FOOTHILL COLLEGE
INSTITUTIONAL RESEARCH & PLANNING

DATE: 2/14/2019

TO: AB 705 Implementation Team

FROM: Doreen Finkelstein, Research Analyst

RE: Success in Math 10 and Math 48A Under AB 705 for Fall 2018

Introduction:

The passage of Assembly Bill (AB) 705 removed barriers for the placement of students into gateway, transfer-level math (e.g., Math 10, Math 48A), with the goal of increasing the number of students who enroll in, and successfully complete, these courses within one year. Prior to AB 705, students received placements into these classes through a combination of their high school GPA, successful completion of high school mathematics coursework, and/or scoring high enough on a placement exam. In Fall 2018, these placement requirements were removed, and all Foothill College students became eligible to enroll directly into Math 10 (statistics) and Math 48A (precalculus).

To better support students who benefit from the increased access to transfer-level math, Foothill College's math department provided the following additional academic support to students in Fall 2018:

- Math 10 added tutors (in the form of embedded peer tutors and supplemental instructors[1]) in all sections except those taught exclusively online. These tutors gave in-class support and also provided workshops and tutoring at specified times outside of class.
- Math 48A added a corequisite, Math 248A, for students who did not place high enough to enroll in Math 48A on its own. Math 48A-only placement was achieved through a combination of high school GPA and successful completion of high school mathematics coursework, or if the student passed Foothill's prerequisite algebra course (Math 105) or its equivalent.

This study looked at 1) the number of students who passed transfer-level math in Fall 2018 compared to the previous year; 2) achievement gaps in Fall 2018 compared to Fall 2017; 3) whether the addition of tutors facilitated student success in Math 10; and 4) whether the addition of the corequisite facilitated student success in Math 48A.

Given the newness of AB 705 implementation and the complexity of factors influencing student success in these courses, these results should be considered as preliminary. Upcoming analyses will

[1] Embedded peer tutors were students who had previously passed the course; they regularly attended class meetings. Supplemental instructors were faculty members who were qualified to assist with teaching the course material; they attended class meetings once a week. Sections had either an embedded peer tutor or a supplemental instructor assisting with the class; the format was at the discretion of the instructor.

further investigate the potential underpinnings of the findings reported here, and further clarity may be reached as additional data becomes available over time.

Results Overview:

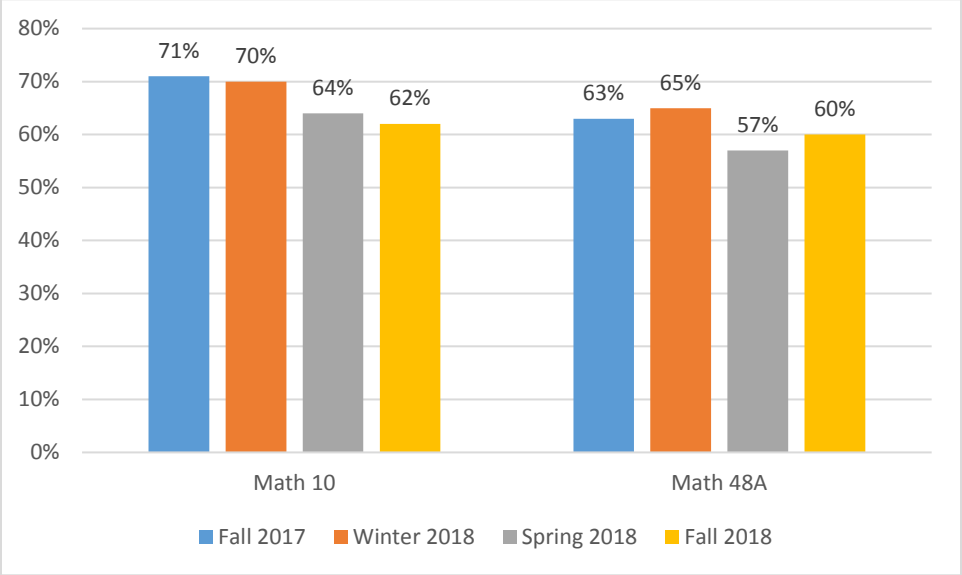
- Success results were in line with the goals of AB 705. There was a 27% gain in the number of students who successfully passed Math 10 in Fall 2018 (118 more students than Fall 2017), and a 31% gain in the number of students who successfully passed Math 48A in Fall 2018 (51 more students than Fall 2017).
- Achievement gaps showed the existence of disproportionate impact for Latinx students for both Math 10 and Math 48A. For Math 10, there was no appreciable change in achievement gaps for Latinx or African-American students in Fall 2018 compared to Fall 2017. For Math 48A, achievement gaps in Fall 2018 decreased for Latinx students (-13% vs. -9%) compared to Fall 2017.
- The addition of tutors to Math 10 in Fall 2018 was associated with improved course success, but only for students with higher high school GPAs. Upcoming research will further investigate possible mechanisms behind this finding.
- The addition of the Math 248A corequisite to Math 48A in Fall 2018 was associated with improved course success. Upcoming research will further investigate the specific factors that were present in the corequisite, or associated with the corequisite, that may be contributing to improved course success.

