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Impact Findings from the Dana Center Mathematics Pathways Long-Term Follow-Up Study

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Large numbers of students entering community colleges are deemed not academically prepared for college-level math. These students have historically been assigned to one or more non-credit-bearing courses for remedial, often called developmental, math instruction before they can take college-level courses.[1] Research has found that most students assigned to traditional developmental math course sequences never complete those sequences or attain a credential.[2] The Dana Center Mathematics Pathways (DCMP) model was created in 2011 to better support the needs of these students. It diversifies developmental and college-level math course content, separating it into distinct pathways that better align with students' career interests. It also streamlines the developmental math sequence so students can move into college-level courses more quickly. This brief highlights the findings from a rigorous long-term follow-up study of an early version of the DCMP model. The study found that the model had a sustained impact on students' successful completion of their first college-level math course of 5.6 percentage points after five years. This impact on college-level math completion did not lead to discernible effects on credential completion, however. Since the launch of this early version of DCMP, the Dana Center has continued to refine and update the model over time and the findings in this study do not reflect the effects of the current version of the DCMP model. The findings do offer some insights that may inform the current implementation of math pathways and other developmental math reforms.

The Problem

Community colleges have been struggling for decades to better support the large number of students entering college who are deemed academically underprepared for college-level work in math. Historically, these students have been required to take and pay for a sequence of one to three, or more, semester-length non-credit-bearing courses, referred to as developmental math courses, before moving on to college-level math. By the early 2000s, 59 percent of students entering two-year institutions were taking at least one developmental math course and students of color and students from lower-income backgrounds were more likely than their White and higher-income peers to take these courses.[3] Unfortunately, this policy has not been successful in supporting underprepared students. Research has found that most students identified for traditional developmental math education never completed their developmental sequence nor completed any college-level math credits, leaving them unable to attain a credential.[4]

A Potential Solution: Dana Center Mathematics Pathways

As the problems with traditional developmental math sequences became clear, practitioners and policymakers began working on ways to reform the developmental math system. The Charles A. Dana Center at the University of Texas at Austin was one of the organizations at the forefront of this reform movement, creating the DCMP model (formerly the New Mathways Project).[5] The Dana Center started implementing DCMP in 2011 with the support of the Texas Association of Community Colleges. The DCMP model implemented for this study was based on the following four core principles.

Multiple math pathways aligned to different fields of study. The program diversified the developmental and college-level math course content, separating it into three distinct pathways. DCMP included a statistics pathway, for students majoring in social and health sciences; a quantitative reasoning pathway, for students majoring in the humanities; and a path to calculus for students majoring in science, technology, engineering, and mathematics (STEM). (Students entering the STEM pathway were not included in this study.) All three pathways began with a one-semester Foundations of Mathematical Reasoning course that covered algebra (the content of standard developmental math courses) but also emphasized statistics and quantitative literacy. Upon successful completion of the Foundations course, students in DCMP took a one-semester college-level statistics or quantitative reasoning course or began a two-semester path to calculus.

Accelerated developmental sequence. The early DCMP model streamlined the developmental math content so that students were prepared to advance to any math pathway after only one semester. Even students who tested two or more levels below college-ready in math needed to take only the one-semester Foundations course. Once students passed the Foundations course, they were able to take college-level math the following semester. The intent of the early version of the DCMP program was that all students, regardless of incoming math level, could complete a college-level math course during their first year of college.

Evidence-based, student-centered curriculum and pedagogy. The DCMP model included curriculum and classroom instructional practices that engaged students in active problem solving pertinent to real-life situations. The model emphasized activities where students collaborate with each other and required students to demonstrate their ability to read, write, and communicate orally about their math learning.

Student success strategies. The DCMP model also included academic and social supports for students that were both integrated into the developmental math courses and aligned with other college services. Instructors were encouraged to incorporate activities that support and engage students in their learning and that help students develop the attitudes and help-seeking behaviors that will foster their success in college—for example, through regular check-ins with advisors or by attending tutoring sessions. While the colleges in the study had myriad supports available for students taking developmental education courses, including tutors and labs, the one area where the DCMP model was not fully implemented across the colleges was in adapting and expanding these services to specifically support students in DCMP courses.

It was hypothesized that these key components would support students in ways that would make them more likely to complete the developmental math sequence, pass their first-year college-level math course, and accumulate more math credits. Changes in math completion would help students persist in college longer and accumulate more overall college credits, and ultimately be more likely to earn a certificate or degree.

