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Five Principles for Reforming Developmental Education

A Review of the Evidence

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and Austin Slaughter*



CAPR \

CENTER FOR THE ANALYSIS OF
POSTSECONDARY READINESS

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Executive Summary

At community colleges and many public four-year institutions, developmental education (sometimes called remedial education) has been a central feature of the broad-access mission. Developmental courses in reading, writing, and math have traditionally been offered in multi-semester prerequisite sequences to be completed by some students before they take college-level courses in the same subject area. The idea was that developmental education would help students considered underprepared for college-level coursework to become more successful at college. But numerous descriptive and causal studies have shown that this system of multi-semester prerequisite developmental education hinders academic progress for large numbers of students and has disproportionately negative effects on students of color and low-income students. Over the past decade, partly in response to such findings, policymakers, educators, and administrators in community colleges and other broad-access postsecondary institutions have focused on reforming developmental education practices, including how students are assessed as needing additional academic support. More than half of U.S. states now mandate or recommend developmental education reforms. Concurrent with widespread changes in practice, researchers have engaged in efforts to study and evaluate interventions that colleges have undertaken to improve outcomes of students traditionally referred to developmental education.

In this report, we review both impact and implementation studies published between 2010 and 2022 with the goal of summarizing what is known about how innovations to developmental education can improve student outcomes. We look across this body of evidence to draw out five principles that are key for colleges that want to engage in developmental education reform, and we describe embedded implementation lessons in the discussion of each principle. This approach acknowledges that institutions may not be able to replicate an intervention exactly as it was studied and that high-quality implementation is critical to success and sustainability. In addition, we consider how well developmental education reforms are working for students traditionally underserved in higher education, including students who are Black, Latinx, and from low-income backgrounds, and students with greater academic needs. Throughout our review, we rely primarily on 17 experimental and quasi-experimental studies of innovative developmental education interventions that meet rigorous research standards. To contextualize our analysis, we also draw on broader developmental education literature, including implementation studies, cost studies, theoretical scholarship, and state policy analyses.

Principle 1. Grant students access to college-level math and English courses.

Evidence suggests that many more students would successfully pass introductory college-level courses if they avoided prerequisite developmental courses altogether and were instead granted direct access to college-level courses in their first term of college enrollment, with additional support provided for some students. One common strategy to increase access to college-level courses is to use multiple measures, including high school GPA, instead of standardized test scores alone to assess incoming students and assign them to developmental or college-level

courses. In two recent random assignment studies, students who were bumped up into college-level courses through multiple measures assessment were more likely than comparison students to complete a college-level math or English course within three terms (Barnett et al., 2020; Cullinan & Biedzio, 2021). Similar patterns emerge in rigorous research on corequisite approaches that allow students traditionally assigned to remediation to enroll instead in college-level courses with additional support (Logue et al., 2019; Miller et al., 2022). Because increasing access to college-level courses may require significant changes to the way colleges do business, institutions pursuing such a strategy may need to engage faculty and staff early in the planning process, build trust, and shift mindsets to support successful and sustainable reform.

Principle 2. Provide targeted and tiered supports to address students' academic and nonacademic needs.

As colleges undertake strategies to increase access to college-level courses among incoming students, evidence suggests that they should offer concurrent targeted and tiered support services for students with weaker academic preparation and with other, nonacademic needs. These services may include pre-college programs, corequisite support courses, embedded tutoring, and high-touch advising. Multiple measures assessment that considers cognitive and noncognitive skills of students can help to identify students who will benefit from these services. A targeted and tiered support structure implies that some students may need fewer services and others more. To be successful in college, students need strong literacy and numeracy skills. They also need to develop productive academic and nonacademic habits and behavior. Two experimental studies in our review (Martinson et al., 2021; Weiss et al., 2021) found that innovative programs with multifaceted supports and thoughtfully designed curriculum and instruction—I-BEST and CUNY Start—had positive effects for lower scoring students. The Integrated Basic Education and Skills Training program, developed by Washington State's Board for Community and Technical Colleges, features a team-teaching approach in the classroom: Basic skills instructors and technical faculty jointly design and teach college-level occupational courses that lead to postsecondary credentials. CUNY Start, a one-semester pre-matriculation program at the City University of New York, uses innovative curriculum and instruction as well as advising and other supports to improve student outcomes.

Principle 3. Employ contextualized curriculum and student-centered pedagogy.