Results Detail:

Success Rates and Number of Students Passing

Chart 1 shows the success rates for Math 10 and Math 48A in Fall 2017, Winter 2018, Spring 2018, and Fall 2018. Because all students had access to these classes in Fall 2018, including lower-achieving students, the average success rates were expected to decrease. The Fall 2018 Math 10 success rate decreased by 9 percentage points compared to Fall 2017 (71% vs. 62%), although it was only 2 percentage points lower than the Spring 2018 success rate (64% vs. 62%). The Fall 2018 Math 48A success rate decreased by 3 percentage points compared to Fall 2018 (63% vs. 60%), but was actually higher than the Spring 2018 success rate (57% vs. 60%).

Chart 1: Success in Math 10 and Math 48A by Term, Fall 2017-Fall 2018



As more students accessed Math 10 and Math 48A in Fall 2018, the number of students who successfully passed these courses also increased. Table 1 compares the increased enrollment to the increased number of students who passed Math 10 and Math 48A in Fall 2017 vs. Fall 2018. For Math 10, an additional 277 students enrolled in Fall 2018 (45% gain vs. Fall 2017), and an additional 118 students passed (27% gain vs. Fall 2017). For Math 48A, an additional 100 students enrolled (38% gain vs. Fall 2017), and an additional 51 students passed (31% gain vs. Fall 2017).

Table 1: Math 10 and Math 48A Gain Enrollment and Gain in # Passed

	# Enrolled			# Passed		
	Fall 2017	**Fall 2018**	**Gain**	**Fall 2017**	**Fall 2018**	**Gain**
Math 10	619	896	277 (45%)	438	556	118 (27%)
Math 48A	264	364	100 (38%)	166	217	51 (31%)

Comparison of Achievement Gaps by Ethnicity and Gender

An analysis of success rates by student characteristics (e.g., ethnicity and gender) explores whether achievement gaps exist and, if so, whether they are increasing or decreasing over time. Gaps can also be analyzed using the percentage point gap method[2] in order to determine whether a group is or is not experiencing disproportionate impact — succeeding at rates that are statistically disproportionately lower than the success rate of the total student population.

Table 2 examines whether there was a decrease in Math 10 achievement gaps in Fall 2018 compared to Fall 2017. Overall, there were no large differences in the achievement gaps between the two years for Math 10; the gap for African-American students went from -6% to -8% (2 percentage point increase) while the gap for Latinx students went from -16% to -14% (2 percentage point decrease).

[2] California Community Colleges Chancellor's Office (2017). Retrieved from http://extranet.cccco.edu/Portals/1/TRIS/Research/Analysis/PercentagePointGapMethod2017.pdf

Using the percentage point gap calculation method, Latinx students experienced disproportionate impact in both Fall 2017 and Fall 2018 for Math 10.

Table 2: Achievement Gaps in Math 10 by Student Group

	Fall 2017			Fall 2018			
Student Group	**Head Count**	**% Passed**	**Gap**	**Head Count**	**% Passed**	**Gap**	**F17-F18 Gap Diff.**
By Ethnicity							
African American	23	65%	-6%	54	54%	-8%	+2%
Asian	185	86%	--	196	75%	--	--
Filipinx	41	71%	--	63	67%	--	--
Latinx	185	55%	-16%*	345	48%	-14%*	-2%
White	162	75%	--	219	74%	--	--
By Gender							
Female	369	71%	--	507	64%	--	--
Male	249	70%	--	381	60%	--	--

*Gaps that were disproportionate impact according to the percentage point gap method.