The Study

A rigorous randomized controlled trial of this early version of DCMP was launched in 2014 at four Texas colleges.[6] It found that DCMP had a positive impact on students' completion of the developmental math sequence, increasing their likelihood of taking and passing college-level math and thus the number of math credits earned during the first three semesters.[7] Researchers from the Center for the Analysis of Postsecondary Readiness—a partnership involving the Community College Research Center at Columbia University's Teachers College and MDRC, as well as research scholars from several universities—conducted the study. The colleges in the study include El Paso Community College, Trinity Valley Community College, and two colleges from the Dallas County Community College District: Brookhaven College and Eastfield College. Students were enrolled in the study in four cohorts from the fall 2015 semester through the spring 2017 semester. A total of 1,411 students were enrolled—856 were assigned to DCMP and 555 were assigned to the colleges' standard developmental math sequence. The study targeted students who planned to major in the social sciences or liberal arts and were referred to one or more levels of the developmental math sequence. Over 60 percent of students were female, over 50 percent were Hispanic, and over 80 percent tested at least two levels below college-ready on the math placement exam.

This brief summarizes the longer-term findings of the study, looking at the impacts on students over five years after random assignment.[8] A more detailed discussion of the study and the findings can be found in this corresponding working paper.[9] The long-term follow-up study

focuses on three goals: successful completion of college-level math courses (math completion), persistent enrollment and college credit accumulation (academic progress), and credential attainment or transfer to and persistence at a four-year institution (academic attainment).[10]

Findings

This section summarizes the findings from the long-term follow-up study, discussing the overall findings for math completion, academic progress, and academic attainment and then discussing the findings by subgroups.

