Assessing the Influence of Dana Center Mathematics Pathways on Dev-Ed Math Students' Early College Outcomes: Fall 2015 and 2016 Cohorts

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Every year, colleges enroll hundreds of thousands of students they deem underprepared for college coursework in remedial math courses. Some students quickly continue on to college-level math courses, which are often required for degree completion. Other students linger in these developmental education (or "dev-ed") math courses for years, either because they are assigned to longer sequences of remediation, struggle to pass these courses, or a combination of the two. Both dev-ed and college-level math requirements are significant barriers for many students, regardless of major (Bailey, Jeong, & Cho, 2010).

Given the challenges students face getting through dev-ed and entry-level college coursework, stakeholders, practitioners, and researchers recognize the need to improve dev-ed in general and dev-ed math in particular. There are two main structural reforms to dev-ed that allow students to more quickly enroll in college-level coursework (Schudde & Keisler, 2019). The first approach condenses long sequences of dev-ed coursework into shorter, accelerated courses that cover the same content in a single semester. The second approach allows students to enroll in college-level math at the same time as dev-ed math, where the dev-ed content is often reviewed "just in time" to support related college-level content. Additionally, because passing college algebra, in particular, is an obstacle for many students, other reforms allow students to enter non-algebra college math pathways where math coursework is aligned with their field of interest.

The Dana Center Mathematics Pathways (DCMP) model combines an accelerated dev-ed math sequence with alternative pathways for fulfilling college-level math requirements. In fall 2013, nine colleges in Texas piloted the model. The scale of the program grew in fall 2014, when 20 Texas community colleges began implementing DCMP. Students who might otherwise have taken multiple semesters of dev-ed math courses instead took one accelerated course. These accelerated courses were often taught using a curriculum, developed by the Dana Center, which emphasized application of math concepts to the real world. Students were advised to enroll in college-level math immediately afterward and were offered alternatives to college algebra (e.g. statistics) in order to fulfil their math requirement.

In this research brief, we use state administrative data to examine outcomes for Texas community college students who enrolled in a DCMP dev-ed math course in fall 2015 and fall 2016, comparing their outcomes with peers enrolled in other dev-ed math coursework. Recently, Schudde and Keisler (2019) showed promising results for the fall 2014 cohort of students enrolled in DCMP's accelerated dev-ed math, where enrolling in the course was linked to higher rates of taking and passing college-level math coursework by the end of a three-year follow-up period. We find evidence of improvements in college-level math course-taking as early as one semester after enrollment in the DCMP course (earlier than the improvements Schudde and Keisler observed). Our results bolster support for preliminary findings from a randomized controlled trial (RCT), which showed improvements in enrollment and passing college-level math by the subsequent semester for students who were randomly assigned to take DCMP's dev-

ed course instead of a traditional dev-ed math course (Zachry Rutschow, 2018). We use state administrative data from all implementing colleges in Texas. Although our approach does not allow us to capture causal effects, as in the RCT, using statewide data allows us to examine differences in the backgrounds of all students enrolled in DCMP and traditional dev-ed courses and explore the impact of the DCMP model across the state.

Table 1 presents summary statistics for all students who were enrolled in dev-ed math at Texas community colleges in fall 2015. We focus on the fall 2015 cohort because we have more long-term data for those students, but we also present preliminary results for the fall 2016 cohort throughout the report. The first two columns include all students enrolled in dev-ed math in fall 2015, broken into those enrolled in DCMP classes and non-DCMP classes at colleges that offered DCMP. The second two columns include only students in their first semester of college (referred to as "first time in college" or FTIC students), broken into the same categories. Within each type of dev-ed enrollment at DCMP-offering colleges, FTIC students comprised of approximately 45% of the dev-ed enrollees.