Note: Gaps were calculated as the success rate for all students minus the success rate for the student group. Negative gaps indicate that a student group's success is lagging behind the success of other students. Only gaps of -3% or greater are shown. Native American, Pacific Islander, and students who did not identify an ethnicity or gender are excluded due to low head counts.

Table 3 examines whether there was a decrease in Math 48A achievement gaps in Fall 2018 compared to Fall 2017. The gap for Latinx students decreased, going from -13% to -9% (4 percentage point decrease). Meanwhile, male students' achievement gap of -6% seemed to close from Fall 2017 to Fall 2018, but female students' achievement gap increased to -3% in Fall 2018.

Using the percentage point gap calculation method, Latinx students experienced disproportionate impact in both Fall 2017 and Fall 2018 for Math 48A.

Success Rates in Sections with Additional Support (Tutoring and Corequisite) in Math 10 and Math 48A

The California Community College Chancellor's (CCCCO) recommends additional support be provided to students with lower high school GPAs (below 2.3 for statistics and below 2.6 for precalculus). In Fall 2018, Math 10 added support in the form of tutors, and Math 48A added support in the form of Math 248, a corequisite. Did the sections with additional instructional support — tutors in Math 10, and the corequisite in Math 48A — have higher course success rates for students, particularly students with lower high school GPAs?

Table 3: Achievement Gaps in Math 48A by Student Group

	Fall 2017			Fall 2018			
Student Group	**Head Count**	**% Passed**	**Gap**	**Head Count**	**% Passed**	**Gap**	**F17-F18 Gap Diff.**
By Ethnicity							
Asian	88	72%		72	63%		
Filipinx	14	86%		19	74%		
Latinx	74	50%	-13%*	151	51%	-9%*	-4%
White	72	61%		97	69%		
By Gender							
Female	112	71%		141	57%	-3%	+3%
Male	150	57%	-6%	219	61%		no gap

*Gaps that were disproportionate impact according to the percentage point gap method.

Note: Gaps were calculated as the success rate for all students minus the success rate for the student group. Negative gaps indicate that a student group's success is lagging behind the success of other students. Only gaps of -3% or greater are shown. African American, Native American, Pacific Islander, and students who did not identify an ethnicity or gender are excluded due to low head counts. No Native American students enrolled in Math 48A in either term.

Use of Matched Students

In Fall 2017-Spring 2018, enrollment in Math 10 or in Math 48A without a corequisite meant that students received a placement through a combination of their high school GPA, previous coursework completion, or placement exam score. In Fall 2018, these requirements were removed for Math 10 students and for Math 48A/Math 248A students. Thus, students who took Math 10 in Fall 2018 were different from students who registered for the same course in the previous year; this dynamic also existed for students who in Fall 2018 enrolled in stand-alone Math 48A vs. those who were in Math 48A with the corequisite. For example, a greater number of students with lower high school GPAs were enrolled in Math 10 in Fall 2018 compared to the previous year, and a greater number of students with lower high school GPAs were enrolled in Math 48A/Math 248A compared to stand-alone Math 48A in Fall 2018. In order to account for these student differences, this study used statistical methods[3] to identify similar students among these groups, and used these students as the basis for comparison. This procedure is known as matching.

Using matched students, the study addressed the following questions by looking at similar students:

- Did students in Math 10 sections with tutoring show higher success rates?
- Did students in Math 48A sections with the corequisite show higher success rates?

Math 10

In Fall 2018, Math 10 added tutors in all sections except those taught exclusively online. Using a matched student sample, a logistic regression was performed to examine whether the addition of tutors

[3] A set of analyses were first run to determine variables that were a) predictive of course success, and b) differently distributed between the groups. Students were then matched using Mahalanobis Distance Matching, a technique that searches out the closest possible match on these variables. For more information, see the Appendix.

was associated with improved course success after controlling for other variables such as high school GPA. Results of the regression found tutors were associated with improved course success, but only for students with higher GPAs (p<.05; for more information, see Appendix).

Table 4 illustrates the regression finding by showing the success rates of matched students who took Math 10 in non-online courses in Fall 2017-Spring 2018 vs. Fall 2018. Success rates were higher in Fall 2018 for matched students with high school GPAs of 3.0 or above (79% vs. 72%) and high school GPAs between 2.3 and 2.9 (48% vs. 44%), but they were lower for matched students with high school GPAs of less than 2.3 (34% vs. 44%). In other words, students at the higher GPA band were more likely to be successful compared to last year's students, while students with lower GPAs were more likely to be less successful. This finding suggests that even with the addition of tutor support, less than half of the students with lower high school GPAs continue to experience non-success in Math 10.