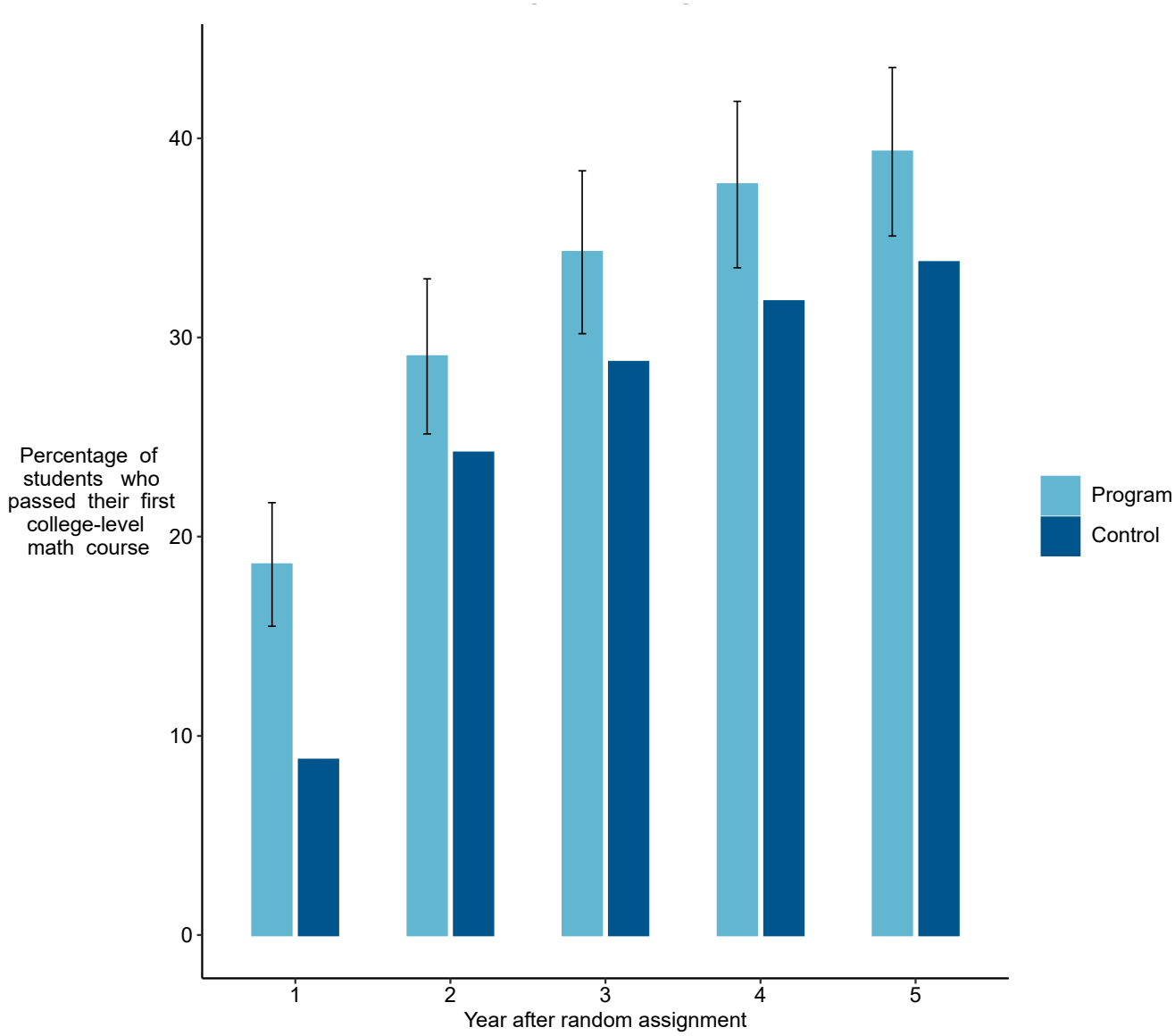
Math Completion

As shown in Figure 1, the early version of the DCMP model evaluated in this study had a positive impact (amounting to almost 10 percentage points) on students' math completion during the first year, and the impacts persisted through the five-year follow-up period, with students who were offered DCMP still 5.6 percentage points more likely to have successfully completed their first college-level math course in the fifth year after the study began.

While the study cannot dissect the effectiveness of each of the different components of the DCMP model, it is worth considering the mechanisms that, when combined, led to positive effects on math completion. First, the acceleration of the developmental math sequence was meant to ensure that students could complete a college-level math course in the first year of college. Second, the content of the developmental course was nontraditional in that it did not focus solely on basic algebraic skills but also emphasized quantitative literacy, statistics, and algebraic reasoning to prepare students for college-level courses related to their course of study. Students offered DCMP were invited to enter into a math pathway, and they were about twice as likely to take a statistics or quantitative reasoning course in their first few semesters compared with their counterparts who were not offered DCMP, who were more likely to take college algebra.[11] Finally, the DCMP developmental course had a curriculum that concentrated more on student engagement and active problem solving than the non-DCMP developmental math courses.[12]

While the early version of DCMP did help a significant number of students complete their first college-level math course, it was not as successful in supporting students' completion of a second college-level math course and it did not have a discernible impact on students' average accumulation of math credits by the end of the five-year study. There was a small impact on math credits earned during the first year and a small impact on completing a second college-level math course in the second year, but evidence of these impacts dissipated in the following years.[13] One reason for the lack of impacts on these other math completion variables may be that the students in this study were pursuing non-STEM degrees (at least at the start of the study) and most non-STEM degrees require students to pass only one college-level math course.

