect persistence (such as a student moving out of state), COVID, duration of time between the last math class taken in high school and the first math class taken at the community college? How did the study control for these factors?

In the multivariate regression analysis, there are 12 variables included in the regression models, including "years between last HS math and first CCC math." See Table 5 in the technical appendices: Preparatory Pathways and STEM Calculus Completion: Implications of the AB 1705 Standards, Technical Appendices, February 2024. Obviously, it is difficult to control for the effects of COVID; however, the state analysis spanned a time prior to COVID and the college reports included cohorts after COVID. Both analyses produced the same key findings.

Does the high school transcript data or CCCApply information account for students who learn prerequisite material by other means, students who have out-of-state high school transcripts, post-military students with training that includes trigonometry, or other factors that may warrant a successful prerequisite challenge?

The disaggregation by high school math preparation and HSGPA in the statewide report is based on California high school transcripts provided by CalPASS Plus and information from CCCApply. Please see the technical appendices for a full description of the methodology. Preparatory Pathways and STEM Calculus Completion: Implications of the AB 1705 Standards, Technical Appendices, February 2024. Colleges do not report the outcomes of prerequisite challenges to the COMIS system. This information may be available to colleges locally.

Aren’t there many other factors that could explain low throughput, e.g., students in programs that only require college algebra (ultrasound tech), students who complete precalculus at the college but take calculus at another college or a university? How did the study control for these factors?

> The statewide study controlled for some of these factors by restricting the cohorts to STEM majors (thus removing students in the ultrasound program) and tracking a calculus completion across colleges systemwide (counting students who first enrolled in a STEM calculus pathway course at College A and then completed calculus at College B).

Not all College Algebra courses are part of the BSTEM pathway. How did you account for this? Was Business Calculus included in this study?

> Business calculus and other forms of applied calculus were not included in the study. College catalogs were used to identify courses in the STEM Calculus pathway.

Many community college students were required to state a major upon enrollment and later learn that STEM is not for them-they do not like all math/science coursework and work it entails. Why are students who switched majors from STEM to non-STEM not removed from data?

> Students who switch to a non-STEM major are part of the story. This study helps explicate the importance of the design and the quality of a program’s entry-level math experiences in both promoting students’ achievement of math milestones for the STEM program and their persistence within the program. When the first math experience for STEM students is associated with a significant decrease in the likelihood that they complete calculus requirements, the program loses a substantial majority of the students interested in the program. When there is evidence, as in this study, that students are capable of completing calculus but are hampered or demotivated by the design of the entry experience, efforts to improve STEM participation and STEM equity hinge on addressing this issue.

If the study is not done with random assignment, how can the conclusion be valid?

> Because of ethical and logistical constraints, randomized, controlled trials are often not possible. We use statistical modeling for this reason. Many commonly

held medical findings come from statistical analyses, such as the unequivocal link between smoking and certain forms of cancer.

This validation study used a combination of decision tree analysis and multivariate logistic regression. It is true that statistical modeling cannot prove a cause-and-effect relationship between variables, but it can identify factors that contribute the most strongly to calculus completion and control the effects of confounding factors. Across the logistic regression models used in this study, starting in a preparatory college course in the STEM Calculus pathway was a strong negative predictor of STEM Calculus 1 completion, even when controlling for other strong predictors such as high school GPA.

Did the calculus classes included in the data have corequisite classes? If yes, then were the coreqs validated?

Calculus pathway courses with and without corequisites are included in the study. For example, students enrolled in a supported College Algebra section or an unsupported section are both included in the cohort of College Algebra students, same for calculus. There are no validation requirements for corequisites at this time.

How did the analysis separate multiple pathways a college may have leading into calculus? For example, a college that has a one course and a separate two course pathway leading to calculus.

College pathways were analyzed by the course type (e.g., College Algebra, Trigonometry, Precalculus) and the number of preparatory courses in the pathway.

Why is biological sciences aggregated with physical sciences?

AB 1705 has a separate set of standards for programs that require STEM Calculus. STEM majors were identified using the C-ID Transfer Model Curricula as programs that require completion of at least a first-level STEM Calculus course, which included both the biological and physical sciences. A separate shorter report that disaggregates the biological and physical sciences is forthcoming in spring/summer 2024 and will be available here (under Evaluation): https://rpgroup.org/RP-Projects/All-Projects/Multiple-Measures/AB705_Resources

Was this data also disaggregated by ethnicity? Any data on disaggregating Asian groups?

> Yes, race/ethnicity was disaggregated using IPEDS categories, which includes Asian and Pacific Islander as separate categories. See Appendix H in the main report for the cohort distribution, high school preparation, and throughput by race/ethnicity.

I'm curious if you thought about using Propensity Score Matching (PSM) for this analysis? When we at college's try to look at our own data, we will have fewer observations than what you do at the state level. I think PSM may give us a more robust result at the college level than decision tree or regression for calculating odds ratio.

> Yes, Propensity Score Matching (PSM) was considered but given the large sample size and number of variables, logistic regression and decision trees were selected. However, local college level analyses might benefit from PSM, which can be more robust than regression in situations with smaller sample sizes or a smaller number of predictor variables. For this validation period, complete the data submission template first. If you want to include additional analyses to support an application for validation or interim approval, submit that through AB705@cccco.edu.

Is there data that shows or doesn't show differences in success rates based on high school math completion? For example, what are the outcomes for a student who has a 3.0 but didn't pass algebra II vs a 2.5 who completed precalculus. Does gpa or level of math have a greater influence on success or is it a combination?

> In the multivariate regression models the interaction of HSGPA and HS math preparation was examined. HSGPA was a much stronger predictor of calculus completion than high school math preparation, which is consistent with prior research conducted during the development of the default placement rules. See the technical appendix for the report, Preparatory Pathways and STEM Calculus Completion: Implications of the AB 1705 Standards, Technical Appendices, February 2024.