CAPR | CENTER FOR THE ANALYSIS OF POSTSECONDARY READINESS

Research Brief \ May 2017

Math in the Real World: Early Findings from a Study of the Dana Center Mathematics Pathways

Elizabeth Zachry Rutschow, John Diamond, and Elena Serna-Wallender
MDRC

Overview

Until recently, most colleges required students to pass a college-level algebra course in order to earn a degree. As many as 50 percent to 70 percent of community college students enter college unprepared to take these courses, and fewer than 20 percent of such students ever successfully complete a college-level math course; the rest are effectively blocked from achieving a college degree. In 2012, the Charles A. Dana Center at the University of Texas at Austin introduced the Dana Center Mathematics Pathways (DCMP, formerly known as the New Mathways Project), which aims to revise the structure, content, and pedagogy of developmental and college-level math classes in an effort to improve students' outcomes. In 2014, the Center for the Analysis of Postsecondary Readiness, with support from the U.S. Department of Education's Institute of Education Sciences, partnered with the Dana Center to launch a rigorous evaluation of the DCMP. Overall, the findings are encouraging; DCMP students are having qualitatively different classroom experiences from those of students in traditional developmental math courses and enrolling in and passing these courses at higher rates. However, work still needs to be done to ensure that all eligible students are correctly advised into these new pathways and that their math credits will transfer seamlessly to four-year college partners.

Introduction

Solve for x: $2x^2 + 4x - 4 = 0$

Factor out the greatest common polynomial:
$8x^4 - 4x^3 + 10x^2$

Solve the following system of equations:
$x - 2y + 3z = 7;$
$2x + y + z = 4;$
$-3x + 2y - 2z = -10$

Though many students may not have realized it, the success of their college careers may heavily depend on their ability to solve math problems like these.[1] Skills such as solving quadratic equations, factoring polynomials, and solving trivariable linear systems are critical for success in a college-level algebra class, which many colleges still require students to pass as part of their bachelor's or associate's degree requirements.[2] However, recent studies have shown that anywhere from 50 percent to 70 percent of entering community college students are not prepared to attempt these classes. Instead, they must take one to four levels of developmental math, a set of preparatory courses that aim to build students' skills, before they can enroll — and hopefully succeed — in college-level math. Few students enroll in and successfully complete these developmental course sequences.[3] For instance, in one sample of mostly urban community colleges, fewer than 20 percent of students made it out of developmental math to successfully complete a college-level math course within a three-year period; the rest were effectively blocked from achieving a college degree.[4]

This research brief analyzes the attempt of a promising new intervention, the Dana Center Mathematics Pathways (DCMP, formerly known as the New Mathways Project), to help students succeed in an accelerated and revised developmental math course aimed at preparing them for entry into a college-level course within one semester. In the past decade, education reformers have sought to reduce students' time in developmental math using different techniques, such as compressing math instruction into short time periods, dividing curricula into small modules with students taking only the modules they need, or allowing developmental students to bypass developmental courses altogether and enroll directly in college-level classes.[5] Other reformers, such as the Charles A. Dana Center at the University of Texas at Austin (Dana Center), the Carnegie Foundation for the Advancement of Teaching (Carnegie), and the California Acceleration Project, seek to improve the content and pedagogy of these courses to make math courses more engaging and relevant to students' lives. These reforms align math content with students' intended careers, with college algebra required only for certain majors; present math in the context of real-world problems; and develop active learning approaches that better engage students in the learning process.[6]

Descriptive and quasi-experimental research studies have shown that many of these programs have promise.[7] For instance, in 2015, Tennessee began using a corequisite math model for all entering community college students in need of remediation, enrolling them into a college-level math class with additional academic support. The students entering in 2015 passed the relevant first-level college math course within one year at four times the rate of the students who had entered in 2012.[8] Similarly, the results from descriptive studies of Statway and Quantway, Carnegie's yearlong developmental and college-level math pathways, and of the DCMP revealed that two to three times as many pathways students enrolled in and passed a college-level math class as did students in the traditional sequence.[9] Despite the promising outcomes, no experimental studies have been conducted to date on these math reforms.

To better understand the effects of these reforms, the Center for the Analysis of Postsecondary Readiness (CAPR) launched a random assignment study of the DCMP in 2014. Funded by the U.S. Department of Education's Institute of Education Sciences (IES), CAPR is co-led by MDRC, a nonprofit, nonpartisan education and social policy research organization, and the Community College Research Center at Teachers College, Columbia University. The DCMP evaluation is one of three major studies being carried out by CAPR. Overall, the evaluation is examining the effects of a two-semester math intervention. This report provides an early look at part of that intervention: the first-semester outcomes of developmental students enrolled in the DCMP's accelerated developmental math course in comparison with outcomes for students enrolled in traditional developmental math sequences.

Skills such as solving quadratic equations, factoring polynomials, and solving trivariable linear systems are critical for success in a college-level algebra class.