Figure 1. Impact on Completing First College-Level Math Course

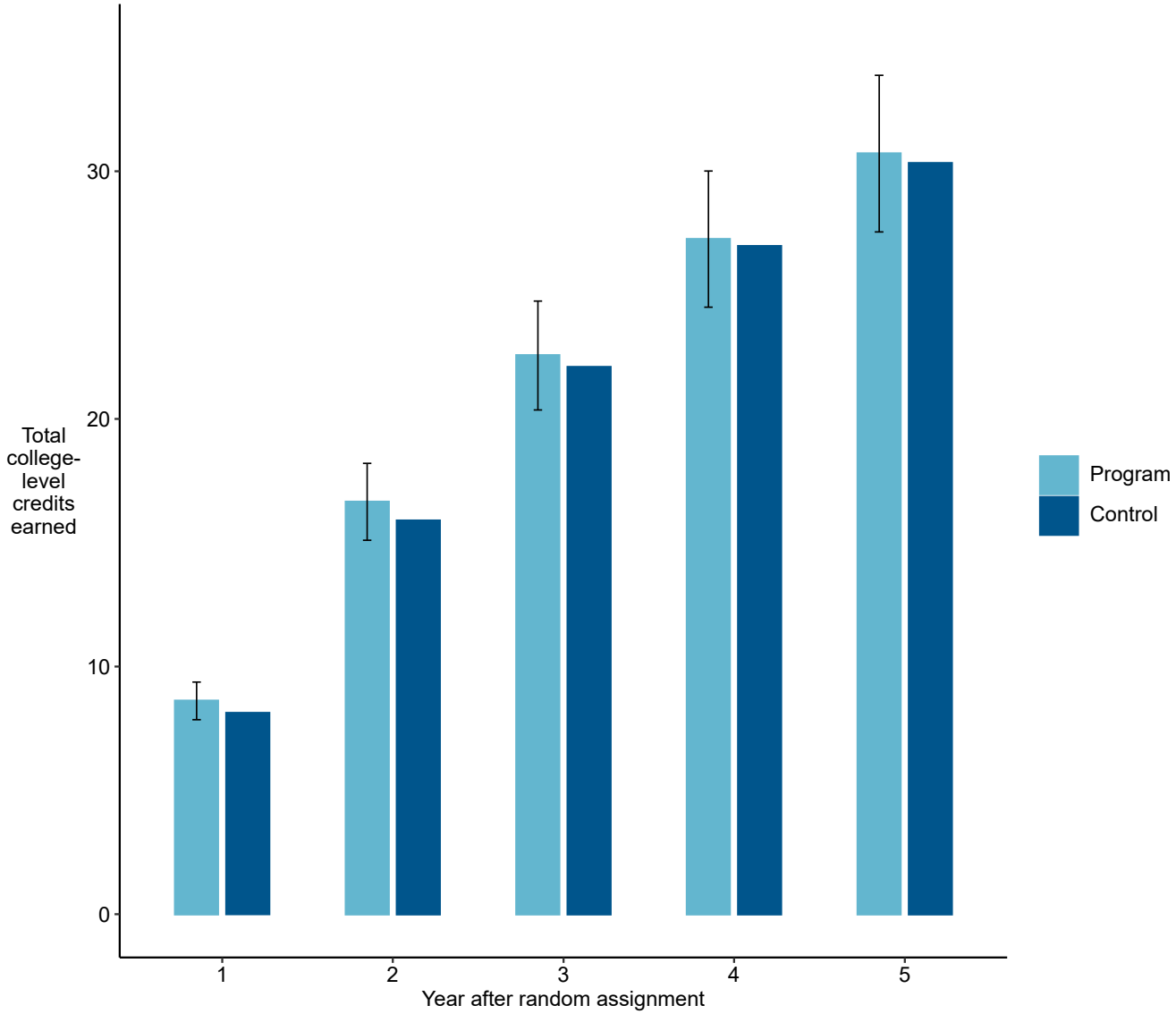


SOURCE: Data provided by the Texas Education Research Center.
NOTES: The vertical lines (or error bars) at the top of each program bar represent the 90 percent confidence intervals around the impact estimates.
Sample size is 1,411.

Academic Progress

As shown in Figure 2, while more students who were offered DCMP passed their first college-level math course, the early version of the DCMP model had no discernible effect on students' total college-level credits earned during any year of the study. This finding suggests that while DCMP helped students succeed in college-level math, it did not lead to students taking or passing more college-level classes in general. Students who were offered DCMP and those who were not offered DCMP also had similar college enrollment rates throughout much of the study and were enrolled in college for a similar number of semesters across the five years.