Our review points to the value of two instructional features that support student learning and success: contextualized curriculum and student-centered pedagogy. A contextualized curriculum, often lacking in traditional developmental courses, engages students in authentic literacy and numeracy tasks like those they will encounter throughout college, foregrounding higher level competencies that students need to master to be successful in college-level courses and beyond. Student-centered pedagogy refers to the design of classroom activities in ways that help students contribute ideas, discuss concepts, and justify their thinking. CUNY

Start, described above, provides an example of both contextualized curriculum and student-centered pedagogy. An experimental study of CUNY Start (Weiss et al., 2021) found much stronger short-term math outcomes among program versus control group students, suggesting that these instructional features are particularly important in math. To introduce contextualized curriculum and student-centered pedagogy, institutions must invest in resources and professional development for faculty.

Principle 4. Use equity-minded approaches for design and implementation.

Given that students of color and low-income students are more often assigned to traditional developmental education and thus disproportionately affected by its negative impacts, efforts to improve developmental education for all students can disproportionately benefit underserved students. Research on state-level reforms in California and Florida has shown encouraging trends. After undertaking reforms that increased access to introductory college-level courses among incoming students, gaps in college-level course enrollment and completion between Black, Latinx, and White students in these two states narrowed considerably (Mejia et al., 2020; Park-Gaghan et al., 2020). At the same time, analysis has shown that students from traditionally underserved groups may be less likely to gain access to reformed course structures (Hern et al., 2020; Schudde & Meiselsman, 2019). What is more, universal reforms do not address classroom experiences that may serve to discourage students from particular groups. Engaging in culturally affirming classroom strategies and those that strive to build a sense of confidence and belonging among underserved students may be particularly useful in closing gaps in course performance (Brady et al., 2020; Buck et al., 2021; Miller-Cotto & Lewis, 2020). Unless reforms consider the needs of particular student groups, even interventions with beneficial effects may be unlikely to close gaps in student outcomes. Therefore, institutions should seek to identify and address institutional- and classroom-level structures, policies, and practices that create or maintain racial or economic inequities in access to and completion of introductory college-level courses.

Principle 5. Implement developmental education reforms alongside comprehensive, sustained supports to improve long-term outcomes.

While discrete reforms to developmental education may improve completion of introductory college-level courses, few interventions have been shown to increase long-term outcomes such as graduation. Implementing developmental education reforms alongside comprehensive supports that span students' entire time in college is likely necessary to move the needle on college completion. A growing body of evidence suggests that reforms that address multiple barriers to student success and that support students throughout their entire time in college can have a substantial impact on important outcomes such as degree attainment. One example is the City University of New York's Accelerated Study in Associate Programs (CUNY ASAP), a multifaceted program that provides full-time students with advising, financial, and academic

support for three years. A random assignment evaluation (Scrivener et al., 2015) found that the program nearly *doubled* the three-year graduation rate for students in developmental education. Another comprehensive approach to student success is guided pathways (Community College Research Center, 2021)—a popular whole-college reform strategy that emphasizes well-structured programs of study, student goal-setting and academic planning, and enhanced advising to help students begin and stay on a clear path to graduation and career.

The Costs of Reform

Among the 17 rigorous studies of developmental education reform included in this review, eight included a cost analysis. The most cost-effective interventions, such as multiple measures assessment, were also the least expensive. Low-cost interventions that produce benefits for students may be a good place for colleges to start when considering how to invest resources; however, investments in higher cost interventions may be necessary to achieve substantial improvements in long-term student outcomes. More cost-effectiveness research is needed on interventions and strategies such as corequisite support courses and granting students direct access to college-level courses without support.

Future Research

In addition to deriving the five principles of developmental reform outlined above, we use this review to identify particular areas in which having stronger evidence is essential for guiding future reform efforts. The field needs research that uncovers specific policies and practices in institutions and classrooms that serve as barriers to racially minoritized students, and it needs evaluations of interventions that are designed and implemented in race-conscious, equity-minded ways. In addition, more knowledge is required on how to support students with greater academic and nonacademic needs so that they can be successful in college-level courses. Other areas for future research include the costs of implementing effective reforms, approaches to pair developmental education with longer-term supports to improve graduation rates, guided self-placement, and online instruction.