Overall, the findings are modestly encouraging: The curriculum and pedagogy of the DCMP developmental math courses have been implemented with fidelity, and students in these classes are generally having a qualitatively different experience with math classroom instruction. Additionally, after one semester, DCMP students were more likely to have enrolled in and passed

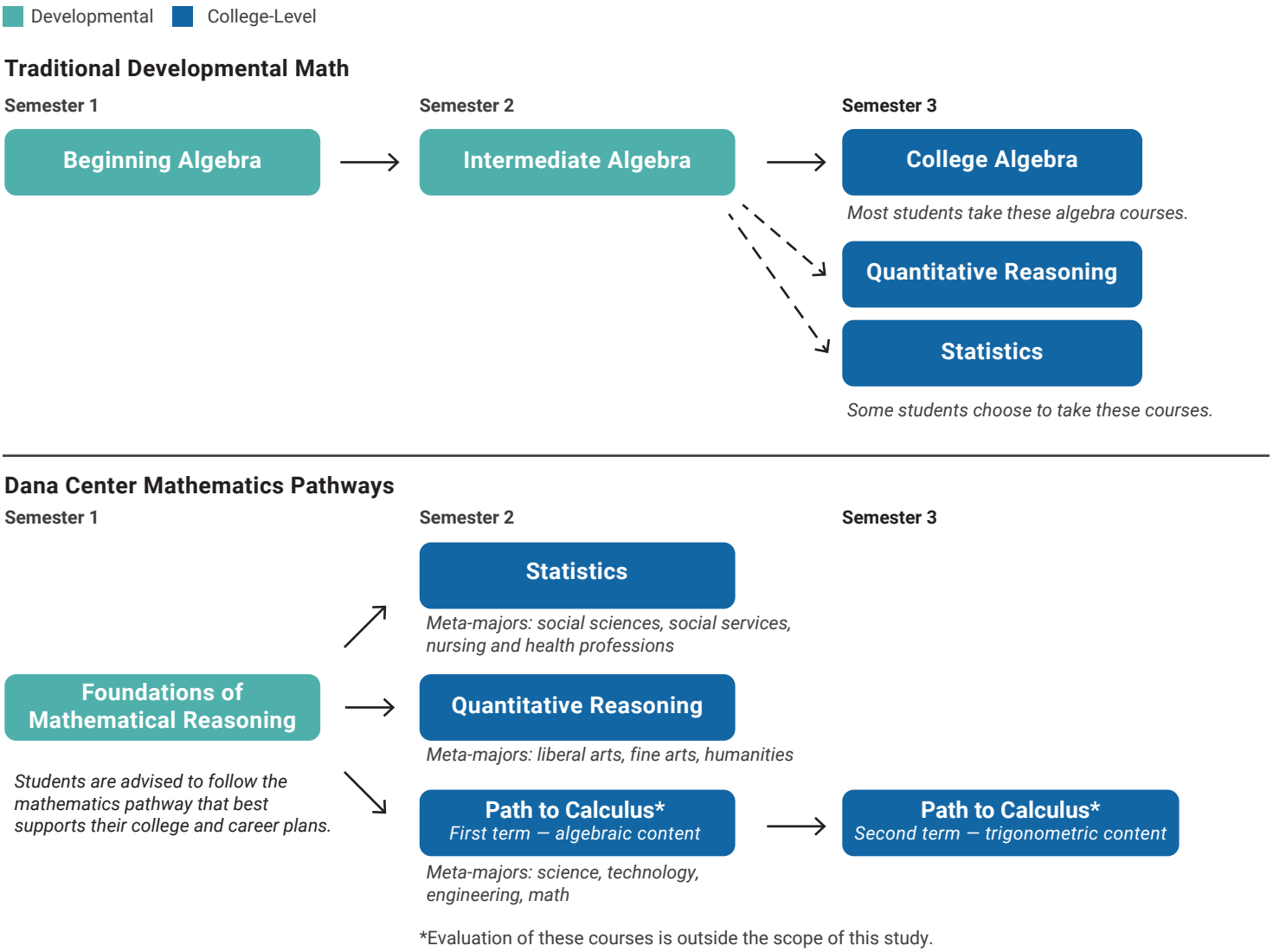
developmental math courses and earned developmental math credits than students assigned to the traditional math sequence, suggesting that DCMP students are making faster progress to and through their developmental math sequences. However, the additional time required to advise students into multiple math pathways and the need to ensure that math requirements align with those of four-year transfer colleges continue to present challenges at some of the colleges.

The Dana Center Mathematics Pathways

Building on their alliance with Carnegie in creating Statway and Quantway in 2010, the Dana Center launched the DCMP in collaboration with the Texas Association of Community Colleges (TACC) in spring 2012. Similar to Statway and Quantway, the DCMP seeks to alter the traditional sequencing, content, and pedagogy in developmental and college-level math courses by offering a revised developmental math course that emphasizes statistical and quantitative reasoning skills. The DCMP also provides models for three alternative college-level math pathways — statistics; quantitative reasoning; and a path to calculus for science, technology, engineering, and mathematics (STEM) majors — which are intended to better align with students' intended fields of study (see Figure 1).[10]

Unlike traditional developmental math courses, which tend to focus primarily on algebraic concepts such as linear equations, exponents, and manipulating formulas,[11] the DCMP developmental math course, Foundations of Mathematical Reasoning (Foundations), emphasizes the development of students' numeracy, statistics, and algebraic reasoning skills.[12] The Foundations curriculum is grounded in the Dana Center's eight curriculum design standards,[13] which emphasize active learning environments where students work closely with one

FIGURE 1. A Comparison of Mathematics Offerings for Students with Two Levels of Developmental Need



*Evaluation of these courses is outside the scope of this study.