Table 1. Summary Statistics for Students in Dev-Ed Math in Fall 2015

	All Dev-Ed Math Students			FTIC Students Only		
	DCMP Classes [1]	Non-DCMP Classes [2]	Non-DCMP Colleges [3]	DCMP Classes [4]	Non-DCMP Classes [5]	Non-DCMP Colleges [6]
Students (count)	4461	24394	56425	2129	10852	24008
Course Enrollments (count)	4544	26536	62420	2166	11853	27661
Pass Rate	68.46%	64.63%***	65.39%***	71.16%	67.90%**	70.95%
Demographics						
Female	64.10%	60.79%***	60.89%***	60.31%	57.98%*	57.04%**
Race						
White	43.75%	25.71%***	26.30%***	43.17%	23.17%***	26.10%***
Asian	1.14%	1.37%	2.82%***	1.27%	1.27%	2.69%***
Black	21.08%	16.16%***	18.98%**	18.55%	13.98%***	15.64%***
Hispanic	31.27%	53.76%***	48.54%***	34.38%	58.98%***	52.45%***
Other	2.76%	3.00%	3.36%*	2.63%	2.61%	3.12%
Age						
0-19	52.21%	49.72%**	47.79%***	81.12%	80.28%	80.04%
20-24	21.15%	24.14%***	25.43%***	10.38%	11.23%	11.20%
25+	26.64%	26.14%	26.78%	8.50%	8.49%	8.76%
Placement Test						
Has TSI Score Record	67.88%	53.06%***	50.78%***	87.74%	66.55%***	70.89%***
Average TSI Score	333.90	331.17***	333.14***	336.09	332.68***	334.66***
Has Any Test Score Record	69.76%	57.01%***	52.94%***	88.40%	67.28%***	71.77%***

Mean Z-Score (Any Test)	-0.56	-0.74***	-0.61***	-0.48	-0.70***	-0.57***
Financial Aid						
Has FADS Record	31.02%	29.75%†	29.00%**	3.24%	2.99%	2.57%†
Average Student Income	$22582	$21417	$21122	$6871	$15923*	$19501**
Average Family Income	$47753	$41121**	$41863*	$30784	$37994	$44048
Average Family Contribution	$2604	$2167†	$2295	$1314	$1895	$2959
Average Unmet Need	$8259	$9263**	$8014	$13196	$33968***	$11990

Notes: The table presents summary statistics for students enrolled in dev-ed math in fall 2015. It separately present results for students enrolled in: a DCMP dev-ed math course at a DCMP-offering college, a non-DCMP dev-ed math course at a DCMP-offering college, and a non-DCMP math course at a college that did not offer DCMP. The first set of columns presents results for all dev-ed math students and the second set presents results for First Time In College (FTIC) Students only. A student enrolled in two categories of dev-ed math (e.g. a student taking DCMP-accelerated dev-ed math as well as another dev-ed math course at the same college) is counted once in each column. The row "Course Enrollments" counts the number of course enrollments in the given category of dev-ed math, which may be more than one per student. Other than that row, students are only counted once per column. The "Placement Test" section is based on TSI Report records from the THECB. Such records do not always include test scores. A student is counted as having a TSI score record if, within five years previous to Fall 2016 (the window of validity for placement test scores), the student has a TSI Report record with a score from the math TSI test. Similarly, a student is counted as having any test score record if they have a record with a score from any math placement test within five years.

Table 1 illustrates that students in DCMP classes were more likely to be white, female, and fall into the youngest age group (19 years old or younger—students who immediately transitioned to college) than students in non-DCMP classes. They were also much more likely to have test scores records from the Texas Success Initiative assessment (TSI) (the mandated placement test in Texas)[1], and, conditional on having scores, their scores tended to be a little higher. There also appear to be some differences in both student and family income measure across students in DCMP and non-DCMP classes; DCMP students had slightly higher average incomes and lower unmet financial need. However, most students did not have financial aid records containing this information—among all students, under a third of students filed for financial aid. Students who enrolled in non-DCMP dev-ed math classes at colleges that offered DCMP were similar to students in dev-ed math at other colleges. Appendix Table A1 shows qualitatively similar summary statistics for the fall 2016 cohort of dev-ed math students. Our main takeaway from these descriptive patterns is that there appears to be systematic differences between students enrolled in DCMP compared with other dev-ed coursework.