1 Introduction

At community colleges and many public four-year institutions, developmental education (sometimes called remedial education) has long been a central feature of the broad-access mission. Developmental courses are traditionally required of incoming college students identified as needing extra academic support in reading, writing, or mathematics as determined by standardized placement tests. The courses are typically offered in a multi-semester prerequisite sequence to be completed before students take college-level courses in the same subject area. Among students who started college in 2015-16, more than half of those at public two-year colleges (53 percent) and nearly half of those at public four-year non-doctorate institutions (44 percent)¹ took a developmental course (National Center for Education Statistics, 2018). Black, Latinx, and low-income students enroll in developmental education courses at higher rates than White and higher income students (Chen, 2016; Chen et al., 2020).

Students who successfully complete developmental courses may learn valuable skills, and some studies have shown modest positive effects for students with lower levels of academic preparation in reading and writing courses (Boatman & Long, 2018; Hodara & Xu, 2016). However, numerous descriptive and causal studies have found that the traditional system of multi-semester prerequisite developmental education hinders academic progress for large numbers of students. An analysis of longitudinal student records across several states showed that of community college students assigned to prerequisite developmental courses in reading and math, only 37 percent and 20 percent, respectively, completed those courses and went on to complete college-level courses (Bailey et al., 2010). Rigorous studies have shown that the subsequent academic outcomes of students referred to prerequisite developmental courses are no better than, and are sometimes worse than, those of similar students who are not referred to them (Boatman & Long, 2018; Dadgar, 2012; Martorell & McFarlin, 2011).

The subsequent academic outcomes of students referred to prerequisite developmental courses are no better than, and are sometimes worse than, those of similar students who are not referred to them.

Developmental education exists at the intersection of K-12 and higher education and is intended to redress failures that both these sectors have experienced in providing equitable educational opportunities for low-income students and students of color. Yet the costs and burdens of developmental education that arise for students, disproportionately borne by low-income students and students of color, are substantial. Developmental courses often delay progress toward a college degree, and students must pay tuition or apply their financial aid to enroll in them.

Partly in response to research findings showing substantial costs and weak outcomes for students referred to developmental coursework, policymakers, educators, and administrators

KEY TERMS

Cohort model: Grouping students together in two or more courses in order to provide a stronger communal experience with a much greater focus on shared learning. The cohort model may be used as part of corequisite remediation, wherein the same group of students enrolls in both an introductory college-level course and an academic support course.

Corequisite remediation: A model of developmental support avoiding prerequisite developmental coursework in which students enroll in an introductory college-level math or English course while also receiving additional course-related academic support. Corequisite remediation has many variations. In one approach, students enroll in designated sections of the introductory college-level course as well as in a one- to three-unit linked support course designed to provide instructional support for the college-level course. In another variant, students receive additional support by enrolling in a higher-credit version of the introductory-level course (e.g., a 4-credit course rather than a 3-credit course).

Culturally responsive practices: Instructional practices that, along with culturally sustaining curricula, explicitly recognize and validate the identity and experiences of diverse student groups. By using an asset-based orientation and making reference to experiences, cultures, and identities of specific populations of students, the practices aim to provide more meaningful connection to and support for minoritized students inside classrooms.

Guided pathways: An increasingly popular whole-college reform approach that aims to support students throughout their college experience. It emphasizes well-designed programs of study, academic and career exploration and planning, and student supports and advising designed to help students choose a path, stay on a path, graduate or transfer, and enter a career.

Integrated reading and writing: A developmental approach in which both reading and writing skills are taught in the same course; students learn both sets of competencies and use writing to demonstrate their reading comprehension.

Math pathways: A curricular model in which students are encouraged to enroll in and complete an introductory college-level math course in their first academic year through the provision of course options that are aligned to a student's program of study. Students may enroll in courses such as statistics or quantitative reasoning, assuming that those courses, rather than college algebra, satisfy program requirements for their chosen program of study.

Multiple measures assessment (MMA): Using two or more criteria—and almost always using recent high school GPA when available—for assessment and placement of incoming students into developmental or college-level courses. Under MMA, standardized testing is no longer the primary means of assessing whether a student is prepared for college-level coursework.

Prerequisite developmental course model: Providing developmental education in math, reading, or writing through a sequence of one to three semester-length courses, depending on perceived need, traditionally assessed through standardized testing. Students are required or encouraged to complete the sequence before enrolling in an introductory college-level math or English course. Public institutions once offered an average of two to three course levels of remediation in math, reading, and writing, but the number of course levels offered and the ubiquity of the prerequisite model have declined across states in recent years.