Figure 2. Impact on Total College-Level Credits Earned

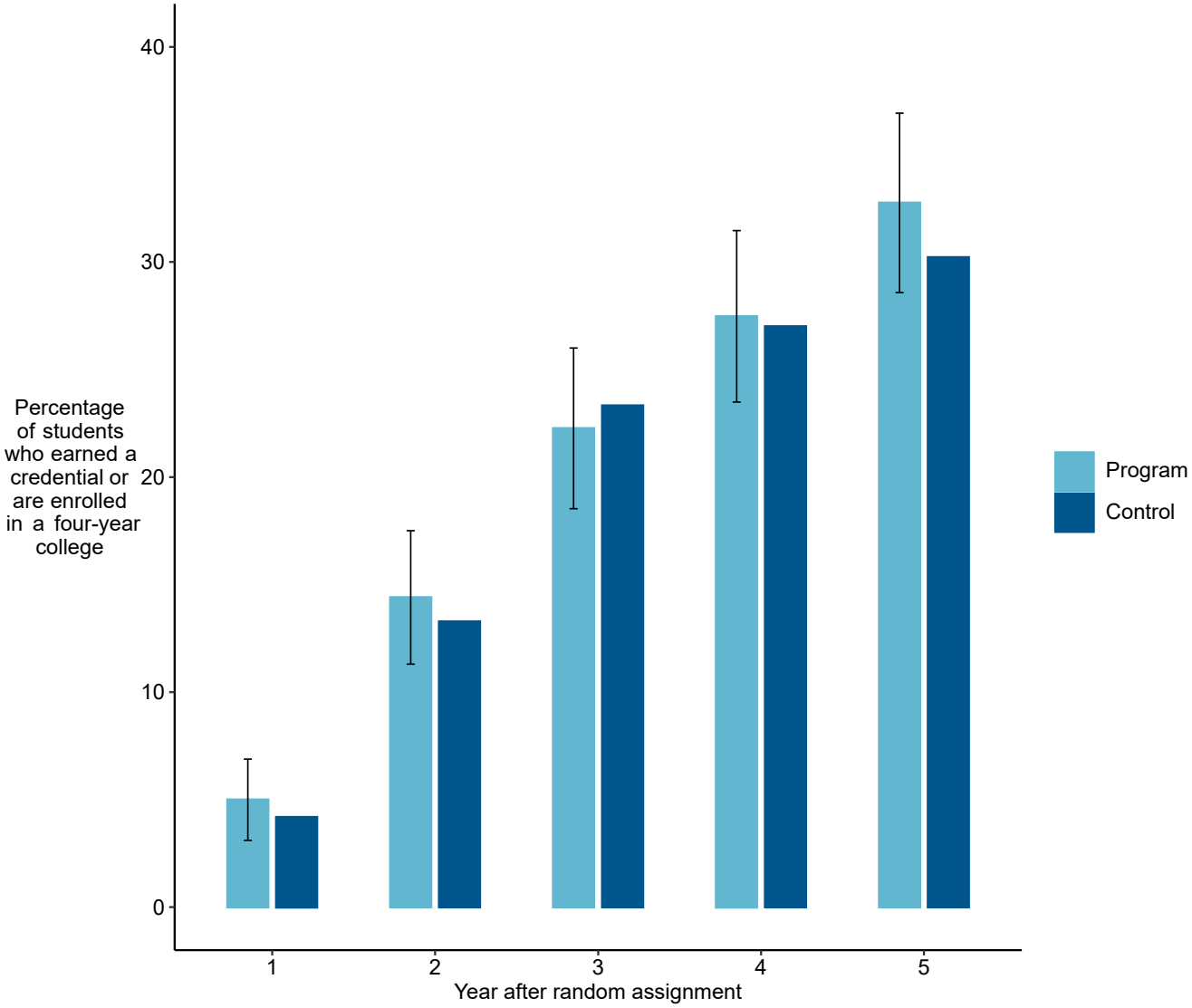


SOURCE: Data provided by the Texas Education Research Center.
NOTES: The vertical lines (or error bars) at the top of each program bar represent the 90 percent confidence intervals around the impact estimates.
Sample size is 1,411.

Academic Attainment

As shown in Figure 3, this early version of the DCMP model did not have a statistically significant impact on students' credential completion or current enrollment at a four-year college during any of the five study years.[14] There were also no impacts on ever earned a certificate, associate's degree, or bachelor's degree after five years when measured separately. At five years after the start of their participation in the study, just under a third of students who were offered DCMP had earned some type of credential or were currently enrolled in a four-year institution.

Figure 3. Impact on Credential Completion or Current Enrollment at a Four-Year College



SOURCES: Data provided by the Texas Education Research Center and the National Student Clearinghouse.
NOTES: The vertical lines (or error bars) at the top of each program bar represent the 90 percent confidence intervals around the impact estimates.
Sample size is 1,411.

Subgroups

The study investigated the effectiveness of the early version of the DCMP model for students who have historically not been supported effectively. The study compared students who tested two to three levels below college level with students who were more college-ready; female students with male students; students of different races and ethnicities; students who planned to enroll part time with those who planned to enroll full time; and students who entered college within six months of graduating from high school with those who entered college more than six months after graduating from high school. While the subgroup

analyses offer some insight into the potential differential effects of DCMP, the small sample sizes make the subgroup findings less reliable than the full sample findings. The subgroup analyses were meant to provide additional context for the impacts on the full sample, in order to generate new hypotheses for future testing.