another to solve math problems that are embedded in the context of real life. Rather than being presented with formulas or algorithms, DCMP students are expected to wrestle with larger mathematical ideas and apply previously learned concepts in multistep math problems, which are often presented in narrative form or require students to dissect and compare math figures, graphs, or tables. Instructors are encouraged to promote students' constructive perseverance — the ability to struggle through challenging concepts and understand the role that struggle plays in learning. Course materials integrate content from other academic disciplines, such as health and science, and students are expected to develop multiple strategies for solving complex mathematical problems. Additionally, the course seeks to develop students' reading and writing skills more fully, as students are routinely engaged with word problems and asked to provide written explanations of their solutions.[14]

These types of instructional approaches differ markedly from the approaches often used in traditional developmental math courses, most of which are heavily focused on algebra with content taught primarily through lecture rather than more student-centered approaches. Traditionally, instruction tends to revolve around procedural understandings of algebraic content, often through the memorization of particular formulas or rules for solving equations with little to no real-world application. Finally, any writing or reading, if present, tends to take place through note taking or textbook reading, respectively. The pervasiveness of technology varies, though it has become more important as the use of computer tutorials such as MyMathLab has increased.[15]

Upon successful completion of the Foundations course, students enter a one-semester, college-level statistics or quantitative reasoning course or begin a two-semester path to calculus (see Figure 1).[16] The Dana Center developed curricula that emphasize similar learning approaches for these courses as well, but the DCMP allows for institutions to offer existing statistics and quantitative reasoning courses that may or may not emphasize this type of instruction. Students who successfully complete the statistics or quantitative reasoning courses have generally met the transferable, college-level math requirement for their major; path-to-calculus students need two semesters to complete their entry-level math requirements to become ready for calculus or other higher-level math courses that their majors might require.

The Evaluation

This evaluation employs a random assignment design to determine the effects of the DCMP by comparing the outcomes for students referred to the DCMP courses with outcomes for students in the traditional developmental and college-level math course sequence.[17] Because the path to calculus was still under development at the start of the study, only the DCMP statistics and quantitative reasoning course pathways were included in the evaluation. Four colleges implementing the DCMP agreed to participate in the study: Brookhaven College and Eastfield College, both part of the Dallas County Community College System; El Paso Community College; and Trinity Valley Community College in East Texas. At all the colleges, faculty members teaching DCMP classes generally volunteered to do so and received at least one week of training in the DCMP course content and approach.[18]

Students in DCMP classes are generally having a qualitatively different experience with math classroom instruction. . . . In traditional classes, instruction tends to involve the memorization of particular formulas or rules for solving equations with little to no real-world application.

Eligible (as defined below) and interested students at these colleges were randomly assigned either to the program group, which had the opportunity to enroll in a DCMP sequence, starting with the developmental Foundations course followed by a college-level statistics or quantitative reasoning course; or the standard group, which received the colleges' traditional developmental and college-level math course sequences. Because assignment to the research groups is random, any differences in the outcomes of students in the program and standard groups can be attributed with a high level of confidence to the program itself, rather than to other differences such as prior math achievement or motivation.

In addition to assessing the program's impact on student outcomes, this study examines the implementation of the DCMP and faculty, staff, and student experiences in DCMP and standard courses through classroom observations, interviews, and focus groups, as well as through a student survey. A cost-effectiveness study is also planned.[19] The key research questions are these:

1. Do DCMP students have better academic outcomes than students in traditional developmental math programs? Are these outcomes mediated through changes in student engagement?
2. To what degree is there fidelity to the DCMP model across

colleges? What aspects of the DCMP are consistent across sites? What adaptations were made and why?

3. How do the curriculum and pedagogy differ between the DCMP courses and the colleges' traditional developmental math courses?
4. Is the DCMP cost-effective relative to business as usual?

This report provides beginning answers to the first three research questions concerning students' first-semester experiences in the program, when most students were enrolled in developmental courses. The findings reported here are based on both qualitative and quantitative data on the experiences and outcomes of the first two cohorts of students in the study (those entering the program in the fall 2015 and spring 2016 semesters). Full results of the study, including students' progress into and through college-level courses, will be provided in a final report in 2019.

Preparing for DCMP Implementation

The DCMP Foundations course was targeted to students who (1) were in need of one or two developmental math courses and (2) were pursuing the humanities and social sciences majors that allowed statistics or quantitative reasoning to satisfy students' college-level math requirements. Ensuring eligibility by major entailed a good deal of preparation before implementation, as colleges generally had to revise institutional and course policies to allow statistics or quantitative reasoning (rather than just algebra) to satisfy the math prerequisites in certain courses or majors. Additionally, colleges had to negotiate with their partner four-year institutions to ensure these new math courses aligned across institutions and would transfer seamlessly. Finally, colleges had to alter their advising procedures to more deliberately identify students' intended majors in order to determine the most appropriate math pathway for them. Though these revisions were made to assist with the smooth implementation of the DCMP, they were changes to larger institutional policies and thus affected students outside the evaluation as well. Both CAPR and the Dana Center provided assistance to the colleges with this upfront work, as these policy changes were crucial to the study colleges' ability to expand the new math sequences.[20] Most colleges began offering DCMP Foundations before successfully instituting all these changes, and they continued throughout the year to work on better aligning policies and processes related to course transfer and advising practices with the DCMP model. This is discussed further in the "Implementation Findings" section.

