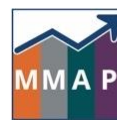


Maximizing Calculus Completion for Students Seeking the Business Administration Degree



California
Community
Colleges

MAY 2023



Multiple Measures
Assessment Project

TheRPGroup

Introduction

[AB 1705](#) requires colleges to validate their math placement policies and associated enrollment practices to ensure that students begin in coursework that gives them the best chance of completing the initial transfer-level math requirements for their academic goal. If students are required to enroll in prerequisite coursework prior to the entry-transfer-level math course for their program, colleges must provide evidence that the student is highly unlikely to succeed in the program's entry-transfer-level course without the prerequisite and that the prerequisite course improves the probability that students complete the program's initial math requirements.

The California Community College system has previously completed validation studies for pretransfer-level prerequisites to introductory transfer-level English and math. Legislatively set deadlines now require validation of transfer-level prerequisites that do not satisfy a program's course requirements. For programs of study outside of the Science, Technology, Engineering, and Math (STEM) disciplines, the deadline to validate transfer-level prerequisites to gateway English and math for the program is July 1, 2023.¹

This report focuses on the largest known example of a non-STEM degree program that will be a prerequisite validation focus for many colleges, the associate degree in business administration. College catalogs for 2021-2022 showed that 109 colleges offer this degree with calculus as an entry-transfer-level math requirement at 97 colleges. Forty-four colleges offer Business Calculus but require completion of a transfer-level prerequisite,² such as college algebra, trigonometry, or precalculus, prior to the calculus course. These transfer-level prerequisites do not satisfy a requirement for the Business Administration degree and therefore require validation under AB 1705.

To support this validation effort, the Multiple Measures Assessment Project (MMAP) used the criteria in AB 1705 to **analyze calculus completion outcomes for students pursuing the Business Administration degree. The analysis seeks to determine if (1) students with lower levels of high**

Multiple Measures Assessment Project (MMAP) Overview

This report was produced in partnership with The RP Group's Multiple Measures Assessment Project. The RP Group launched MMAP in 2014 to help advance developmental education reform in the California Community Colleges. MMAP now supports the California Community Colleges Chancellor's Office with AB 705 and AB 1705 implementation.

Learn more about AB 705, AB 1705, and MMAP at www.rpgroup.org/mmap.

school math preparation are highly unlikely to succeed when directly enrolled in Business Calculus, and if (2) placing and enrolling students into transfer-level prerequisite math courses improves their likelihood of completing calculus.

Methodology

For this report the cohort is limited to all California Community College (CCC) Business Administration³ students whose first math course was a transfer-level course in a calculus-based pathway (college algebra, trigonometry, precalculus, or calculus) between summer 2012 and summer 2022.⁴ Students who started math below transfer level were excluded from the analysis, as well as students who started in transfer-level math courses that are not prerequisites to calculus, such as statistics or finite math.

Students within the cohort were disaggregated by highest math successfully completed with a C or better while in high school. Educational Results Partnership's CalPASS Plus provided the MMAP team with data files on the highest-level of high school math completed, which included both 11th and 12th grade data as well as self-reported information from CCCApply. The analysis in this report uses self-reported information if available and 11th/12th grade data otherwise.

This report addresses two questions relevant to AB 1705 standards for validating transfer-level prerequisites to calculus for students seeking the Business Administration associate degree:

1. Are students with lower levels of high school math preparation highly unlikely to succeed in Business Calculus⁵ if directly enrolled in that course?

Business Calculus throughput was calculated in a one-year timeframe for students in the cohort who directly enroll in Business Calculus as their first community college math course, disaggregated by the highest math successfully completed with a C or better while in high school.⁶ The one-year timeframe tracks the cohort for an academic year (up to four academic terms) from initial transfer-level math enrollment in a calculus-based pathway. The one-year timeframe is specified in AB 1705.

2. Does starting in a transfer-level prerequisite to calculus improve the probability that students will complete calculus within a one-year timeframe when compared to students with similar high school math preparation that directly enroll in calculus?

Since Business Administration students may complete various forms of calculus to meet their program requirements and not all colleges offer Business Calculus, the throughput calculations from transfer-level prerequisites in the calculus pathway included all possible calculus completions (e.g., Business Calculus or STEM Calculus I) that would satisfy the requirements of a Business

Key Terms

Throughput: the number of students who successfully complete a target course (in this report, Business Calculus or Calculus) out of the number of students starting in a specified math course.

Conditional throughput: the percentage of students who successfully complete a target course (e.g., Calculus) considering only those who enroll in that course.

Administration degree. Given that various types of entry-level calculus courses can share the same prerequisites, this approach allowed for the most comprehensive throughput calculation for the completion of Business Calculus or the equivalent for Business Administration students. The intent of this design was to afford the prerequisite pathway the greatest opportunity to demonstrate equivalent or greater throughput relative to direct enrollment into Business Calculus.

Throughput for any calculus course was analyzed as a function of both (1) the highest math successfully completed with a C or better while in high school, and (2) the first math course taken at a community college in a calculus-based pathway (i.e., college algebra, trigonometry, precalculus, or calculus). Throughput was analyzed in two different timeframes: (1) the one-year timeframe required by AB 1705, and (2) an extended timeframe to determine if the transfer-level prerequisite validation results changed when the one-year restriction was removed. By removing the time constraint, this additional analysis afforded the prerequisite pathway the greatest possible opportunity to demonstrate its impact on throughput. In other words, if the prerequisite approach leads to superior rates of calculus completion, but students take longer to complete, then the extension would allow the prerequisite a time-unrestricted opportunity to demonstrate its effectiveness. Both analyses include students enrolled between summer 2012 and summer 2022. The extended timeframe allowed for the completion of calculus at any time through summer 2022 while the one-year time frame tracked completion within one year and aggregates all one-year cohorts over the ten-year timeframe. For the extended timeframe, only the very last set of students who started in summer 2021 were limited to a one-year timeframe; all other cohorts had a longer timeframe based on their starting term. For example, a Business Administration student who took their first math class in summer 2012 would have up to 10 years to complete calculus. Completion was tracked anywhere within the CC system, e.g., Business Administration students who started in precalculus at one college and completed calculus at another were included in the throughput calculations.