The systematic differences across DCMP and non-DCMP students motivated our inclusion of various controls in the regression analysis. We estimated a linear probability model of the impact, for students in dev-ed math at DCMP colleges, of enrollment in DCMP-accelerated dev-ed math on the probability of passing college math within 2 years (or within 1 year, for specifications performed on students from the fall 2016 cohort). In Table 2, we present coefficient estimates from those regressions. Column 1 shows that fall 2015 DCMP students

[1] The Texas Higher Education Coordinating Board published an overview of the TSI placement test here: http://www.thecb.state.tx.us/reports/PDF/9055.PDF

were around 6 percentage points more likely to pass college math within 2 years, prior to controlling for student background. In column 2, we introduce demographic controls, which do not change the estimate much.

In our preferred specification in column 3, we also control for TSI score, a potential predictor of passing college math. Once we control for TSI score, DCMP students no longer appeared more likely than their peers to pass their dev-ed math course. DCMP were somewhat less likely to persist to the next semester, but also appear much more likely to enroll in a college-level math course that term, where participating in DCMP's dev-ed course in fall 2015 increased the probability of enrolling in college-level math in the next term by 15.6 percentage points. Within two years, students in DCMP's dev-ed math course were 8.7 percentage points more likely to enroll in college-level math and 3.6 percentage points more likely to pass college math than their peers in the non-DCMP dev-ed sequence. We should expect that there is a larger effect in the short term (the next semester outcomes), since students in DCMP-accelerated classes are on a path to take fewer dev-ed math courses overall and enroll in college math earlier. We also estimated some specifications which included family and student income as controls, but the sample proved to be too small to get precise estimates (available upon request).

Column 4 shows results for the fall 2016 cohort of dev-ed math students at colleges offering DCMP classes, but, due to a shorter follow-up period, the long-term dependent variables capture the probability of enrolling in and passing college math within 1 year rather than 2 years. The short-term (next semester) results from the fall 2016 are smaller in magnitude than those observed from the sample of fall 2015 students. Column 5 pools the fall 2015 and fall 2016 cohorts to show the combined DCMP results within 1 year. The point estimates from the combined cohorts are a little higher for immediate passing of dev-ed math and somewhat lower for most other outcomes than our preferred specification from the 2015 cohort.

Table 2. Impact of DCMP-Accelerated Dev-Ed Math

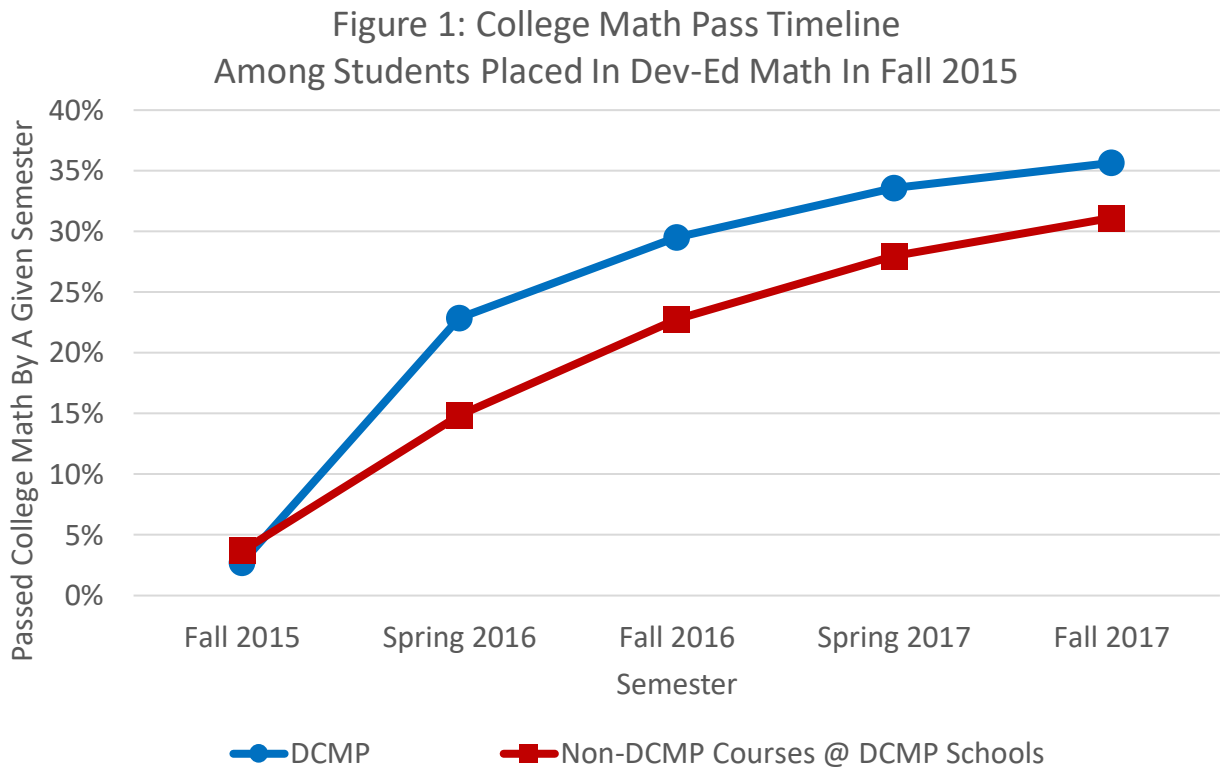
	Fall 2015 Cohort			Fall 2016 Cohort	Combined
	No Controls	Only Demographic Controls	Full Controls	Full Controls	Full Controls
Dependent Variable	[1]	[2]	[3]	[4]	[5]
Passed Dev-Ed Math	0.048***	0.052***	0.008	0.087***	0.055***
	(0.010)	(0.010)	(0.012)	(0.011)	(0.008)
Next Semester:					
Enrolled In College	-0.018**	-0.015**	-0.019**	0.005	-0.005
	(0.007)	(0.007)	(0.009)	(0.008)	(0.006)
Enrolled in College-Level Math	0.157***	0.155***	0.156***	0.089***	0.117***
	(0.007)	(0.007)	(0.009)	(0.007)	(0.006)