Characteristics of Students in the Study

Table 1 presents selected characteristics of the 594 students discussed in this report. These students enrolled in the study in the fall 2015 and spring 2016 semesters.[21] The statistics shown in

TABLE 1. Selected Characteristics of Students in the Study, Fall 2015 and Spring 2016 Cohorts

Characteristic	Full Sample
Age (years)	23.3
Gender (%)	
Female	64.0
Missing	8.9
Race/ethnicity (%)	
White	13.3
Black	10.4
Hispanic	52.9
Other	2.7
Missing	20.7
Planned full-time enrollment (12 credits or more) this semester (%)	56.3
Has failed a high school or college math class in the past (%)	34.2
Missing	7.4
Math placement[a] (%)	
College-ready	2.5
Placed 1 level below college-ready	14.0
Placed 2 levels below college-ready	82.7
Placed 3 levels below college-ready	0.8
Sample size	**594**

SOURCES: Authors' calculations using data from baseline survey of students participating in the study and administrative student data. Baseline survey was administered to students immediately before random assignment, during the study intake process.

NOTES: Rounding may cause slight discrepancies in sums and differences. Missing values are shown only for items with more than 5 percent missing values.

[a]While course names vary between colleges, math courses three levels below college readiness are frequently referred to as Pre-Algebra, courses two levels down as Beginning Algebra, and courses one level down as Intermediate Algebra.

Table 1 demonstrate that the colleges were largely successful in targeting the program to appropriate students — those with developmental needs or difficulties with math, in an appropriate program of study. Students in the study tended to be in their early twenties. More than 50 percent of students were Hispanic, and nearly 65 percent of students in the sample were female.[22] Additionally, nearly all the students had developmental math needs, with more than 80 percent of students in need of two developmental courses, at the Beginning Algebra and Intermediate Algebra levels. Nearly 90 percent of students in the sample reported majoring in areas aligned with statistics and quantitative reasoning math pathways.[23] These

areas included health sciences, social sciences, arts and humanities, and other majors; some students were undecided, but advisers determined they were leaning toward one of these majors. Finally, a substantial portion of the sample — 34 percent — reported that they had failed a math class in the past.

Implementation Findings

Researchers visited each of the four study colleges in the fall 2015 and spring 2016 semesters to interview faculty, staff, and administrators; observe both DCMP and non-DCMP courses; and hold focus groups with DCMP and non-DCMP students.[24] The key goal of the implementation research was to assess how the colleges' implementation of the DCMP, including the content and pedagogy of the courses, hewed to the Dana Center's model, as well as to assess the contrast in the content and pedagogy of DCMP and non-DCMP classes. To conduct the instruction-based analyses, researchers generally observed both DCMP and non-DCMP class sessions at each college, interviewed each instructor teaching each session observed, and undertook a focus group with students attending each class. Based on this information, researchers used a rating matrix to assess the use of different instructional approaches, such as making course content relevant to real life, active learning, the integration of reading and writing practice, and attempts to promote constructive perseverance. Ratings and narrative assessments were reviewed by a two- to three-person team after each round of implementation visits to ensure reliability across researchers, colleges, and semesters of data collection.

Key findings on colleges' implementation of the DCMP and experiences with the first-semester developmental courses during the 2015-2016 academic year are presented below. The analyses are based on information from about half the 1,400 study enrollees at all four colleges; the final report will include findings on the entire student sample as well as students' performance and experiences in the second-semester college-level courses.

- **The study colleges changed administrative and advising policies and procedures, resulting in many students being placed in the correct math pathway; however, the colleges fell short of reaching the full eligible student population.** By spring 2016, all the colleges had revised the math requirements for most social sciences and humanities majors or programs of study to include quantitative reasoning and statistics course options as well as algebra. At most of the colleges, this involved painstaking reviews of major requirements and negotiations with other administrators and department chairs. Additionally, all the colleges built specific procedures into their advising processes to identify each student's intended major or program of study, with the goal of equipping advisers and counselors to correctly counsel students into the appropriate math pathway, whether by one-on-one meetings or by processes for identifying and advising groups of eligible students. Undecided majors were generally advised based on students' broad interests or leanings, though some advisers expressed concern about the challenges in guiding these students to an appropriate pathway. Though policies were successfully changed, staff members at each college struggled to enact these procedures with the majority of the student body for a variety of reasons, including some advisers' spotty knowledge of the DCMP requirements (particularly in larger, multicampus schools), difficulties with spending extra time to discern students' majors, and continued concerns that students would need algebra. As a result, only a fraction of the students who might have been eligible for DCMP were identified and enrolled in the study and DCMP courses during the fall 2015 and spring 2016 registration periods.
- **By spring 2016, most of the colleges had succeeded in aligning the math requirements for many majors with their main four-year transfer college partners; however, this continued to be a challenge at some schools.** Alignment with four-year transfer partners was often facilitated by Dana Center-moderated discussions between the two-year and four-year colleges, resulting in written agreements between the colleges noting which majors would accept the statistics and quantitative reasoning courses as fulfilling the college-level math requirements. However, at least 2 of the 11 four-year colleges that were primary transfer partners for the study colleges continued to require college-level algebra courses to fulfill the math requirements in some non-STEM majors, including nursing and criminal justice, which were popular majors at their two-year partner colleges. Some advisers were therefore hesitant to recommend the DCMP to students in these majors. This lack of alignment occurred with a few majors at three of the four study colleges, which contributed to the lower-than-expected enrollment in DCMP courses.