The report also separately examines successful calculus completion rates for only those students who eventually enroll in calculus, defined as conditional throughput. This analysis used the extended timeframe, which gives students one to ten years to complete calculus depending on the year they enrolled in calculus, with disaggregation by highest math course completed in high school and the first course taken in the calculus-based pathway at the community college. This analysis is included to highlight the way in which conditional throughput is often used to raise concerns about the potential for lower success rates in a gateway course when students bypass prerequisites. By examining this argument directly, the discussion can fairly balance that concern against the substantial impact of prerequisites on program enrollments and students' progress within the program that is revealed by the throughput analyses. Importantly, this is done as an exercise to assist understanding only. Conditional throughput is not sufficient to understand AB 1705 compliance because this perspective specifically obscures the impact of a student's placement and first course enrollment on completing the gateway course for the student's program.

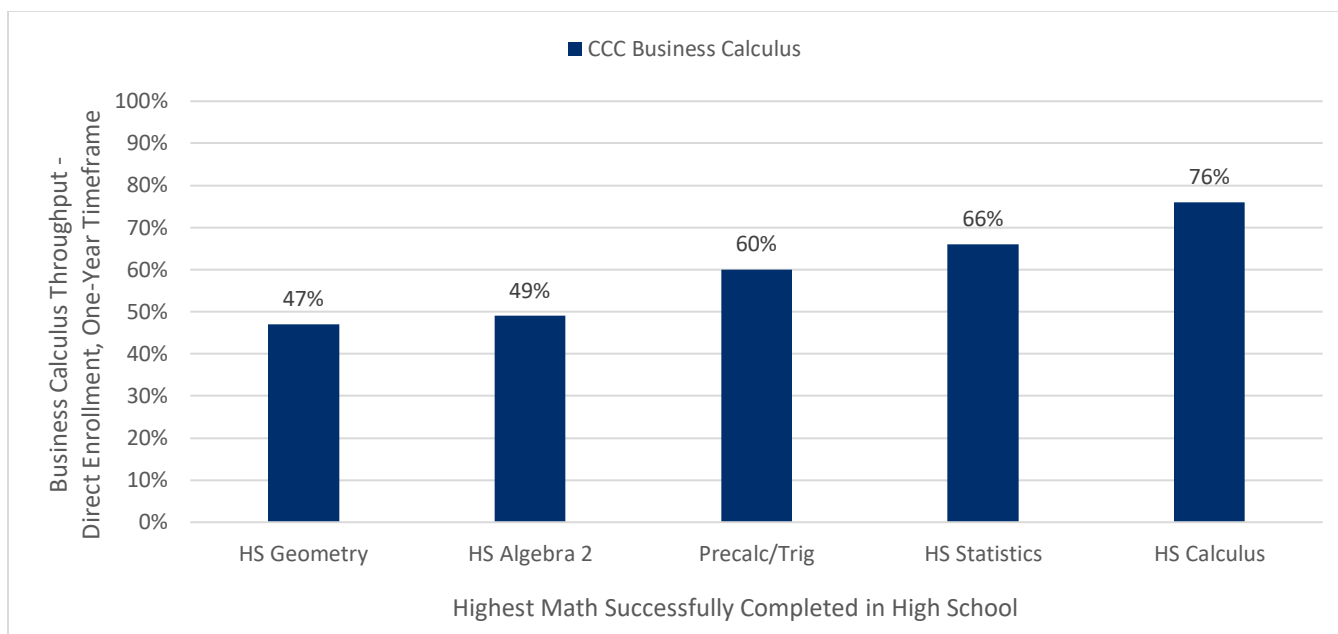
Findings and Discussion

Business Calculus Throughput in One-Year for Business Administration Students Who Start in Business Calculus

Finding #1: For students pursuing Business Administration, across all levels of high school math preparation, there are no groups of students who are highly unlikely to succeed when directly enrolled in Business Calculus. Students with lower levels of math preparation are good candidates for and should be provided corequisite support linked to Business Calculus.

Business Calculus throughput shown in Figure 1 was calculated in a one-year timeframe for students in the cohort who directly enroll in Business Calculus as their first community college math course. Throughput was disaggregated by the highest math successfully completed with a C or better while in high school to determine if students with lower levels of high school math preparation are highly unlikely to succeed in Business Calculus without taking a transfer-level prerequisite.⁷

Figure 1. Business Calculus Throughput in One-Year (y-axis) by Highest High School Math (x-axis) for Business Administration Students Who Directly Enroll in Business Calculus



As can be seen in Figure 1, disaggregating the cohort by high school math preparation does not reveal any group of Business Administration students who were highly unlikely to succeed when directly enrolled in Business Calculus. Yet, the impact of high school math preparation is noticeable. Students with lower levels of high school math preparation had lower rates of completion of Business Calculus in one year. For example, consider students with Geometry as their highest high school math success: 47% of those who directly enrolled in Business Calculus successfully completed Business Calculus in one year, compared to 60% of students who had a precalculus or trigonometry course as their highest high school math success. Despite these observed differences in completion by different levels of high