Passed College-Level Math	0.056*** (0.008)	0.053*** (0.008)	0.039*** (0.010)	0.029*** (0.008)	0.033*** (0.006)
College Credits Attempted	1.662*** (0.088)	1.435*** (0.089)	1.418*** (0.111)	0.774*** (0.094)	1.046*** (0.071)
College Credits Earned	1.004*** (0.080)	0.838*** (0.082)	0.715*** (0.102)	0.471*** (0.087)	0.569*** (0.066)
Subsequent Years:	Within 2 Years			Within 1 Year	
Enrolled In College Math	0.096*** (0.009)	0.094*** (0.009)	0.087*** (0.011)	0.059*** (0.009)	0.070*** (0.007)
Passed College Math	0.059*** (0.008)	0.060*** (0.008)	0.036*** (0.010)	0.048*** (0.008)	0.042*** (0.006)
N	28111	27015	14883	23515	38398

Notes: The table presents the regression coefficients representing the relationship between being enrolled in DCMP-accelerated dev-ed math courses compared with enrollment in non-DCMP dev-ed math courses. Columns [2]-[5] include controls for gender, race, age, and whether the student was first-time-in-college (FTIC). Columns [3]-[5] also include a control for students' TSI math placement test scores, and those regression analyses exclude students without TSI score records. Full set of regression results are available from the authors upon request.

In Figure 1, we examine how acceleration and the yearlong math experience, where students are encouraged to immediately enroll in college-level math, predict the timing of completing college-level math. The figure shows the portion of students enrolled in DCMP and non-DCMP dev-ed math courses in fall 2015 who passed college math by each subsequent semester. There is a clear gap starting in spring 2016. The gap narrows over time, but remains significant through fall 2017, two years after the initial dev-ed course. These lines flatten out over time, as fewer additional students in a given cohort continue to pass college math. It seems possible that the gap in passing college math after two years may be close to the gap in passing college math much further out in time, given the slowdown in additional course completion. In the Appendix, Figure A1 shows the same graph with the outcome variables after controlling for race, gender, age group, FTIC status, and TSI score; the results are qualitatively similar.