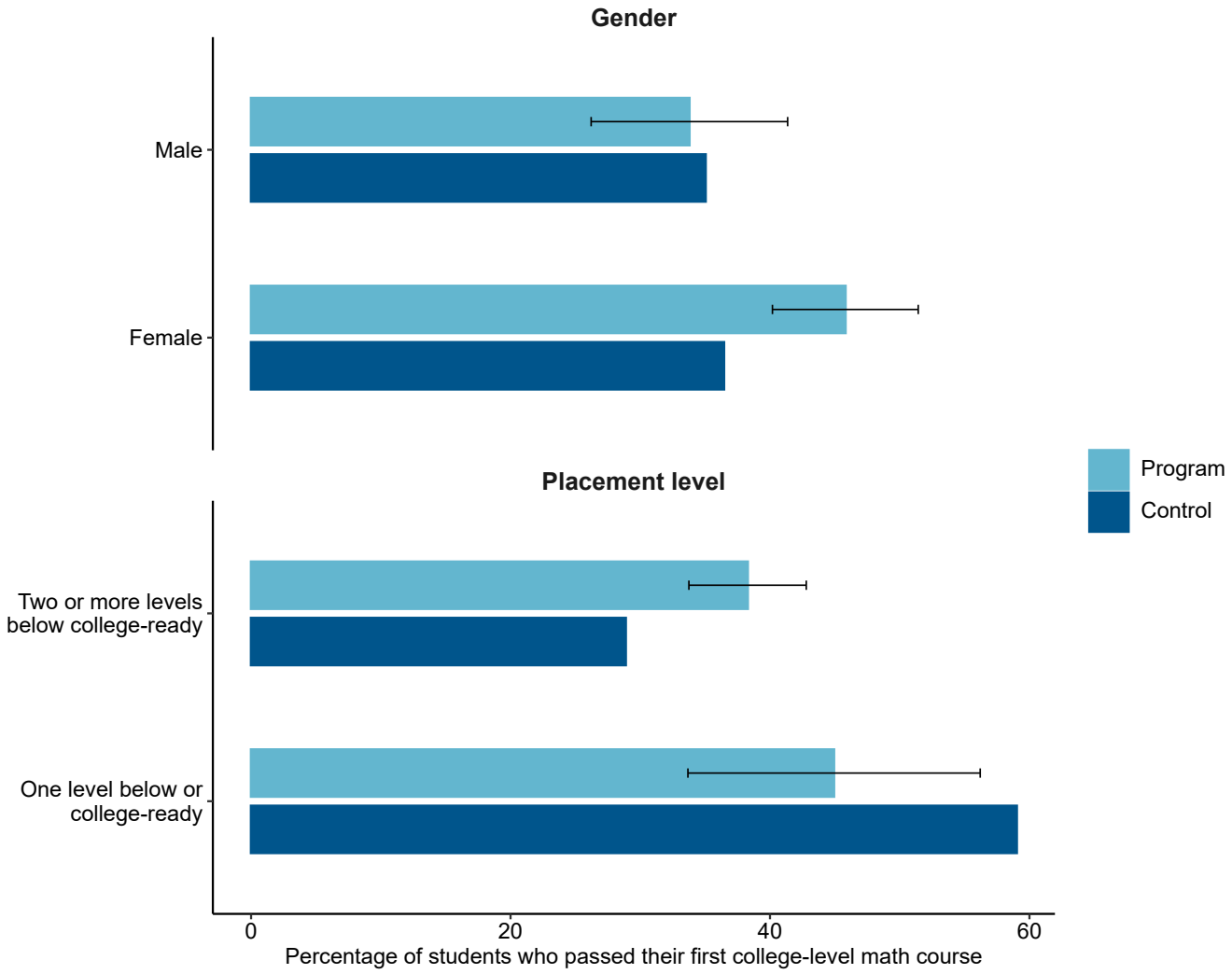
As shown in Figure 4, there is a significant difference in the successful completion of a first college-level math course between students who tested two or three levels behind in math compared with students who were assessed as no more than one level behind.[15] There is a significant positive effect on students who were two or more levels behind and a significant negative effect of this early version of DCMP for students who tested one level behind or were college-ready. While the negative finding for students who tested near or at college level is concerning, it is consistent with other research showing that developmental course taking can result in negative effects on college outcomes for these students.[16] The DCMP model was originally envisioned to support students who were assessed at more than one level below college-ready, and these students represent 84 percent of the study sample. The program provides these less prepared students with substantial benefits as these students were over 9 percentage points more likely to successfully complete a first college-level math course within five years. Significant differences were not found between more and less prepared students on outcomes of academic progress (college-level credits accumulated in five years) or academic attainment (credential attainment by the fifth year or current enrollment in a four-year institution).