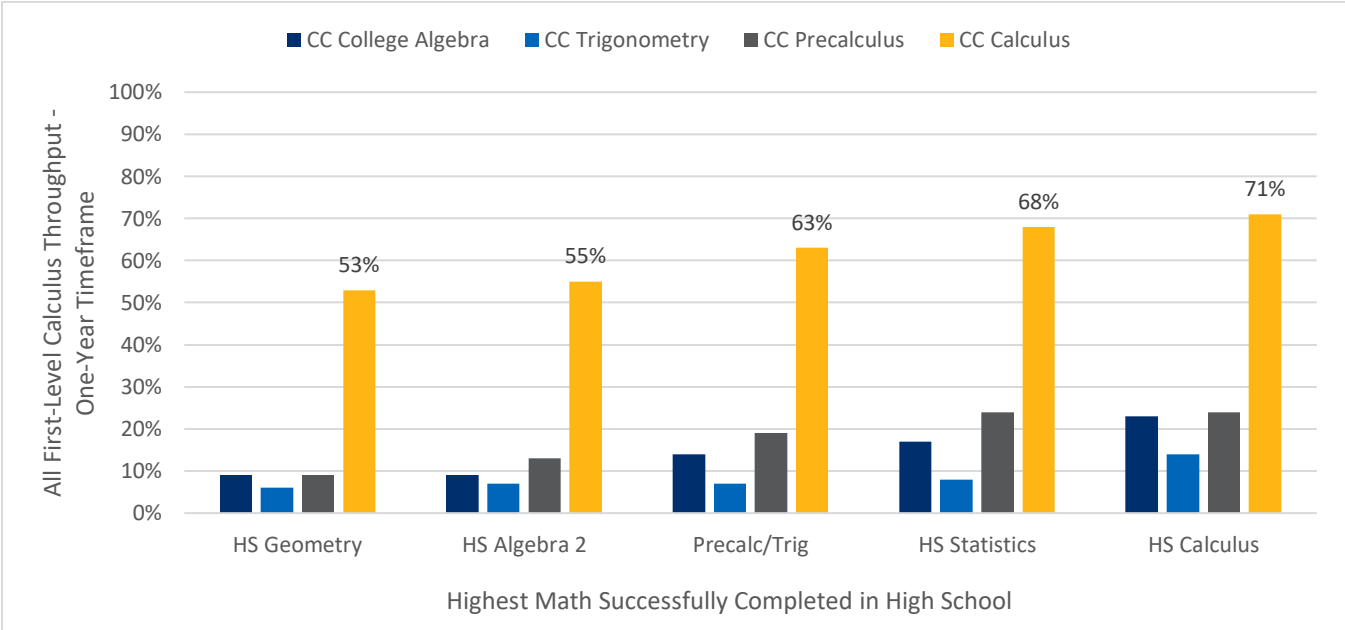
school math preparation, no group emerged from this analysis as highly unlikely to succeed in Business Calculus. As a result, the first standard for prerequisite validation in AB 1705, which is a key element of the state’s longstanding requirements for a prerequisite, is not met at the statewide level of analysis. However, given the lower completion rates for students with lower levels of high school math preparation, this analysis strongly suggests that these students would be excellent candidates for additional corequisite support linked to Business Calculus.

Throughput For Any Calculus in One-Year Timeframe for Business Administration Students

Finding #2: For Business Administration students who need calculus to meet program requirements, direct enrollment into calculus (*across all types*) resulted in far higher rates of completion of calculus within one year relative to students beginning in any transfer-level prerequisites, across all levels of high school preparation.

In AB 1705, the second standard for prerequisite validation requires evidence that the prerequisite improves the probability that a student will complete the gateway course within a one-year timeframe. To give the prerequisite pathway the greatest possible opportunity for validation, the calculus throughput from the prerequisite included all possible calculus courses that Business Administration students could complete to meet program requirements, (e.g., Business Calculus or STEM Calculus I).⁸ As can be seen in Figure 2, Business Administration students are far more likely to complete a calculus course if they start there directly than they are if they begin in any transfer-level prerequisite. Importantly, this holds true across all levels of high school mathematics preparation.

Figure 2. All First-Level Calculus Throughput in One-Year (y-axis) by Highest High School Math (x-axis) and First Community College Course (legend) for Business Administration Students



Note: Legend represents the first community college math course for Business Administration students.

In the analysis displayed in Figure 2, Business Administration students are grouped by the highest math course completed in high school, as before. Within each level of high school math preparation, students are further categorized by the first math course taken at a community college in a calculus-based pathway: college algebra, trigonometry, precalculus, or calculus (of any type). The height of each bar represents the successful completion of calculus of any type (calculus throughput) within one year.

Beginning on the left in Figure 2 are students for whom Geometry was the highest high school math course they successfully completed. For Geometry-completers who started in a transfer-level prerequisite, one-year calculus throughput rates were low: 9% for those starting in college algebra, 6% for those starting in trigonometry, and 9% for those starting in precalculus. In contrast, when Geometry-completers enrolled directly in calculus (of any type), their completion rate was 53%, over five times higher. This pattern is similar across all levels of high school math preparation. One-year throughput was substantially higher when students began in a calculus course instead of a transfer-level prerequisite, regardless of high school math preparation. Importantly, this remains true across all levels of high school preparation when the one-year throughput from the transfer-level prerequisites into *any* first calculus course (Figure 2) – allowing any possible path to Calculus completion - is used as a more comprehensive measure to compare against the one-year throughput of students who start only in Business Calculus (Figure 1).⁹

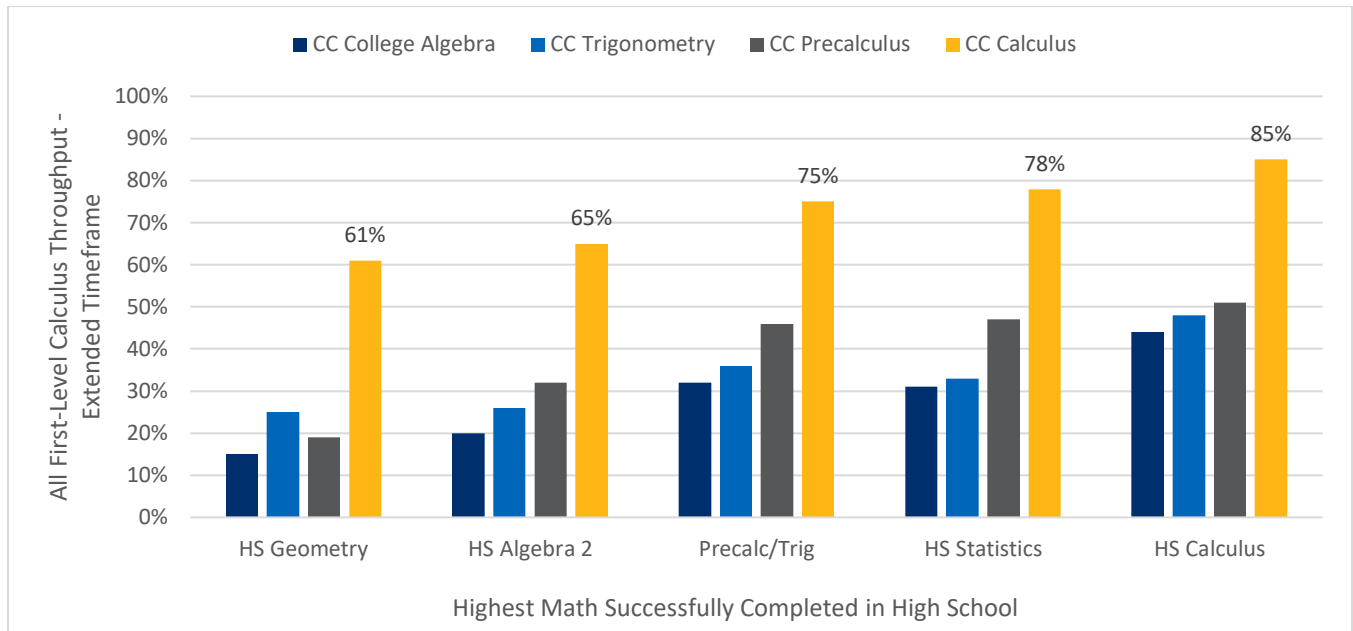
As noted in the earlier discussion of Figure 1, students with lower levels of high school math preparation did demonstrate lower one-year calculus throughput when they directly enrolled in calculus (any type) in Figure 2. It remains the case that for every level of high school preparation, Business Administration students are far more likely to successfully complete calculus if they began there. Once again, given the relationship between high school mathematics and calculus performance, students with lower levels of high school math preparation are good candidates for corequisite support linked to calculus and should have such support available.