Table 4: Math 10 Success Rates by High School GPA and Year
(Matched Students, Non-Online Sections)

	F17-Sp18		F18	
HS GPA Band*	Count	Passed	Count	Passed
GPA >=3.0	119	72%	194	79%
GPA 2.3-2.9	117	44%	192	48%
GPA <2.3	36	44%	59	34%

*GPA band categories are from CCCCO's AB 705 placement recommendations for statistics.

The analyses examined the influence of the two forms of tutoring aimed at facilitating student success: embedded peer tutors and supplemental instructors. Embedded peer tutors were students who had previously passed the course; they regularly attended class and held workshops outside of class multiple times per week. Supplemental instructors were non-credit faculty members qualified to assist with teaching the course material; they attended class meetings once a week and held tutoring sessions outside of class at least once per week. Table 5 compares the success rates of sections with an embedded peer tutor vs. a supplemental instructor. Overall, there was no difference in the success rate based on type of tutor (63% for peer tutors vs. 62% for supplemental instructors).

Table 5: Math 10 Success Rates by Type of Tutor
(All Students, Non-Online Sections)

Type of Tutor	Count	Passed
Embedded peer tutor	280	63%
Supplemental instructor	350	62%

Future research will investigate possible mechanisms behind these findings. For example, students with higher GPAs may have been more likely to attend the optional out-of-class workshops and tutoring sessions given by tutors, and may have had higher rates of interaction with their tutors during class sections.

Math 48A

In Fall 2018, Math 48A added a corequisite (Math 248A) that students were required to take unless they received a higher placement (achieved through a combination of high school GPA and successful completion of high school mathematics coursework) or had passed Foothill's prerequisite algebra course (Math 105) or its equivalent. Using a matched student sample, a logistic regression was performed to examine whether Math 248A improved course success after controlling for other variables such as high school GPA. Regression results show that the corequisite was associated with improved course success for all students, including those with lower GPAs ($p<.01$; for more information, see Appendix).

Table 6 illustrates the regression finding by showing the success rates of matched students who took Math 48A in Fall 2018 with or without Math 248A. Success rates were higher for students who took the corequisite in all three GPA bands.

Table 6: Math 48A Success Rates by High School GPA and Corequisite (Matched Students)

	No Coreq		Coreq	
HS GPA Band*	**Count**	**Passed**	**Count**	**Passed**
GPA >=3.4	10	55%	22	77%
GPA 2.6-3.3	32	36%	69	64%
GPA <2.6	25	41%	55	47%

*GPA band categories are from CCCCO's AB 705 placement recommendations for precalculus.

While enrollment in the corequisite was associated with improved performance in Math 48A, it is unclear what specifically occurred in Math 248A that facilitated course success. For example, students in the corequisite may have been more likely to attend optional out-of-class workshops and tutoring sessions that were available to all Math 48A students. Perhaps there were differences in instruction and pedagogy unrelated to the corequisite's curricular differences. Additionally, the curricular design to integrate Math 48A and Math 248A meant that it was more challenging to identify the specific corequisite components that facilitated success.

A survey of Fall 2018 Math 48A students was conducted in December 2018; the questions asked included whether the level of in-class support (reviews, individual or small-group time with the instructor or tutor) was about right, more than needed, or less than wished. The response rate for students enrolled in the corequisite was 29% (52 responses), while the response rate for students not in the corequisite was 21% (38 responses). As shown in Table 7, 85% of students in Math 248A reported that the level of in-class support was about right compared to 61% of Math 48A only (no corequisite) students. These students were also more likely to wish there was more in-class support (34%) than report there was more support than needed (5%).

Table 7: Fall 2018 Math 48A:
Rating of Level of In-Class Support by Coreq (Survey Results)

	No Coreq		Coreq	
Response	**Count**	**%**	**Count**	**%**
I wish there had been more in-class support	13	34%	4	8%
The level of in-class support was about right for me	23	61%	44	85%
There was more in-class support than I needed	2	5%	4	8%
Total	38	100%	52	100%

Note: Percents may not sum to 100 due to rounding.