There was a significant difference in the impacts on math completion between female and male students. The model had a large positive impact (over 9 percentage points) on the completion of a first college-level math course for female students. The model had no impact for male students. Female students are generally overrepresented in developmental math programs and this finding suggests that the program was particularly helpful for women.[17] There were no significant differences between female and male students on academic progress or academic attainment outcomes.

Differential impacts (that is, impacts on subgroups) were not found between Black, Hispanic, and White students, but Hispanic students represent a majority of students in this study and the samples of Black and White students were relatively small (less than 15 percent of the full sample for each group). About 17 percent of the sample were missing race or ethnicity information and thus were not included in the analysis, so these findings should be interpreted with some caution. Students of color tend to be overrepresented in developmental math programs.[18] To the extent that the program is effective in boosting math completion, it can be assumed that DCMP can help colleges to raise math completion rates for students of color. No significant differences between Black, Hispanic, and White students were found on academic progress or academic attainment.

No differential impacts on math completion, academic progress, or academic attainment were found for student subgroups based on planned level of enrollment or time between high school graduation and college enrollment. (Given the lack of differential impacts, these findings are not included.)

Figure 4. Impact on Completing First College-Level Math Course, By Gender and Placement Level, Five Years After Random Assignment



SOURCES: Data provided by the Texas Education Research Center and the National Student Clearinghouse.
NOTES: The horizontal lines (or error bars) on each program bar represent the 90 percent confidence intervals around the impact estimates.
Sample sizes for each group are: 866 (female), 432 (male), 1,188 (two or more levels below college-ready), and 223 (one level below or college-ready).

Conclusion

This early version of the DCMP model had an initial and sustained positive impact on students' completion of a first college-level math course through five years after random assignment. The requirement to pass college-level math is a major obstacle to attaining a credential for many students, and this model supported more students in overcoming that obstacle. The effect on math completion was particularly strong for those students who

tested two or more levels below college-ready (versus those students who tested at college level or one level below), suggesting that this early version of the DCMP model was most effective in supporting the students who most struggle to complete their math sequence. It also was particularly effective in supporting female students, a group that is overrepresented in developmental math.

These impacts on math completion did not lead as hypothesized to broader impacts on academic progress and attainment. The only impact found on those outcomes was on college persistence (that is, current enrollment in college or previously earned a credential) and only during the fifth year. Perhaps the expectation that a single math intervention targeted to incoming students would affect college completion was overly optimistic. It is also possible that some adjustments to this early version of the DCMP model could make it more effective. Over the 10 years since this study began, the Dana Center has been working on ways to strengthen the model's impact. For example, the center has integrated a corequisite remediation course structure into their model recommendations. This structure further accelerates students' entrance into credit-bearing courses. Instead of the one-semester developmental course included in the version of the DCMP model in this study, students may enter directly into a college credit course in their pathway. At the same time, those students in need of developmental assistance may receive holistic services that include a companion support course, tutoring, and help from an advisor, among other services.[19] A recent long-term experimental study of corequisite remediation in a math pathways setting in three City University of New York colleges found impacts of that program on earning associate's and bachelor's degrees.[20] Those findings suggest that the Dana Center's current effort to move to a corequisite remediation model may lead to stronger effects on academic progress and attainment. One of the key hypotheses for what might make corequisite remediation effective, especially when combined with a math pathways model, is that it allows students to directly enter college-level math, removing the obstacles of developmental sequencing and making it possible for students to earn college-level math credits in their first semester of college.

Still, not all studies of corequisite remediation have found impacts on longer-term outcomes. A study of a statewide intervention in Tennessee that instituted corequisite remediation with math pathways found that students on the margin of the college-readiness threshold who were placed into corequisite remediation were 15 percentage points more likely to pass their first college-level math course. But, similar to this DCMP study, the Tennessee study did not find significant impacts on enrollment persistence, transfer to a four-year college, or degree completion.[21] An experimental study of an intervention that utilized corequisite remediation but not math pathways (that is, program group students entered college-level algebra) also found a significant impact on college-level math course completion within three years but did not show a measurable impact on student persistence at the college or on degree completion within three years.[22] While pairing math pathways with corequisite remediation may lead to stronger impacts, the impact of corequisite remediation on longer-term outcomes, even with math pathways, may be dependent on other important factors, such as the student sample, the setting, or the particular design of the intervention.