What Works Clearinghouse (WWC): A leading federal source of information about education programs, policies, and interventions that show promise for improving student outcomes, based on evidence from rigorous studies as determined by WWC assessments of internal validity. The WWC offers a number of resources for researchers, practitioners, and policymakers, including intervention reports, practice guides, reviews of individual studies, and resources for researchers, such as methodological guidelines and training on rigorous research designs.

in community colleges and other broad-access postsecondary institutions have focused on reforming developmental education over the past decade. For example, institutional and system leaders have modified placement practices and policies to include additional measures of college readiness for assessing students (Barnett & Reddy, 2017). Faculty have designed new course sequences, realigned curricula, and embedded additional student supports in developmental coursework (Zachry Rutschow, Cormier, et al., 2019). And colleges have experimented with shortening the time students spend in developmental education by reducing the total number of developmental education course levels offered (Jaggars et al., 2015), combining developmental reading and writing into one course (Bickerstaff & Raufman, 2017), revising developmental math course content to align with the quantitative literacy needs of students' programs of study (Hartzler & Blair, 2019), using technology to deliver content (Boatman, 2019), and placing students who would have formerly taken prerequisite developmental courses into college-level courses with added corequisite supports (Henson et al., 2017; White, 2018).

Policy action and legislation in California, Florida, Texas, and other states have accelerated these trends. Over half of U.S. states now mandate or recommend developmental education reforms. According to the Education Commission of the States' compilation of developmental education policies (Whinnery & Odekar, 2021), 33 states have a state- or system-wide assessment and developmental placement policy, and 26 allow for the use of multiple measures assessment and placement. Twenty-four states allow or require the use of corequisite supports, and 26 allow for the use of "innovative developmental education instructional methods and interventions," including summer boot camps, refresher courses, peer tutoring, compressed course pathways, computer-assisted instruction, and other academic supports. These efforts are supported by a number of national initiatives and organizations that provide resources and guidance to states and institutions to accelerate reforms.²

Over half of U.S. states now mandate or recommend developmental education reforms.

Concurrent with these widespread changes, researchers have engaged in efforts to rigorously evaluate interventions to improve the outcomes of students referred to developmental education. In 2016, the What Works Clearinghouse (WWC)³ released a practice guide on developmental education that included relevant experimental and quasi-experimental research findings published between 1995 and 2015 (Bailey et al., 2016). But a proliferation of research on new reforms and a rapidly evolving state policy landscape over the past six years have rendered this and other developmental education literature reviews outdated. What is more, even in the current landscape, in which reforms to traditional developmental education are widespread and promoted by state policy, colleges continue to employ traditional approaches (often alongside reformed strategies), and the field continues to raise questions about strategies to refine and improve on their existing reform approaches (Zachry Rutschow, Cormier, et al., 2019). The review we present here draws on the most recent evidence to provide guidance to today's educators as well as to identify areas for future research.

In this report, we review both impact and implementation studies published between 2010 and 2022 with the goal of summarizing what is known about how developmental education reform can improve student outcomes. To do this, we address three research questions:

1. What are the structures and features of reforms and interventions with positive impacts on student success as measured by completion of a college-level course, credit accumulation, and credential completion?
2. What is known about approaches to increase success and equity for racially minoritized students, low-income students, students with lower levels of academic preparation, and English language learners?
3. What do research findings suggest about how to successfully implement effective developmental education reform?

To answer these questions, we rely primarily on randomized controlled trials and quasi-experimental studies of developmental education interventions that meet rigorous research standards. To contextualize our analysis, we also draw on broader developmental education literature, including implementation studies, cost studies, theoretical scholarship, and state policy analyses.

To create a useful resource that responds to the needs of practitioners and policymakers, we do three things in this report. First, rather than summarizing findings by type of intervention, we look across the body of evidence to draw out five *principles* for developmental education reform that include embedded implementation lessons (see box below). This approach acknowledges that institutions may not be able to replicate an intervention exactly as it was studied and that high-quality implementation is critical to success and sustainability. Second, we focus primarily on interventions that affect completion of college-level courses as well as credit accumulation and credential completion. While many studies have measured the impact of interventions on the completion of developmental requirements, in this review we focus on completion of college-level courses as our primary outcome of interest, under the assumption that students who gain momentum by completing introductory college-level courses in math and English are better positioned for academic success (Jenkins & Bailey, 2017). Because several studies report on this outcome, we are able to make comparisons across interventions and contexts; fewer studies report on credit accumulation and credential completion, but we include this information when available. Finally, we consider how well developmental education reforms are working for students traditionally underserved in higher education, including students who are Black, Latinx, and from low-income backgrounds, and students with greater academic needs. Previous research reviews have often overlooked questions of differential outcomes by student subgroup.