By spring 2016, most of the colleges had succeeded in aligning the math requirements for many majors with their main four-year transfer college partners.

- **The study colleges offered a steady number of Foundations developmental math courses during the fall 2015 and spring 2016 semesters, though many of these classes were small.** As of spring 2016, the four study colleges had offered a total of 25

sections of Foundations, ranging from 2 to 5 sections per college, per semester. However, partly due to the course transfer and advising challenges discussed above, many classes had fewer than 10 students. For instance, of the 12 Foundations classes observed, only 4 had more than 10 students in the classroom, whereas the standard developmental math classes observed typically had 15 to 20 students present. As was common at many of the nonstudy colleges implementing the DCMP for the first time, the colleges usually decided to keep these small courses open in order to allow instructors and students to experience the course, in hopes that momentum would build in subsequent semesters. Focus groups and interviews indicate that Foundations students generally appreciated the smaller classes, though reactions among faculty were mixed. Further analyses of class size will be included in the final report.

- **Foundations courses exhibited moderately strong fidelity to the Dana Center's model.** Classroom observations, interviews, and focus groups revealed that most Foundations course instructors closely followed the DCMP curriculum and key tenets of the DCMP instructional model. The context given for math problems was a particularly strong attribute of the courses, with students developing math skills by working through word problems related to real-world situations, such as estimating blood alcohol content, comparing sales discounts, and estimating the cost of lawn services, in nearly all the courses observed. Though some instructors struggled with the active learning approach, students in nearly all Foundations classes were observed working and problem solving in small groups, often sharing their solution strategies at the board or through class discussions. Over half the Foundations course instructors were also observed allowing students the opportunity to struggle with problem solving rather than giving them answers directly, a key tenet behind the concept of constructive perseverance. Students and instructors also commented on the high amount of reading and writing required in the class, and said that writing was generally focused on narrative explanations of math solutions or processes rather than just calculations and note taking. Finally, students employed technology on a regular basis, both in the form of calculators and in the use of MyMathLab,[25] a computer-based math program, for homework assignments. Results from the student survey (see Table 2) bolstered these findings, as 68 percent or more of Foundations students noted discussing and sharing strategies, working in small groups, using information from real life when solving math problems, reading, writing out their reasoning, and using a computer.[26]
- **Traditional developmental education courses tended to contrast with the Foundations courses across several content and instructional components.** Most of the non-DCMP developmental math courses that were observed tended to focus heavily on procedural understanding of algebra. Implementation and survey analyses (Table 2) showed that students in the program group were much more likely than students in the standard group to use math problems drawn from real-life scenarios, to read, and to write out their reasoning during class. Contrast between the two groups was less pronounced in two main areas: Students in both groups reported using similar technology, and about half the non-DCMP courses observed by researchers included active learning approaches such as group work and interactive discussion. However, on the survey (Table 2), students in traditional courses tended to report fewer instances of group work than what was observed by researchers.

Students in Foundations courses tended to have relatively positive to highly positive perspectives of their math courses.

- **Students in Foundations courses tended to have relatively positive to highly positive perspectives of their math courses and tended to find the math they were learning to have more connection with their everyday lives than did students in traditional courses.** Students in focus groups regularly noted how different the Foundations courses were in comparison with other math courses they had taken at the college or in high school. Foundations students tended to be positive about the courses, noting how much more the content related to their lives. On the survey (Table 2), differences of more than 15 percentage points existed between Foundations students and traditional developmental math students in their interest in what they were learning, the utility of the math they were learning for their everyday life, and their interest in math. Via the survey, students in the program group were also more likely than students in the standard group to report that their instructors would not let them give up.

Early Student Impacts

Early analyses of student transcript data for the first two cohorts show that during their first semester in the study, program group students registered for and passed developmental math classes at higher rates than their standard group counterparts.[27] Program group students also earned more developmental math credits than

TABLE 2. Responses to Selected Student Survey Questions, Fall 2015 and Spring 2016 Cohorts

Response (%)	Sample Size	Program Group	Standard Group	Difference	Standard Error
Currently taking a math class	379	86.1	80.5	5.6	3.9
Among those taking a math class, reported that always or often during class					
Instructor showed class multiple ways to solve problems	*317*	*77.7*	*67.3*		
Students discussed and shared strategies	*316*	*76.2*	*45.6*		
Students worked in small groups	*316*	*81.4*	*23.1*		
Students worked on problems on own	*316*	*41.1*	*69.4*		
Problems used information from real life	*315*	*68.0*	*26.4*		
Student had to read	*315*	*73.7*	*43.6*		
Student was asked to write out reasoning	*313*	*71.2*	*24.8*		
Student used a computer in class or at home	*311*	*68.4*	*64.4*		
Among those taking a math class, agreed or strongly agreed with the following statements about the class					
You learned how to struggle through problems	*306*	*81.4*	*63.8*		
Class taught you to think more about what you're learning	*307*	*86.1*	*71.8*		
Among those taking a math class, thought the following statements were always true or mostly true					
What you learned was interesting	*309*	*64.0*	*44.1*		
You use the math you learned for daily activities	*307*	*58.3*	*26.8*		
Class made you more confident in math ability	*306*	*63.8*	*55.6*		
Class increased your interest in math	*306*	*47.7*	*29.4*		
Instructor did not let people give up	*305*	*80.6*	*65.7*		
Sample size	**382**	**235**	**147**		

SOURCE: Authors' calculations from DCMP survey fielded to students at Brookhaven, Eastfield, El Paso, and Trinity Valley Community Colleges.