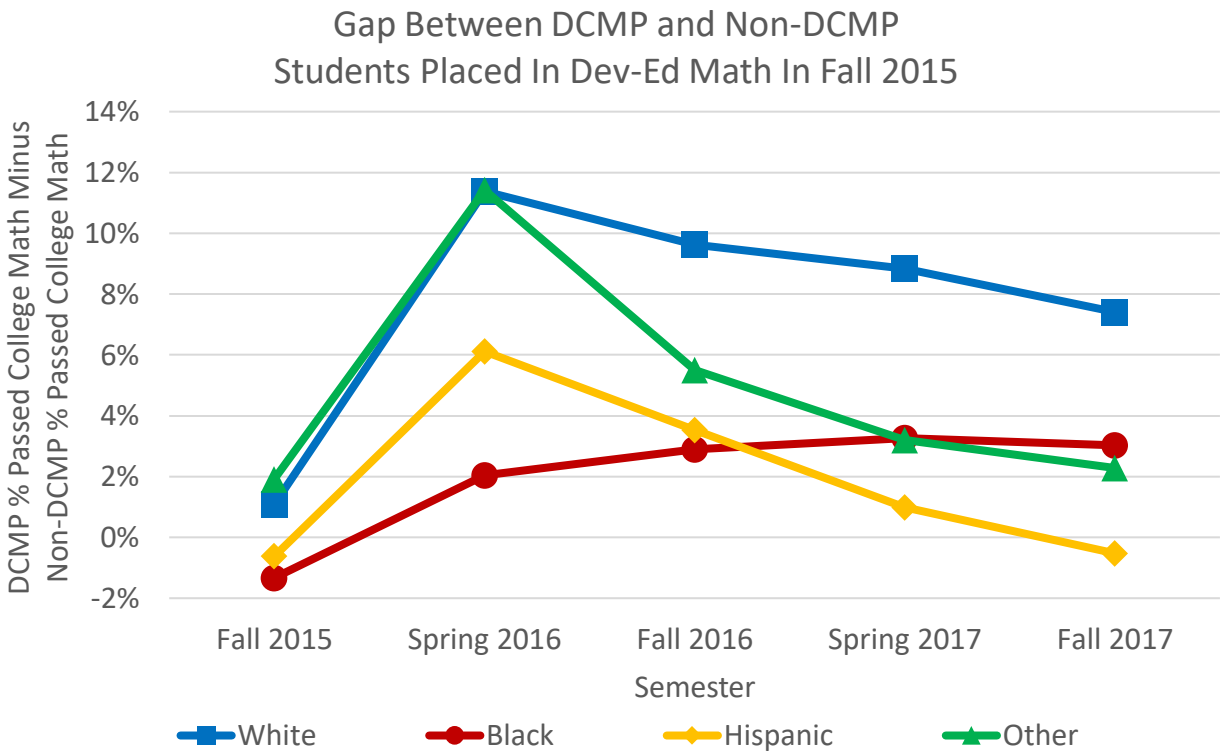
Figure 1



Notes: Lines show when DCMP and non-DCMP dev-ed math students in the fall 2015 cohort passed college math for the first time. A small number of students had already passed a college-level math course but had nevertheless been enrolled in dev-ed math in fall 2015.

We were also interested in variation in the impact of DCMP-accelerated dev-ed math and examine heterogeneity by race in Figure 2. Rather than show the pass rates of DCMP and non-DCMP students against each other, Figure 2 shows, for each racial or ethnic group, the gap in passing rates between DCMP and non-DCMP students. Whereas white students gained a substantial long-term advantage by enrolling in DCMP, the gains of Hispanic and other students seem to have diminished over time. For black students, participating in DCMP did not initially increase passing college-level math as substantially as for other groups, but black students showed a gradual increase in passing rates where the DCMP advantage slowly grew over time). No racial group exhibits negative effects of DCMP in the long run. It is possible that of the dramatic increase in passing college math in spring 2016 among Hispanic and other race students levels out over time because those students had a greater propensity to eventually take college math, where DCMP still seems to increase college-level math taking (and passing) among white and black students two years later.

Figure 2



Notes: The blue line shows the difference between the percentage of white students placed into DCMP-accelerated dev-ed math in Fall 2015 who passed college math by a given semester and the percentage of white students in non-DCMP dev-ed math who passed. Other lines for other races/ethnicities.