FIVE PRINCIPLES FOR REFORMING DEVELOPMENTAL EDUCATION

1. Grant students access to college-level coursework.
2. Provide targeted and tiered academic and nonacademic supports.
3. Employ contextualized curriculum and student-centered pedagogy.
4. Use equity-minded approaches for design and implementation.
5. Pair developmental education with comprehensive, sustained supports.

2 Our Approach to Reviewing the Literature

We began the review process by searching for research studies that met four primary inclusion criteria: (1) published during or after 2010; (2) focused on a change to developmental education policy, placement, course structure, curriculum, or teaching; (3) included both a program/treatment group and a control/comparison group; and (4) examined the impact of a reform or intervention on at least one of four outcomes: completion of developmental education requirements, completion of a college-level math or English course, total credits earned, or completion of a credential or transfer to a four-year college. To find studies that met these criteria, we reviewed federally funded study publications, examined study reviews conducted by the WWC, and searched research databases using key terms relevant to developmental education.⁴ We documented key features of a total of 43 studies that met these criteria,⁵ including intervention type examined, research context, student population, research design, and outcome and implementation findings.

From this body of research, we identified well-designed experimental studies and quasi-experimental studies.⁶ To assess the quality of these studies, we consulted reviews by the WWC. Those that met WWC standards with or without reservations were categorized as rigorous studies.⁷ We identified 17 such studies (see Table 1; for more information about the studies, see Appendix Table A1).⁸

The following principles are derived from the 17 studies that met our standards for rigor. We identified the shared features of the interventions under study that had a positive, statistically significant impact on the completion of college-level courses as well as on medium- and long-term outcomes such as credit accumulation and degree completion.⁹ We also looked at the size of the impact for each study. Similarly, we considered the shared features of interventions that had no significant impact on these outcomes. We also examined the impact of reforms on specific student populations—with a focus on Black and Latinx students, low-income students, students with lower levels of academic preparation, and English language learners—to understand how rigorous research can inform strategies to advance equity. Throughout the report, we also draw on a broader corpus of descriptive, correlational, and quasi-experimental studies that do not meet WWC standards as well as qualitative studies, cost studies, and theoretical scholarship. We use this additional literature to contextualize the principles, offer implementation lessons, and identify opportunities for future research.

We identified the shared features of interventions from 17 rigorous studies that had a positive impact on the completion of college-level courses and on other outcomes such as credit accumulation and degree completion.

TABLE 1. Rigorous Studies of Developmental Education Interventions With Positive Impacts on Student Success