Additional Analysis: Calculus Throughput in an Extended Timeframe

Finding #3: Even when the timeframe was extended, Business Administration students starting in a transfer-level prerequisite were still far less likely to successfully complete calculus than students who began directly in calculus, across all levels of high school math preparation.

AB 1705 clearly specifies a one-year timeframe for evaluating the impact of prerequisites on gateway course completion. However, an additional analysis was conducted in an extended timeframe to determine if the effectiveness of the prerequisites emerged when the one-year time constraint was removed. In this analysis the same cohort of Business Administration students was tracked for one to ten years, depending on their starting term, from their first course enrollment in a calculus-based pathway, as explained in the methodology section. Again, completion of any calculus course was counted to afford the prerequisite pathway the greatest opportunity to demonstrate effectiveness in supporting completion of gateway requirements for the Business Administration degree.

Figure 3. All First-Level Calculus Throughput (y-axis) Extended Timeframe by Highest High School Math (x-axis) and First Community College Course (legend) for Business Administration Students



As can be seen from the results of the analysis in Figure 3, even with an extended time frame, starting in a transfer-level prerequisite resulted in lower rates of calculus completion than directly enrolling in calculus across all levels of high school math preparation. However, throughput rates within the extended timeframe were higher than those in the one-year timeframe, as expected. For example, for high school Geometry-completers who started in a college algebra course, only 9% completed some form of calculus within a year (Figure 2) compared to 15% when given an extended timeframe (Figure 3). Despite higher throughput rates overall, the overall pattern did not change. Even with an extended timeframe, across all levels of high school math preparation, students were much more likely to complete calculus if they began in a calculus course than if they began in any transfer-level prerequisite.

In fact, **Business Administration students who started in a calculus course were much more likely to complete calculus in one-year than Business Administration students with the same level of high school math preparation who started in a transfer-level prerequisite when given up to 10 years.** For example, compare the calculus completion rates of Business Administration students whose highest high school math success was Geometry: 53% of those who started directly in any form of calculus successfully completed calculus in **one-year** (Figure 2), compared to 15% of those who started in college algebra, when given up to 10 years to complete any calculus course (Figure 3). Similarly, when the analysis is restricted to Business Calculus, 47% of Geometry-completers who started in Business Calculus completed Business Calculus in one-year (Figure 1), which is over three times as high as the comprehensive throughput calculation of 15% that afforded the college algebra prerequisite extended time and included every calculus course option

that students might have used to complete the calculus requirement for the Business Administration degree.

These analyses highlight the actual capacity of community college students with aspirations for a degree in Business Administration. Students across all levels of high school math preparation completed calculus at relatively high rates if given access to it and were far more likely to do so than if they started in a transfer-level prerequisite course. When a Business Administration program constrains access to a gateway calculus course by tracking students into prerequisite coursework, even at the transfer level, large numbers of students who could have successfully completed the gateway calculus course for the program do not complete it. The low levels of calculus completion for those who started in a prerequisite course was not explained by students' high school math preparation or the amount of time it might take them to complete.

Additional Analysis: Conditional Throughput

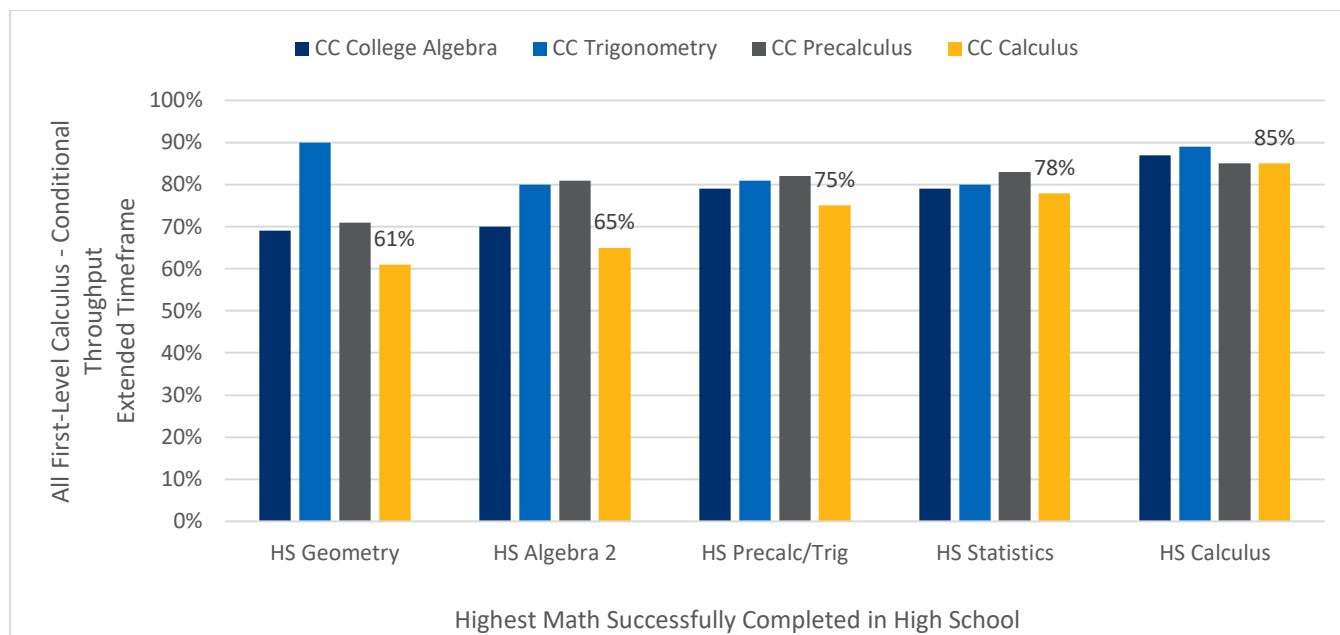
Finding #4: Restricting Business Administration students' access to calculus resulted in modestly higher conditional throughput rates but at a very high cost to program enrollment and gateway math course completion. Thousands of students who could have succeeded in a calculus course never made it to calculus because of the prerequisites and their progress and completion in Business Administration was powerfully, unnecessarily, and unfairly curtailed.