NOTES: This survey was fielded to both the fall 2015 and spring 2016 cohorts during the spring 2016 semester. The survey asked students in the spring 2016 cohort to consider their current math class when responding to questions, while students in the fall 2015 cohort were asked to think about their math class from the previous semester.

The survey was fielded to 594 students. The overall response rate was 64 percent (66 percent in the program group and 62 percent in the standard group). Survey fielding to students in later cohorts of the study is ongoing. A later report will include additional details about the full sample.

Rounding may cause slight discrepancies in sums and differences.

Estimates are adjusted by site-cohort differences.

*A two-tailed t-test was applied to differences between research groups. Statistical significance levels are indicated as follows: *** = 1 percent; ** = 5 percent; * = 10 percent.*

Values shown in italics are calculated for a subset of the full sample. Differences and statistical significance are not calculated for these values.

the standard group. Taken together, these results suggest that program group students are making more rapid progress toward college-level math than students in the standard group.

Table 3 shows these results. After one semester, 78 percent of program group students had enrolled in a developmental math class, compared with 68 percent of standard group students — a difference of 10 percentage points. Similarly, 47 percent of program group students had passed a developmental math course, a rate almost 11 percentage points higher than among standard group students. (The large proportions of students from both groups who did not enroll or did not pass developmental math courses underscores the magnitude and importance of the problems that DCMP seeks to address.) Program group students also earned an average of 1.7 developmental math credits — 0.5 credits more than the standard group, which earned an average of 1.2 credits.[28] These differences between the program and standard groups are statistically significant (in all likelihood not the result of chance).

It is important to note that these results are preliminary, and though they indicate potential benefits of the DCMP, the early successes of the students in the program group may also be influenced by other factors, such as the close attention paid to registering program students into the DCMP courses (which were generally blocked for the general student body and required advisers' permission for entry) or to the differing sizes of DCMP and non-DCMP classes. While increasing developmental enrollment was not an explicit intention of the DCMP, and factors such as different registration procedures and class size were not specific areas of focus for the DCMP model, these factors may have contributed to the higher rates of enrollment among students in the program group. This in turn could explain some of the increases in DCMP students' course pass rates. Finally, the different content of the DCMP courses may have made them easier for students in the program group to pass.

Next Steps

The final report on the DCMP, scheduled to be released in 2019, will include information on program implementation, a larger sample of students, and longer-term program impacts on students' academic outcomes, including students' performance in college-level classes. One of the key questions this study hopes to address is whether the DCMP's changes to math course content, sometimes highlighted as a key concern about the program, ultimately serve students well in the long run, as they seek to complete their math requirements and other college courses. The final report will help shed light on this question as it examines a full year or more of data on students' college course taking.

TABLE 3. Academic Outcomes After One Semester, Fall 2015 and Spring 2016 Cohorts

Outcome	Program Group	Standard Group	Difference	Standard Error
Registered (%)	87.8	85.9	1.8	2.8
Registered for developmental math course (%)	77.9	67.8	10.1***	3.7
Passed developmental math course[a] (%)	47.1	36.6	10.5**	4.1
Developmental math credits attempted	2.7	2.3	0.4***	0.1
Developmental math credits earned[a]	1.7	1.2	0.5***	0.1
Total credits attempted	9.3	8.8	0.5	0.4
Developmental	4.5	3.9	0.6**	0.3
College-level	4.9	4.9	0.0	0.3
Total credits earned	6.0	5.3	0.6	0.4
Developmental[a]	2.6	2.1	0.5**	0.2
College-level	3.3	3.2	0.1	0.3
Sample size (total = 594)	**358**	**236**		

SOURCE: Authors' calculations from transcript data provided by Brookhaven, Eastfield, El Paso, and Trinity Valley Community Colleges.
NOTES: Rounding may cause slight discrepancies in sums and differences.
Estimates are adjusted by site-cohort interactions.
*A two-tailed t-test was applied to differences between research groups. Statistical significance levels are indicated as follows: *** = 1 percent; ** = 5 percent; * = 10 percent.*
[a]Students were counted as passing a developmental course and receiving developmental credits if they received a grade of "C" or better for the course.