Name of Intervention (Related Principles)	Study: Description of Study	Impacts on Student Success
AMP-UP: Accelerated Mathematics Sequence (1)	Douglas, McKay, & Edwards (2020): RCT at one New Jersey community college (Bergen) of a 7.5-week, intensive developmental math course followed by a 7.5-week, intensive college-level math course.	The accelerated course sequence increased completion of a college-level math course by 33 percentage points, college credit accumulation by 6.2 credits, and graduation rate by 9 percentage points.
Corequisite Remediation (1, 2)	Douglas, Edwards, & McKay (2020): RCT at one New Jersey community college (Union County). Students enroll in college-level math and participate in required weekly tutoring.	Corequisite math increased completion of a college-level math course by 11.4 percentage points. There was no impact on degree attainment after three years.
	Logue et al. (2019): RCT at three New York City community colleges of corequisite math. Students enroll in college-level statistics and receive weekly supplemental instruction.	Corequisite statistics increased completion of a college-level math course by 19.2 percentage points, credit accumulation by 4.4 credits, and graduation rate by 8.1 percentage points.
	Miller et al. (2022): RCT at five Texas community colleges of corequisite English.	Corequisite English increased completion of a college-level English course by 18.4 percentage points and credit accumulation by 1.5 credits. There was no impact on persistence.
CUNY Accelerated Developmental Writing Courses (1, 3)	Hodara & Jaggars (2014): Quasi-experimental study at three New York City community colleges of an accelerated developmental writing course that emphasizes group discussion.	The accelerated course increased completion of a college-level English course by 6.1 percentage points, credit accumulation by 2.1 credits, and graduation rate by 2.2 percentage points.
CUNY ASAP (2, 5)	Scrivener et al. (2015): RCT at three New York City community colleges of a three-year program that provides advising, tutoring, and financial support.	CUNY ASAP increased credit accumulation by 8.7 credits and graduation rate by 18.7 percentage points.
CUNY Start (2, 3, 4)	Weiss et al. (2021): RCT at four New York City community colleges of a pre-matriculation program that emphasizes student-centered teaching and provides support services.	CUNY Start increased completion of college-level math and English by 4 to 5 percentage points, college-level credit accumulation by 1.4 credits, and graduation rate by 3.1 percentage points.
Dana Center Mathematics Pathways (DCMP) (1, 3)	Biedzio & Sepanik (2022): RCT at four Texas community colleges of accelerated developmental math pathways in statistics and quantitative reasoning. DCMP emphasizes student-centered, contextualized instruction.	DCMP increased completion of a college-level math course by 6 percentage points. There was no impact on credits earned or degree attainment.
	Schudde & Keisler (2019): Quasi-experimental study of accelerated developmental math pathways in 20 Texas community colleges.	DCMP increased completion of a college-level math course by 36 percentage points and credit accumulation by 5.9 credits. There was no impact on degree attainment.
	Schudde & Meiselman (2019): Quasi-experimental study of accelerated developmental math pathways in 27 Texas community colleges.	DCMP increased completion of a college-level math course by 6 percentage points and college-level credit accumulation by 1.1 credits. There was no impact on degree attainment.
I-BEST (2, 3)	Martinson et al. (2021): RCT at three Washington State community colleges. I-BEST offers concurrent, contextualized instruction in workforce training and basic skills.	I-BEST increased total credits earned by 10.9 percentage points and receipt of any credential by 31 percentage points.
Multiple Measures Assessment ^a (1)	Barnett et al. (2020): RCT at seven New York community colleges of multiple measures assessment (MMA) systems.	MMA increased completion of a college-level course by 8 to 10 percentage points and credits earned by 3.9 credits.
	Cullinan & Biedzio (2021): RCT at five Midwestern community colleges of MMA systems.	MMA increased completion of a college-level course by 11 to 16 percentage points and college-level credits accumulation by 1.3 to 1.5 credits.

NOTE: Length of study follow-up period varies. See Appendix Table A1 for additional detail.

^a Impacts reported are for students in the “bump-up zone,” who were placed into college-level courses using multiple measures assessment but would have been placed into developmental courses using their placement test score alone.

3 Five Evidence-Based Principles for Developmental Education Reform

Principle 1. Grant students access to college-level math and English courses.

Summary of the evidence

Research has shown that under traditional developmental education policies in which standardized tests alone are used to assess students, college placement systems tend to underplace many students into prerequisite developmental courses they do not need (Scott-Clayton, 2012; Scott-Clayton et al., 2014). This suggests that many students would have greater success in college-level courses by taking fewer developmental education courses beforehand.

A large number of descriptive and rigorous studies support this idea. Research has found that similar students who are placed into shorter rather than longer developmental sequences or who are placed into college-level rather than developmental courses are more likely to complete college-level math and English courses (Ngo & Kosiewicz, 2017; Ran & Lin, 2022; Scott-Clayton & Rodriguez, 2015; Xu & Dadgar, 2018) and in some cases more likely to go on to graduate (e.g., Douglas, McKay, & Edwards, 2020; Hodara & Jaggars, 2014). In addition, several rigorous studies of interventions that *do not* grant students earlier access to college-level math and English courses (e.g., interventions involving content modularization, use of instructional technology, a cohort model, and mentoring in developmental coursework) have yielded disappointing results (Visher et al., 2010; Visher et al., 2012; Weiss & Headlam, 2019). These findings have compelled more colleges to grant larger numbers of students earlier access to college-level courses, including in their first term of college enrollment, often with additional supports.

Research suggests that many students would have greater success in college-level courses by taking fewer developmental education courses beforehand.