The low calculus throughput rates associated with transfer-level prerequisites are not easily visible to classroom faculty. Calculus instructors are more readily able to see shortcomings in the work of the students who are in front of them. The forgotten trigonometry identity or difficulty factoring a complicated polynomial raises faculty's concerns about student preparation and is among the reasons colleges adopt prerequisites.¹⁰ The impact of these prerequisites on calculus completion is often left unexamined.

To visualize this perspective in a manner that remains parallel with the other analyses in this report, this last analysis examined the successful completion of a calculus course but only among students who attempted a calculus course. The introduction of this constraint makes the observed throughput conditional on the student enrolling in calculus.¹¹ However, it is important to note that "conditional throughput" does not meet the validation requirements of AB 1705 because it does not measure the overall impact of a college's placement policy on students' progress to and through the gateway math course for their program. Nevertheless, conditional throughput better reveals the observed experiences often articulated by faculty.

The analysis displayed in Figure 4 was restricted to only those students who enrolled in a calculus course, either directly or after taking one of the transfer-level prerequisite courses. The same extended timeframe was used in this analysis over the same ten-year window as the analysis displayed in Figure 3. Students had anywhere from a year to 10 years, depending on their start date, to successfully complete any calculus course once they had enrolled in the calculus course.¹²

Figure 4. All First-Level Calculus Conditional Throughput Extended Timeframe (y-axis) by Highest High School Math (x-axis) and First Community College Course (legend) for Business Administration Students



Note: Legend represents the first community college math course for Business Administration students.

The conditional throughput rates in calculus were slightly to somewhat higher for students who started in a prerequisite course when compared to students who did not, particularly for students with lower levels of high school math preparation. For example, consider again the high school Geometry completers in Figure 4. For those who enrolled directly in calculus without taking a transfer-level prerequisite, 61% passed the calculus course, compared to 69% of those taking calculus who had started in a college algebra prerequisite. From the point of view and felt experience of faculty teaching calculus, this finding can appear as evidence of the effectiveness of the college algebra prerequisite.

However, this point of view does not consider the large negative impact of the prerequisite on the potential enrollment in the Business Administration program. For example, out of the 641 Business Administration students who were high school Geometry-completers that started in the college algebra course, only 139 enrolled in calculus (22%) at any point and only 96 (15%) ever completed calculus. In other words, 85% (545 of 641) of this group of Business Administration majors took a transfer-level prerequisite to calculus but did not complete the gateway calculus course for the program. The fact that 61% of students *with the same level of high school math preparation* successfully completed calculus when they began in that course without taking a transfer-level prerequisite strongly suggests that a substantial majority of capable Business Administration students are unnecessarily and unfairly being sacrificed to attrition in transfer-level math prerequisites that do not satisfy requirements for the Business Administration degree in order to attain modest improvements in the course outcomes of the students who make it to a calculus course. If all those 641 students had started instead directly in a calculus course, 391 of them (61% of 641) would have likely completed – **nearly 300 more students** (and more than quadruple the

number who actually did) – and these students would be far more likely to persist in and ultimately complete a Business Administration program.

Thus, the slight evidence of a modest improvement in outcomes among students who make it to a calculus course seen in the conditional throughput (or in other success rate-based analyses) is vastly outweighed by the evidence in this report that these transfer-level prerequisites are neither necessary for Business Administration students success in calculus nor compatible with fundamental principles and requirements for prerequisites, including those that predate the changes of AB 705 and AB 1705, namely that prerequisites meet the dual standards of being necessary for successful performance in the course and meaningfully improve the likelihood of students completion of the course.

Summary

Business Administration students were far more likely to complete a calculus requirement for their program when they started directly in a calculus course than if they started in a transfer-level prerequisite. Importantly, these findings were consistent across every level of high school math preparation and across all transfer-level prerequisites. Regardless of the highest math course completed in high school, students were much less likely to ever complete calculus when they began in any of the traditional transfer-level prerequisite courses: college algebra, trigonometry, or precalculus. As a result, these prerequisites do not meet AB 1705 standards at the statewide level. Any additional support or preparation that students might need or want is most appropriately provided concurrently or as a corequisite.

The discussion of conditional throughput (and any similar discussion of course success rates) that our system has traditionally focused on must be re-balanced by adding to our understanding the very real impacts of transfer-level prerequisites on program enrollment and student progress within a program. In this study, the impact of such prerequisites on students in Business Administration programs suggests that, in fact, transfer-level prerequisites are astoundingly ineffective in supporting that program and that they have very real and substantially negative impacts on students.

This paper 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 program and their persistence within the program. When the first math experience for students significantly decreases the likelihood that students complete the gateway mathematics course for the program, 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 gateway math coursework but are hampered by the design of the entry experience, both the educational and legal imperatives could not be clearer. In the case of Business Administration majors, this analysis suggests that **business programs are losing large numbers of capable students due to prerequisite structures that prevent students' direct enrollment into calculus.** Many more students could make progress toward and complete a business degree if they began directly in an appropriate calculus course, with concurrent support as needed, instead of taking prerequisite math courses, even if those courses are transfer-level.