Notes

1. Solutions: $x = -1 \pm \sqrt{3}$; $2x^2(4x^2 - 2x + 5)$; $x = 2$, $y = -1$, $z = 1$.
2. Coburn and Coffelt (2013).
3. Bailey, Jeong, and Cho (2009); Biswas (2007).
4. Bailey, Jeong, and Cho (2009).
5. Fong and Visher (2013); Adams, Gearhart, Miller, and Roberts (2009); Jaggars, Edgecombe, and Stacey (2014); Zachry Rutschow and Schneider (2011); Fain (2012, 2013); Barnett et al. (2012).
6. Hayward and Willett (2014); Strother, Van Campen, and Grunow (2013); Zachry Rutschow and Diamond (2015); Charles A. Dana Center (2014).
7. Zachry Rutschow and Diamond (2015).
8. Tennessee Board of Regents (2016).
9. Sowers and Yamada (2015); Zachry Rutschow and Diamond (2015).
10. The DCMP also includes a student success course (Frameworks for Mathematics and Collegiate Learning) aimed at helping students develop skills as learners. However, the study colleges offered few to no Frameworks courses, and thus it is not part of the program being studied.
11. Stigler, Givvin, and Thompson (2009).
12. The DCMP allows colleges the flexibility to implement their own, internally developed models for math pathways courses, but all the colleges in this study implemented DCMP Foundations.
13. Charles A. Dana Center (2013).
14. A fuller description of the DCMP program components and their differences from traditional courses can be found in Supplementary Table S.1 in Elizabeth Zachry Rutschow, John Diamond, and Elena Serna-Wallender, "Math in the Real World: Early Findings from a Study of the Dana Center Mathematics Pathways — Supplementary Tables," May 2017, on the websites of CAPR (http://postsecondaryreadiness.org) and MDRC (www.mdrc.org).
15. Ganter and Haver (2011); Jones (2016); Epper and Baker (2009); Carpenter, Brown, and Hickman (2004); Zavarella and Ignash (2009); Jaggars and Bailey (2010).
16. The names of quantitative reasoning courses vary by college. Common names include Modern Math, Contemporary Math, Math in the Modern World, College Math, Quantitative Literacy, and Quantitative Reasoning.
17. This study uses an intent-to-treat analysis to estimate the effects of offering students in the program group the opportunity to enroll in DCMP courses. That is, the program group consists of all students randomly assigned to DCMP, whether or not they enrolled in the courses. For ease of reading, this report will refer to "the effects of DCMP" rather than "the effects of the opportunity to enroll in DCMP courses."
18. A further discussion of teacher training and the voluntary nature of faculty participation will be discussed in the final report.
19. Findings on costs will be included in the final report.
20. Additional information about this assistance and its influence on colleges' implementation of the DCMP can be found in Zachry Rutschow and Diamond (2015) and will be discussed further in the final report in 2019.
21. An additional two cohorts of students were randomly assigned in the fall 2016 and spring 2017 semesters. Data on these students will be included in the final report.
22. The gender and race/ethnicity composition of the study sample was similar to that of the aggregate student population at the colleges participating in the random assignment study. For fall 2015 enrollment, the Integrated Postsecondary Education Data System (IPEDS), a national data system maintained by the Institute of Education Sciences (IES), reported that students across these schools were 57 percent female and 62 percent Hispanic.
23. Majors are not included in Table 1 but can be seen in Supplementary Table S.2 on the websites of CAPR (http://postsecondaryreadiness.org) and MDRC (www.mdrc.org). Among the remaining 10 percent of students (who reported that they planned to major in either "science, technology, engineering, or math" or "business and communications"), some students may have reported their major incorrectly, and other students may have been incorrectly advised to join the study.
24. The non-DCMP students in the focus groups were not necessarily students in the study's standard group.
25. The Dana Center partnered with Pearson Inc. to develop a specialized version of MyMathLab tailored to the DCMP curricula.
26. Table 2 shows selected survey responses. For responses to all student survey questions, see Supplementary Table S.3 on the websites of CAPR (http://postsecondaryreadiness.org) and MDRC (www.mdrc.org).
27. Course pass rates were based on final grades. None of the study colleges had standardized course exit exams.
28. While this increase in developmental credits earned may be due to higher developmental math pass rates among students in the program group, it is important to note that it may also be because students received 4 developmental credits for completing DCMP Foundations, compared with 3 credits for completing most traditional developmental classes.

References

Adams, Peter, Sarah Gearhart, Robert Miller, and Anne Roberts. 2009. "The Accelerated Learning Program: Throwing Open the Gates." *Journal of Basic Writing (CUNY)* 28, 2: 50-69.

Bailey, Thomas, Dong Wook Jeong, and Sung-Woo Cho. 2009. "Referral, Enrollment, and Completion in Developmental Education Sequences in Community Colleges." CCRC Working Paper No. 15. New York: Community College Research Center, Teachers College, Columbia University. Website: http://ccrc.tc.columbia.edu/.

Barnett, Elisabeth A., Rachel Hare Bork, Alexander K. Mayer, Joshua Pretlow, Heather D. Wathington, and Madeline Joy Weiss. 2012. *Bridging the Gap: An Impact Study of Eight Developmental Summer Bridge Programs in Texas.* New York: National Center for Postsecondary Research.

Biswas, Radha Roy. 2007. *Accelerating Remedial Math Education: How Institutional Innovation and State Policy Interact.* Achieving the Dream Policy Brief. Boston: Jobs for the Future.

Carpenter, Trudy G., William L. Brown, and Randall C. Hickman. 2004. "Influences of Online Delivery on Developmental Writing Outcomes." *Journal of Developmental Education* 28, 1: 14-18, 35.

Charles A. Dana Center. 2013. *The New Mathways Project Curriculum Design Standards.* Austin: University of Texas at Austin. Website: www.utdanacenter.org/wp-content/uploads/NMP_curriculum_design_standards_Sept2013.pdf.

Charles A. Dana Center. 2014. T*he New Mathways Project Implementation Guide.* In collaboration with the Texas Association of Community Colleges. Austin: University of Texas at Austin. Website: https://dcmathpathways.org/sites/default/files/2016-08/NMP%20Implementation%20Guide.pdf.

Coburn, John W., and Jeremy Coffelt. 2013. Table of contents to *College Algebra*, 3rd ed. New York: McGraw-Hill.