Colleges have primarily used two mechanisms to increase student access to college-level courses: changes to placement policies and implementation of a corequisite support model. Recent random assignment studies have shown that granting greater access to college-level courses using these mechanisms leads to positive outcomes. One common strategy to reform placement is to use multiple measures assessment (MMA). MMA is grounded in research showing that the use of additional measures, particularly high school GPA, can yield more accurate predictions of who can be successful in college-level courses than placement test scores alone (Scott-Clayton, 2012). In two recent random assignment studies, students who were bumped up into college-level courses through MMA were more likely than comparison

students to complete a college-level math or English course after three terms (Barnett et al., 2020; Cullinan & Biedzio, 2021). In one case, students bumped up into college-level courses through MMA were 11 and 16 percentage points more likely to complete a college-level math and English course with a C or higher (Cullinan & Biedzio, 2021).¹⁰

Similar patterns emerge in rigorous research on corequisite approaches that allow students assigned to remediation to enroll in college-level courses with concurrent support. In a corequisite approach, students enroll directly in the college-level course and co-enroll in a complementary course that provides additional academic (and sometimes nonacademic) support.¹¹ In an experimental study of corequisite remediation, students who traditionally would have been placed into the highest level prerequisite developmental education course were instead placed into a college-level English course with corequisite reading and writing support; those students were 18 percentage points more likely than control group students to complete a college-level English course within two years (Miller et al., 2022). Another experimental study found that students placed into a college-level statistics course with corequisite support earned 4 more credits after one year and were 8 percentage points more likely to earn a degree within three years as compared to students placed into a prerequisite developmental algebra course (Logue et al., 2019).

In three of these four experimental studies on MMA and corequisite remediation, students in all racial/ethnic subpopulations that researchers investigated generally showed similar positive gains when granted access to college-level courses.¹² Black and Latinx students made up roughly 70 percent of students in the two corequisite remediation studies. In the two MMA studies, roughly 30 percent of students identified as Black or Latinx.

Providing early access to college-level courses has been scaled through a number of statewide reforms. For example, in 2013, Florida passed Senate Bill 1720, which made developmental education optional for students with a Florida high school diploma or in active-duty military service. Concurrently, the law stipulated that public colleges had to offer developmental instruction through other formats, such as corequisite, modularized, compressed, or contextualized courses (Hu & Hu, 2022). Analysis of statewide data found that after the reform was implemented in 2014, students were more likely to complete college-level math and English courses in their first year. Importantly, research found that Black and Latinx students experienced greater college-level course passing gains relative to White students (Park-Gaghan et al., 2020) and that students with weaker high school academic preparation experienced greater gains relative to students with stronger high school preparation (Park-Gaghan et al., 2021). In another example, in 2017 California passed Assembly Bill 705, which seeks to maximize the chances that students complete introductory college-level math and English courses in their first year by using high school information or guided student self-placement to place students. The legislation also established that students have the right to enroll in college-level courses unless “placement research that includes consideration of high school grade point average and coursework shows that those students are highly unlikely to succeed in

Providing early access to college-level math and English courses has been scaled through statewide reforms in California and Florida, resulting in increased course completions.

transfer-level coursework in English and mathematics” (California AB-705 Seymour-Campbell Student Success Act, 2017). Research on California community colleges has shown increased access to college-level courses, declines in prerequisite developmental course enrollments, narrowing outcome differences across racial groups, and introductory college-level course success rates in math and English that have remained relatively stable (Mejia et al., 2020).

Implementation considerations

Implementation research in states where earlier access to college-level courses has been expanded offers important lessons for successfully executing and sustaining these reforms. Increasing access to college-level courses may require significant changes to the way colleges do business, and the nature of these changes may raise concerns among faculty and staff (Hu et al., 2015). For example, if a college’s advisors are not fully familiar with a new approach to placement and the rationale underlying the change, they may default to placing students into traditional prerequisite developmental sequences if those are still available (Daugherty et al., 2018). And among colleges that succeed in increasing college-level enrollments, they will necessarily offer fewer traditional developmental education course sections, which has serious implications for instructional staffing. Colleges engaging in such a strategy must adjust to shifting student enrollments and potential loss of enrollment in departments housing developmental courses, even as greater numbers of students enroll in college-level courses and accrue college credits. If faculty who previously taught developmental courses are not certified to teach at the college level, they may need additional training or risk job loss. Beyond these operational challenges, faculty and staff may be skeptical that students will be successful in college-level courses. And they may perceive that the move away from traditional developmental education reflects a devaluation of their contributions and expertise (Daugherty et al., 2018). Without attending to faculty and staff understandings and perceptions, colleges may adopt some new practices but maintain restrictions that limit the number of students who can directly access college-level courses. As discussed below in Principle 4, when student access to college-level courses is limited, more advantaged students appear to benefit disproportionately. Even in state contexts where reforms are mandated through legislation, institutions are likely to vary in their degree of adoption of required changes, such as in California, where many colleges have been slow to phase out remedial course offerings (California Acceleration Project, 2021; Hern et al., 2020).