Appendix A. Student Counts by Cohort (Ten-Year Window, 2012-2022)

Table 1. Business Calculus Throughput One-Year Timeframe by Highest High School Math for Business Administration Students Who Directly Enroll in Business Calculus

		Highest High School Math Successfully Completed									
		Geometry or Lower		Algebra 2		Precalculus/Trig		Statistics		Calculus	
		Cohort	TP Rate*	Cohort	TP Rate	Cohort	TP Rate	TP Rate	Cohort	Cohort	TP Rate
First CCC Course	Business Calculus	105	47%	506	49%	1,207	60%	438	66%	485	77%

* Throughput Rate

Note: Cohort is Business Administration students starting in Business Calculus as their first transfer-level math course in a calculus-based pathway between summer 2012 and summer 2022, disaggregated by highest math course completed in high school with a C or better. Throughput in Table 1 is the percentage of students who began in Business Calculus (denominator) and successfully completed Business Calculus within a one-year timeframe (numerator).

Table 2. All First-Level Calculus Throughput One-Year Timeframe by Highest High School Math and First Community College Course for Business Administration Students

		Highest High School Math Successfully Completed									
		Geometry or Lower		Algebra 2		Precalculus/Trig		Statistics		Calculus	
		Cohort	TP Rate*	Cohort	TP Rate	Cohort	TP Rate	TP Rate	Cohort	Cohort	TP Rate
First CCC Course	College Algebra	641	9%	2,326	9%	2,018	14%	986	17%	318	23%
	Trigonometry	143	6%	645	7%	752	7%	323	8%	178	14%
	Precalculus	141	9%	744	13%	1,450	19%	480	24%	460	24%
	Calculus	158	53%	750	55%	2,813	63%	789	68%	1,958	71%

* Throughput Rate

Note: Cohort is Business Administration students starting in a transfer-level math course in a calculus-based pathway at a CCC between summer 2012 and summer 2022, disaggregated by highest math course completed in high school with a C or better. Throughput in Table 2 is the percentage of students who began in a given course (denominator) and then successfully completed Business Calculus or STEM Calculus I within a one-year timeframe (numerator).

Table 3. All First-Level Calculus Throughput, Extended Timeframe, by Highest High School Math and First Community College Course for Business Administration Students

Highest High School Math Successfully Completed											
		Geometry or Lower		Algebra 2		Precalculus/Trig		Statistics		Calculus	
		Cohort	TP Rate*	Cohort	TP Rate	Cohort	TP Rate	Cohort	TP Rate	Cohort	TP Rate
First CCC Course	College Algebra	641	15%	2326	20%	2,018	32%	986	31%	318	44%
	Trigonometry	143	25%	645	26%	752	36%	323	33%	178	48%
	Precalculus	141	19%	744	32%	1,450	46%	480	47%	460	51%
	Calculus	158	61%	750	65%	2,813	75%	789	78%	1,958	85%

* Throughput Rate

Note: Cohort is Business Administration students starting in a transfer-level math course in a calculus-based pathway at a CCC between summer 2012 and summer 2022, disaggregated by highest math course completed with a C or better in high school. Throughput in Table 3 is the percentage of students who began in a given course (denominator) and then successfully completed Business Calculus or STEM Calculus I within the timeframe of the study (2012-2022) (numerator).

Table 4. All First-Level Calculus Conditional Throughput, Extended Timeframe, by Highest High School Math and First Community College Course for Business Administration Students

Highest High School Math Successfully Completed											
		Geometry or Lower		Algebra 2		Precalculus/Trig		Statistics		Calculus	
		Cohort	Conditional TP*	Cohort	Conditional TP	Cohort	Conditional TP	Cohort	Conditional TP	Cohort	Conditional TP
First CCC Course	College Algebra	139	69%	658	70%	825	79%	388	79%	163	87%
	Trigonometry	39	90%	211	80%	337	81%	131	80%	97	89%
	Precalculus	38	71%	292	81%	807	82%	268	83%	275	85%
	Calculus	158	61%	750	65%	2813	75%	789	78%	1958	85%

* Throughput Rate

Note: Cohort is Business Administration students starting in a transfer-level math course in a calculus-based pathway at a CCC between summer 2012 and summer 2022, disaggregated by highest math course completed with a C or better in high school. Conditional throughput in Table 4 is the percentage of students who enroll in Business Calculus or STEM Calculus I for each starting course (denominator) and then successfully completed the calculus course within the timeframe of the study (2012-2022) (numerator). Conditional throughput excludes students who start in a transfer-level math prerequisite and never enroll in calculus.

Appendix B. Student Counts by Cohort (Most Recent Three-Year Window, 2019-2022)

Figure 5. Business Calculus Throughput in One-Year for 2019-2022 (y-axis) by Highest High School Math (x-axis) for Business Administration Students Who Directly Enroll in Business Calculus