Epper, Rhonda M., and Elaine DeLott Baker. 2009. *Technology Solutions for Developmental Math: An Overview of Current and Emerging Practices*. Seattle: Bill & Melinda Gates Foundation.

Fain, Paul. 2012. "How to End Remediation." *Inside Higher Ed* (April 4). Website: www.insidehighered.com.

Fain, Paul. 2013. "Remediation If You Want It." *Inside Higher Ed* (June 5). Website: www.insidehighered.com.

Fong, Kelley, and Mary Visher. 2013. *Fast Forward: A Case Study of Two Community College Programs Designed to Accelerate Students Through Developmental Math.* New York: MDRC.

Ganter, Susan L., and William E. Haver, eds. 2011. *Partner Discipline Recommendations for Introductory College Mathematics and the Implications for College Algebra.* Washington, DC: Mathematical Association of America.

Hayward, Craig, and Terrence Willett. 2014. *Curricular Redesign and Gatekeeper Completion: A Multi-College Evaluation of the California Acceleration Project.* Berkeley: Research and Planning Group for California Community Colleges.

Jaggars, Shanna Smith, and Thomas Bailey. 2010. *Effectiveness of Fully Online Courses for College Students: Response to a Department of Education Meta-Analysis.* New York: Community College Research Center, Teachers College, Columbia University.

Jaggars, Shanna Smith, Nikki Edgecombe, and Georgia W. Stacey. 2014. *What We Know About Accelerated Developmental Education.* New York: Community College Research Center, Teachers College, Columbia University.

Jones, Philip Ray. 2016. "The Structure and Pedagogical Style of the Virtual Developmental Education Classroom: Benefit or Barrier to the Developmental Learning Process?" *International Journal of Language and Literature* 4, 1: 43-48.

Sowers, Nicole, and Hiroyuki Yamada. 2015. *Pathways Impact Report: Three Years of Results from the Community College Pathways.* Stanford, CA: Carnegie Foundation for the Advancement of Teaching.

Stigler, James W., Karen B. Givvin, and Belinda J. Thompson. 2009. "What Community College Developmental Mathematics Students Understand about Mathematics." Problem Solution Exploration Paper. Stanford, CA: Carnegie Foundation for the Advancement of Teaching. Website: www.carnegiefoundation.org/wp-content/uploads/2013/05/stigler_dev-math.pdf.

Strother, Scott, James Van Campen, and Alicia Grunow. 2013. *Community College Pathways: 2011-2012 Descriptive Report.* Stanford, CA: Carnegie Foundation for the Advancement of Teaching.

Tennessee Board of Regents. 2016. "Tennessee Board of Regents Co-Requisite Remediation Model Produces Giant Leaps in Student Success in Math and English." Press release, January 29. Website: www.tbr.edu.

Zachry Rutschow, Elizabeth, and John Diamond. 2015. *Laying the Foundations: Early Findings from the New Mathways Project.* New York: MDRC.

Zachry Rutschow, Elizabeth, and Emily Schneider. 2011. *Unlocking the Gate: What We Know About Improving Developmental Education.* New York: MDRC.

Zavarella, Carol A., and Jan M. Ignash. 2009. "Instructional Delivery in Developmental Mathematics: Impact on Retention." *Journal of Developmental Education* 32, 3: 2-8.

Acknowledgments

We are grateful for the support provided to the Center for the Analysis of Postsecondary Readiness (CAPR) by the Institute of Education Sciences, U.S. Department of Education, and by the Charles A. Dana Center at the University of Texas at Austin, which contributed funding for the development of this report. We also greatly appreciate the input from the four colleges that are participating in this study: El Paso Community College, Trinity Valley Community College, and Brookhaven College and Eastfield College, both of which are a part of the Dallas County Community College District.

We are also thankful to the many individuals who read and reviewed this brief. In particular, we are grateful to those who gave us excellent written and oral feedback, including Alexander Mayer, Evan Weissman, Lashawn Richburg-Hayes, Robert Ivry, and Mary Visher of MDRC; Thomas Bailey and Nikki Edgecombe of the Community College Research Center (CCRC) at Teachers College, Columbia University; Jennifer Dorsey, Martha Ellis, and Connie Richardson of the Charles A. Dana Center; and Hunter Boylan, director of the National Center for Developmental Education and professor at Appalachian State University. Finally, we would like to thank the publications staff from MDRC and CCRC, including Jennie Kaufman and Doug Slater.

CAPR is a partnership of research scholars led by CCRC and MDRC. The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305C140007 to Teachers College, Columbia University. The opinions expressed are those of the authors and do not represent views of the institute or the U.S. Department of Education.

For more information about CAPR, visit postsecondaryreadiness.org.

CENTER FOR THE ANALYSIS OF POSTSECONDARY READINESS
Teachers College, Columbia University
525 West 120th Street, Box 174, New York, NY 10027
P 212.678.3091 | @CAPR_deved
capr@columbia.edu postsecondaryreadiness.org

CCRC COMMUNITY COLLEGE RESEARCH CENTER
TEACHERS COLLEGE, COLUMBIA UNIVERSITY
ccrc.tc.columbia.edu | @CommunityCCRC

mdrc
BUILDING KNOWLEDGE TO IMPROVE SOCIAL POLICY
mdrc.org | @MDRC_News