Implications of Results

Overall, DCMP appears to be effective at accelerating community college students through their math requirements. Students enrolled in a DCMP-accelerated dev-ed math course are 5 to 9 percentage points more likely to pass college level math within one semester and 3 to 5 percentage points more likely to pass college math within two years than their peers in non-DCMP dev-ed math. DCMP offers students an immediate boost in college-level math enrollment and completion.

Although some non-DCMP students catch up over time, the acceleration in meeting the math completion milestone represents time and effort saved for DCMP students. Conditional on eventually passing college math, completing the requirement a semester or two earlier may be a substantial benefit, as it could allow students to graduate earlier and receive full-time wages for several additional months. Further, some DCMP students (mostly White and Black students, as illustrated in Figure 2) pass college-level math who may not pass otherwise.

Given the positive relationship between DCMP dev-ed participation and important college outcomes, the systematic sorting we observed in which students get access to DCMP is concerning. DCMP-implementing colleges tend to assign younger, whiter students with higher TSI scores to DCMP's dev-ed course compared with traditional dev-ed math courses. Because dev-ed math innovations may be an opportunity for struggling students to succeed in college, colleges' placement practices have important implications for equity, especially when they allow some students to accelerate their progress through dev-ed and college requirements, while others are left with the status quo. We recommend additional inquiry into the placement procedures colleges use to determine who participates in the DCMP-accelerated dev-ed coursework. Working with colleges to determine equitable approaches to selecting students for participation could ensure the model is more accessible for all students.

References

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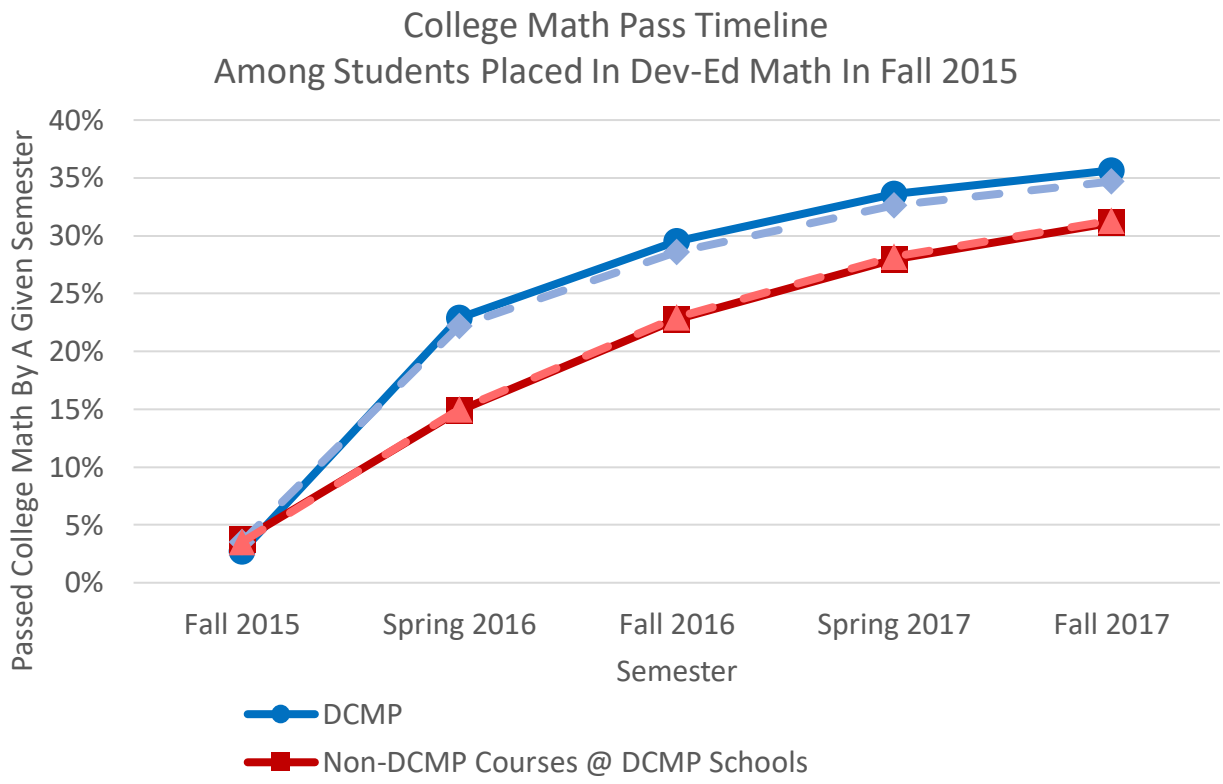
APPENDIX