A movement toward corequisite remediation is underway. Since the start of this study, the state of Texas has moved its colleges toward corequisite remediation. The state legislature voted Texas House Bill 2223 into law in 2017 requiring colleges to offer 100 percent of developmental sections as corequisite courses starting in the 2021–2022 academic year, and about nine out of ten institutions met the goal that year.[23] Many other states are also moving toward requiring or promoting corequisite remediation.[24] For example, in 2017 California legislators passed Assembly Bill 705 requiring colleges to allow incoming students access to transfer-level classes (that is, college credit-bearing courses) unless they are deemed highly unlikely to succeed in those courses. This law has led to a statewide movement toward corequisite remediation at both the community college and university levels.[25] More research is needed to fully assess the effectiveness of the corequisite model combined with the math pathways model.

Another option to help boost graduation rates might be to pair accelerated or corequisite math pathways with multifaceted support programs that extend past the first year of college. These programs use multiple components such as academic advising, tutoring, individual career and employment services, and tuition assistance over multiple years to address an assortment of barriers to students' college success. One notable example, the Accelerated Study in Associate Programs model, has been shown to nearly double graduation rates in multiple colleges across two states with different student populations.[26] While programs such as DCMP can make an important contribution, colleges may want to consider integrating math reforms with multifaceted services to meet the needs of a diverse set of students. A synthesis of experimental studies of community college reforms found that the effects tend to be larger for interventions that are more comprehensive (those that have more components). It also found promising evidence that the effects of community college reforms tend to be larger for interventions that increase students' advising use, increase students' tutoring use, and provide increased financial support to students, which could all be components of a more comprehensive reform that includes math pathways as a key component.[27] While the math pathways model is an effective tool for supporting students through college-level math completion, pairing it with other services could help students overcome additional obstacles they may face to college success.

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6. Randomized controlled trials measure the effectiveness of an intervention by randomly assigning participants to receive the intervention or not and then comparing the outcomes of the two groups. The randomness of the assignment creates two groups that are similar, on average, in all ways except their receipt of the intervention.
7. Zachry Rutschow et al. (2019).
8. An interim brief published in 2022 reported findings after three years. For that brief, researchers only had access to the full transcript data for three of the four participating colleges and National Student Clearinghouse (NSC) data. The findings in this brief utilize the Texas Education Research Center (Texas ERC) data repository, which includes transcript data from public and private postsecondary institutions across Texas. Using the Texas ERC data allowed the researchers to better capture students' course taking and credit earning across all Texas colleges and universities and not just the colleges participating in the study, allowing the study to follow students who moved to another public or private institution in Texas. It also provides an additional source of enrollment and degree information in case of missing or mismatched NSC data.
9. Susan Sepanik and Sukanya Barman, "Long-Term Effects of the Dana Center Math Pathways Model Evidence from a Randomized Trial: A CAPR Working Paper," (New York: Center for the Analysis of Postsecondary Readiness, 2023), website: https://www.mdrc.org/work/publications/long-term-effects-dana-center-math-pathways-model.
10. Current enrollment in a four-year college is included in the measure of academic attainment because the follow-up study lasted only five years, but many students transferring from community college into four-year institutions take six or more years to earn a bachelor's degree.
11. Zachry Rutschow et al. (2019).
12. Zachry Rutschow et al. (2019).
13. See Table 2 in Sepanik and Barman (2023) for detailed impact findings. The math credit completion variable is less sensitive to small differences between groups than the completion of a first college-level math course variable leading to a lack of significant impact on this variable in later years even though more students who were offered DCMP successfully completed a first college-level math course.
14. When an impact is not statistically significant it cannot be proven that the impact is different from zero—that is, it is possible that the impact was due to chance alone rather than the program.
15. While the study was meant to only include students who tested below college-ready, a small percentage of students (about 2.6 percent) were found to be college-ready according to the testing data collected. The discrepancy likely comes from the fact that the study team collected the test

score data from the colleges after random assignment, and it may be that the test score data provided to the study team were different for some students than the information used by advisors at the time of enrollment.

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