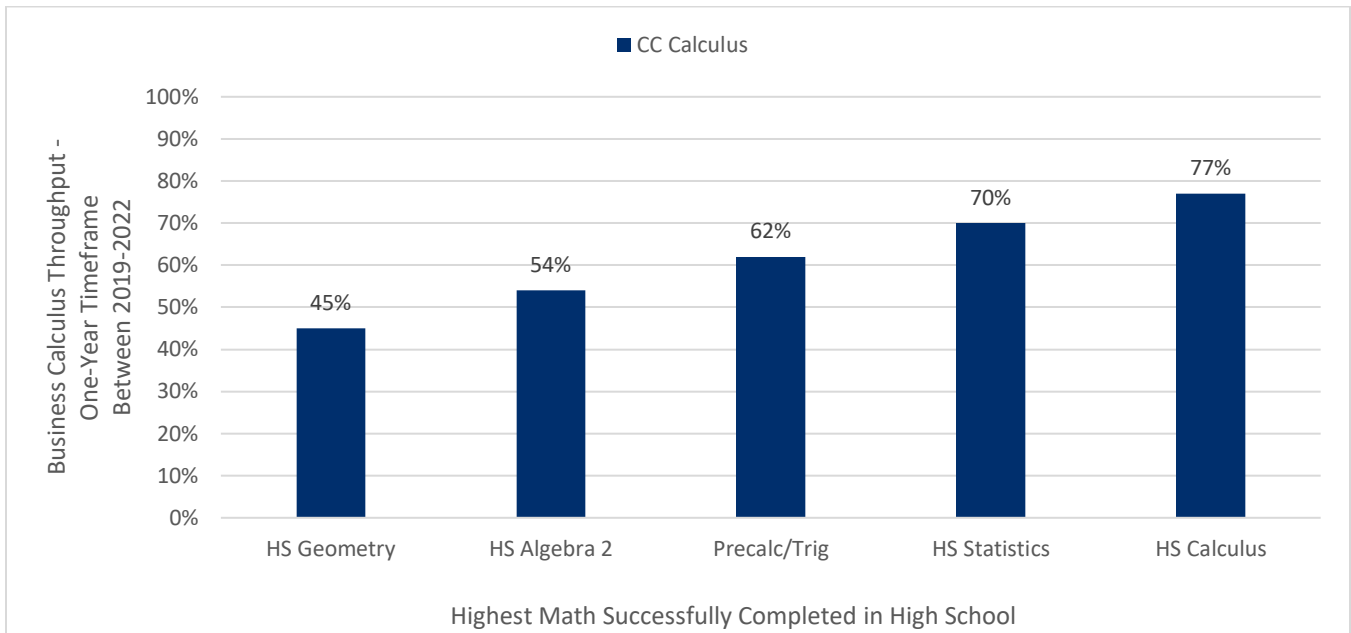
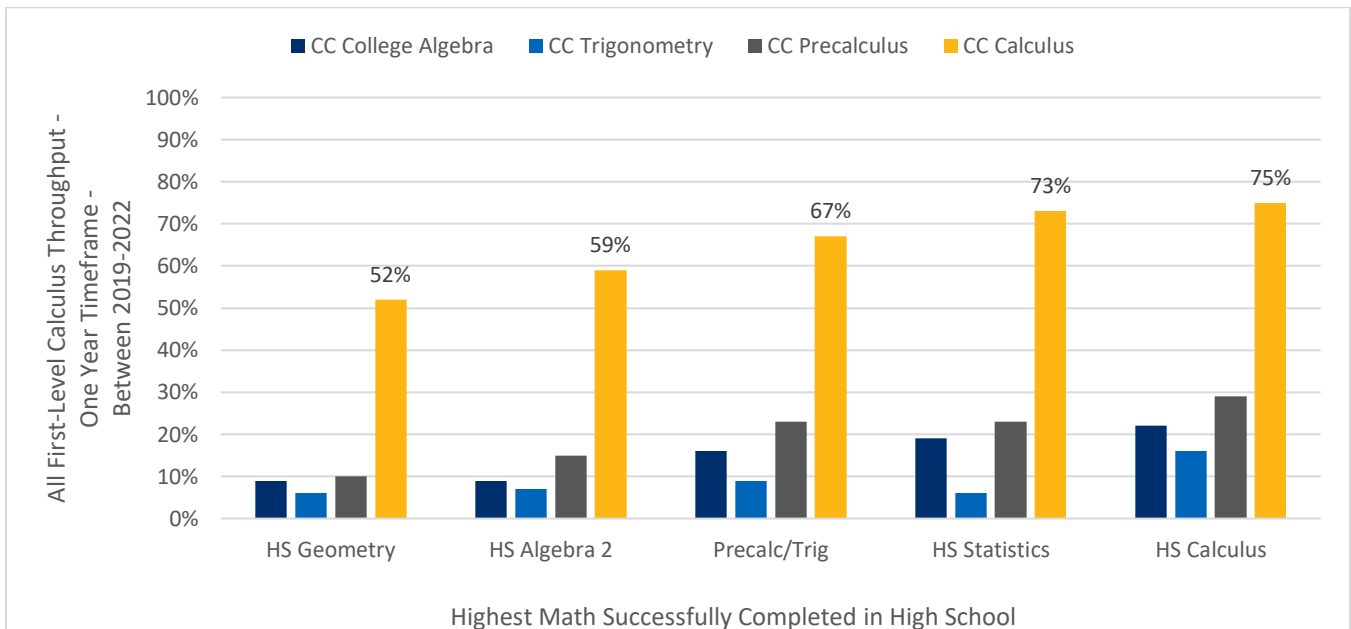
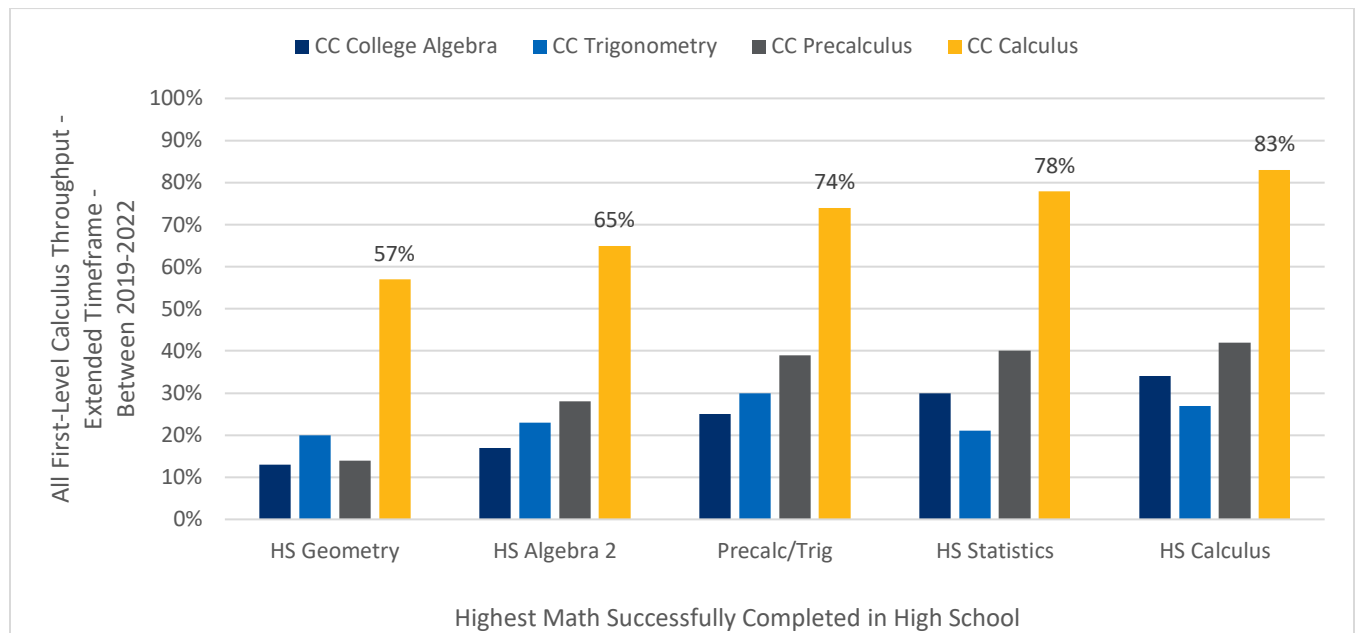


Figure 6. All First-Level Calculus Throughput One-Year Timeframe for 2019-2022 (y-axis) by Highest High School Math (x-axis) and First Community College Course (legend) for Business Administration Students



Note: Legend represents the first community college math course for Business Administration students.