Upcoming research will further analyze these survey responses and continue to investigate the factors associated with improved student success in the corequisite sections.

Methodology

Course enrollments, grades, and class modality (face-to-face, hybrid, online) were obtained from the ODS table Registration_Analysis, while student ethnicity and gender were obtained from the ODS table SS_Student_Term_Attributes. Information about which Math 48A sections required corequisites (Math 248A) was obtained from the college Active Division records. Information about the type of tutor present in each section was obtained through communication with the mathematics department. The survey was administered online in December 2018 to all students who were enrolled in Math 10 or Math 48A, and sent to students via the email address on file. Student groups were excluded from achievement gap analyses if head counts in both years were fewer than 15 students.

Appendix: Matching and Logistic Regression

Data categorization. Due to low head counts among some ethnicities, which would have led to difficulties in matching, a coarse matching approach was used for ethnicity: Asian or White vs. Not Asian or White. The category "Asian or White" included students who self-identified as Asian or White. The category "Not Asian or White" included students who self-identified as African-American, Filipinx, Latinx, Native American, or Pacific Islander. Students who listed "Decline to State" as their ethnicity or "N" as their gender were excluded, as were students with missing data, including those without a high school GPA on record at Foothill College.

Preliminary analyses. A set of analyses were first run to determine variables that were a) predictive of course success, and b) differently distributed between the groups. Based on these analyses, two variables were used for matching Math 10 across years: high school GPA, and the dichotomous ethnicity variable. Three variables were used for matching Math 48A/Math 248A to Math 48A a: high school GPA, the dichotomous ethnicity variable, and gender.

Matching. Matching was done through the R program MatchIt using Mahalanobis distance matching with replacement: Daniel E. Ho, Kosuke Imai, Gary King, Elizabeth A. Stuart (2011). MatchIt: Nonparametric Preprocessing for Parametric Causal Inference. Journal of Statistical Software, Vol. 42, No. 8, pp. 1-28.

Math 10 matching results. As shown below, matching successfully reduced the prior differences in high school GPA and ethnicity between the groups.

	Before matching		After matching	
	F17-Sp18	**F18**	**F17-Sp18**	**F18**
High school GPA	3.16	2.85	2.86	2.85
Ethnicity	0.53	0.62	0.62	0.62

Math 10 regression results. The logistic regression equation included main effects for Year (F17-Sp18 vs. F18), high school GPA, and ethnicity, and all 2-way interactions. The effect of interest for the purpose of this study was the Year_GPA interaction, which indicated that differences between the years (tutors vs. no tutors) was dependent upon the student's high school GPA. This interaction was significant at $p<.05$.

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Coefficients:
                 Estimate Std. Error z value Pr(>|z|)
(Intercept)      -4.34298    1.21288  -3.581 0.000343 ***
Year             -1.82387    0.97174  -1.877 0.060531 .
GPA_for_analysis  1.77315    0.41397   4.283 1.84e-05 ***
Ethnicity_dich    3.20869    1.22046   2.629 0.008561 **
Year_GPA          0.75811    0.34858   2.175 0.029643 *
Year_Ethnicity   -0.05635    0.13099  -0.430 0.667090
GPA_Ethnicity    -1.41094    0.42490  -3.321 0.000898 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Math 48A matching results. As shown below, matching successfully reduced the prior differences in high school GPA, ethnicity, and gender between the groups.

	Before matching		After matching	
	No coreq	**Coreq**	**No coreq**	**Coreq**
High school GPA	2.96	2.75	2.78	2.75
Gender	0.37	0.36	0.36	0.36
Ethnicity	0.47	0.29	0.29	0.29

Math 48A regression results. The logistic regression equation included main effects for Coreq (being enrolled in Math 248A), high school GPA, ethnicity, and gender. Two-way interactions were not included because preliminary analyses showed that none were significant. The effect of interest for the purpose of this study was the main effect of Coreq, which was significant at $p<.01$.

```
Coefficients:
                 Estimate Std. Error z value Pr(>|z|)
(Intercept)       -2.7497     0.8605  -3.196  0.00140 **
GPA_for_analysis   0.8795     0.3016   2.916  0.00354 **
Ethnicity_dich     0.3323     0.3220   1.032  0.30212
Gender_dich       -0.5765     0.3122  -1.846  0.06483 .
Coreq              0.8468     0.3113   2.720  0.00653 **
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
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