Table A1. Summary Statistics for Students in Dev-Ed Math in Fall 2016

	All Dev-Ed Math Students			FTIC Students Only		
	DCMP Classes [1]	Non-DCMP Classes [2]	Non-DCMP Colleges [3]	DCMP Classes [4]	Non-DCMP Classes [5]	Non-DCMP Colleges [6]
Students (count)	5896	38638	44619	2946	17502	17856
Course Enrollments (count)	7063	41321	49301	3636	19049	20640
Pass Rate	73.91%	65.41%***	62.98%***	78.21%	70.33%***	70.36%***
Demographics						
Female	64.81%	60.00%***	61.16%***	62.86%	57.63%***	57.47%***
Race						
White	41.23%	23.86%***	25.12%***	40.29%	21.79%***	25.28%***
Asian	1.61%	2.43%***	2.28%***	1.56%	2.12%*	2.08%*
Black	14.80%	16.88%***	19.13%***	13.03%	13.55%	14.81%**
Hispanic	38.81%	54.61%***	50.64%***	41.31%	60.55%***	55.54%***
Other	3.55%	2.22%***	2.83%**	3.80%	2.00%***	2.28%***
Age						
0-19	56.86%	53.30%***	47.37%***	80.21%	80.48%	77.93%**
20-24	20.64%	23.33%***	25.34%***	10.42%	10.67%	12.34%**
25+	22.50%	23.37%	27.29%	9.37%	8.85%	9.73%
Placement Test						
Has TSI Score Record	70.12%	54.49%***	55.26%***	81.47%	64.74%***	70.08%***
Average TSI Score	334.07	332.46***	332.17***	335.65	333.78***	333.40***
Has Any Test Score Record	71.69%	56.19%***	56.41%***	81.74%	65.04%***	70.43%***
Mean Z-Score (Any Test)	-0.63	-0.74***	-0.73***	-0.58	-0.70***	-0.72***
Financial Aid						
Has FADS Record	25.90%	28.47%***	31.06%***	3.77%	3.29%	2.14%***
Average Student Income	$20212	$21140	$21322	$23938	$16638	$17144
Average Family Income	$46030	$43979	$44204	$55316	$41755	$48870
Average Family Contribution	$3218	$2547	$2589	$3032	$1743	$2916
Average Unmet Need	$6967	$7693***	$7143	$7196	$6040	$7396

Notes: The table presents summary statistics for students enrolled in dev-ed math in fall 2016. It separately present results for students enrolled in: a DCMP dev-ed math course at a DCMP-offering college, a non-DCMP dev-ed math course at a DCMP-offering college, and a non-DCMP math course at a college that did not offer DCMP. The first set of columns presents results for all dev-ed math students and the second set presents results for First Time In College (FTIC) Students only. A student enrolled in two categories of dev-ed math (e.g. a student taking DCMP-accelerated dev-ed math as well as another dev-ed math course at the same college) is counted once in each column. The row "Course Enrollments" counts the number of course enrollments in the given category of dev-ed math, which may be more than one per student. Other than that row, students are only counted once per column. The "Placement Test" section is based on TSI Report records from the THECB. Such records do not always include test scores. A student is counted as having a TSI score record if, within five years previous to Fall 2016 (the window of validity for placement test scores), the student has a TSI Report record with a score from the math TSI test. Similarly, a student is counted as having any test score record if they have a record with a score from any math placement test within five years.

Figure A1



Notes: Solid lines show when accelerated and non-accelerated students in the Fall 2015 cohort passed college math for the first time. Dotted lines show the same timeline but passing college math is residualized on race, gender, age group, TSI score (the value is the residual from a regression of passing college math by a given semester on race, gender, age group, TSI).