Figure 7. All First-Level Calculus Throughput Extended Timeframe for 2019-2022 (y-axis) by Highest High School Math (x-axis) and First Community College Course (legend) for Business Administration Students



Note: Legend represents the first community college math course for Business Administration students.

Table 5. Business Calculus Throughput in One-Year for 2019-2022 by Highest High School Math for Business Administration Students Who Directly Enroll in Business Calculus

Highest High School Math Successfully Completed											
		Geometry or Lower		Algebra 2		Precalculus/Trig		Statistics		Calculus	
		Cohort	TP Rate*	Cohort	TP Rate	Cohort	TP Rate	TP Rate	Cohort	Cohort	TP Rate
First CCC Course	Business Calculus	80	45%	355	54%	676	62%	283	70%	268	77%

* Throughput Rate

Note: Cohort is Business Administration students starting in Business Calculus as their first transfer-level math course in a calculus-based pathway between summer 2019 and summer 2022, disaggregated by highest math course completed in high school with a C or better. Throughput in Table 5 is the percentage of students who began in Business Calculus (denominator) and successfully completed Business Calculus within a one-year timeframe (numerator).

Table 6. All First-Level Calculus Throughput One-Year Timeframe for 2019-2022 by Highest High School Math and First Community College Course for Business Administration Students

Highest High School Math Successfully Completed											
		Geometry or Lower		Algebra 2		Precalculus/Trig		Statistics		Calculus	
		Cohort	TP Rate*	Cohort	TP Rate	Cohort	TP Rate	Cohort	TP Rate	Cohort	TP Rate
First CCC Course	College Algebra	527	9%	1820	9%	1071	16%	686	19%	118	22%
	Trigonometry	113	6%	475	7%	305	9%	190	6%	44	16%
	Precalculus	105	10%	517	15%	688	23%	277	23%	152	29%
	Calculus	109	52%	506	59%	1502	67%	461	73%	999	75%

* Throughput Rate

Note: Cohort is Business Administration students starting in a transfer-level math course in a calculus-based pathway at a CCC between summer 2019 and summer 2022, disaggregated by highest math course completed in high school with a C or better. Throughput in Table 6 is the percentage of students who began in a given course (denominator) and then successfully completed Business Calculus or STEM Calculus I within a one-year timeframe (numerator).

Table 7. All First-Level Calculus Throughput Extended Timeframe for 2019-2022 by Highest High School Math and First Community College Course for Business Administration Students

Highest High School Math Successfully Completed											
		Geometry or Lower		Algebra 2		Precalculus/Trig		Statistics		Calculus	
		Cohort	TP Rate*	Cohort	TP Rate	Cohort	TP Rate	Cohort	TP Rate	Cohort	TP Rate
First CCC Course	College Algebra	527	13%	1820	17%	1071	25%	686	30%	118	34%
	Trigonometry	113	20%	475	23%	305	30%	190	21%	44	27%
	Precalculus	105	14%	517	28%	688	39%	277	40%	152	42%
	Calculus	109	57%	506	65%	1502	74%	461	78%	999	83%

* Throughput Rate

Note: Cohort is Business Administration students starting in a transfer-level math course in a calculus-based pathway at a CCC between summer 2019 and summer 2022, disaggregated by highest math course completed in high school with a C or better. Throughput in Table 7 is the percentage of students who began in a given course (denominator) and then successfully completed Business Calculus or STEM Calculus I within a three-year timeframe (numerator).

Endnotes

¹ Statute references: §78213 (e) and (i)(2). See also Chancellor’s Office guidance [memo](#) and AB 1705 [Implementation Guide](#).

² The C-ID descriptor for Math 140 Business Calculus lists an intermediate algebra prerequisite, not a transfer-level one.

³ Business Administration students were identified by selecting students with a [TOP code](#) of 0505.000 identified as their program of study (SMO2).

⁴ The throughput analysis for the most recent three-year window, 2019-2022, is included in Appendix B. This analysis was added to address an ASCCC concern that statewide changes to placement processes and placement rules that took place in fall of 2019 broadened access to transfer-level courses and may have affected the findings. However, the findings remained consistent with the additional analysis. Even in the most recent three-year window, Business Administration students who directly enrolled in calculus were much more likely to complete calculus than students with the same level of high school math preparation who started in a transfer-level prerequisite.

⁵ Different course titles for Business Calculus include but are not limited to: Business Calculus, Calculus for Business and Social Science, Applied Calculus, Calculus with Applications, and Mathematical Analysis for Business.

⁶ Throughput calculations include students who may have received corequisite support when directly enrolled in Business Calculus.

⁷ High school integrated math courses are included and coded as IM2=Geometry, IM3/4=Algebra 2. HS Geometry includes students who completed high school geometry or lower. Completion means a grade of C or better.

⁸ See Appendix A for associated tables.

⁹ This comparison is specifically noted in this analysis because examining throughput to only Business Calculus for students who started in a transfer-level mathematics prerequisite would have omitted students who began in a prerequisite and then completed the mathematics requirement in a STEM Calculus course and thus lowered the throughput rate. In this way, the analysis produces the greatest throughput rate possible based on the course-taking of Business Administration students.

¹⁰ The students who are not in the gateway course but could have successfully completed it, in the absence of the previous throughput analyses, are otherwise invisible and the structural consequences that limit those students’ outcomes are far less directly observable.

¹¹ Conditional throughput is like a success rate in that it is the percentage of students who successfully complete a target course (e.g., Calculus) considering only those who enroll in that course. However, the time frames are different. Success rates typically account for successful completions within one academic term, but the conditional throughput extends the timeframe and considers all successful calculus completions within one year up to 10 years depending on the student’s start date.

¹² For this reason, the conditional throughput rates were higher than one-term success rates that may be more familiar to faculty.