Implementation research offers examples of strategies to engage faculty and staff, build trust, and shift mindsets to support successful and sustainable reform. Studies of multiple measures assessment and corequisite support implementation show the importance of building diverse, inclusive, cross-functional planning teams (comprised of faculty, administrators, and staff) for decision-making (Barnett et al., 2020). At the institutional level, these teams can anticipate and identify stumbling blocks early on, and they can generate innovative, customized approaches to meet specific institutional needs. Early and authentic engagement and shared implementation decision-making may build buy-in for reform. States

Studies of multiple measures assessment and corequisite support implementation show the importance of building diverse, inclusive, cross-functional planning teams.

have also used this cross-functional approach to system-wide developmental education reform planning and decision-making (Kalamkarian et al., 2015). At both levels, research points to the important role faculty champions can play in interpreting student data, shifting mindsets, and providing their colleagues with a roadmap for change. Organizations accustomed to providing technical assistance that have strong relationships or credibility at a college (e.g., student success centers, disciplinary societies) can also assist in preparing institutions to make the changes necessary to broaden access to college-level courses (Zachry Rutschow, Sepanik, et al., 2019).

Principle 2. Provide targeted and tiered supports to address students' academic and nonacademic needs.

Summary of the evidence

Evidence shows that students who would have traditionally been placed in prerequisite developmental education courses do better overall when granted access to college-level courses in the first term. While a segment of students who would have traditionally placed into developmental education can be successful when directly placed into a standalone college-level course without additional learning support (Barnett et al., 2020), evidence also suggests that colleges should offer targeted and tiered supports for students with weaker preparation and other, nonacademic needs. These services may include pre-college programs, corequisite support courses, embedded tutoring, and high-touch advising. Multiple measures assessment that accounts for cognitive and noncognitive factors can help to identify students who will benefit from these supports. A targeted and tiered support structure suggests that some students may need fewer services and others may need more.

Within the body of rigorous research we reviewed, comparatively less is known about students with very low placement test scores, in part because quasi-experimental studies using a regression discontinuity design make up much of this work, and they have mostly focused on students scoring on the margin between college-level and the highest level of developmental education rather than on students on the margin between two developmental levels. Yet several quasi-experimental studies have shown negative or null effects on the traditional developmental sequence for lower scoring students, particularly in math (Boatman & Long, 2018; Dadgar, 2012; Xu & Dadgar, 2018). In English, Boatman and Long (2018) did find that students who placed into less advanced, second-level developmental reading and writing courses had stronger medium and long-term outcomes (e.g., persistence in college, credits earned) than similar students who placed into more advanced, first-level developmental courses. On the other hand, when looking at outcomes after statewide reforms were enacted that grant more students access to college-level courses, recent studies show that students with weaker academic preparation experience greater benefits than students with stronger preparation (see Park-Gaghan et al., 2021, for analysis in Florida). Ran and colleagues (2022) showed, for example,

A targeted and tiered support structure suggests that some students may need fewer services and others more.

that the statewide implementation of a corequisite reading approach in Tennessee reduced the differences in college-level English completion between high- and low-scoring students by half.

To be successful in college, students need strong literacy and numeracy skills. They also need to develop productive academic and nonacademic habits and behavior. Two experimental studies in our review have found that programs with multifaceted supports and thoughtfully designed curriculum and instruction—I-BEST and CUNY Start, both to be described later—had positive effects for lower scoring students (Martinson et al., 2021; Scrivener et al., 2018; Weiss et al., 2021). Taken together, the available evidence suggests that integrated academic and nonacademic supports, including corequisite support courses, are likely beneficial for some portion of the incoming student population; yet these supports should be offered on a targeted basis, keeping in mind that many students can be successful in college-level courses alone.¹³

Implementation considerations

The literature offers implementation lessons from two support models with rigorous evidence of effectiveness. The first, introduced above, is the corequisite model. The literature has documented a wide array of approaches to corequisite course design. Some corequisite course sections are linked to the college-level section and taught by the same instructor. In other systems, students have the choice to enroll in any available section of either course. In some approaches, the college-level course is intentionally comprised of “on-level” and “developmental-level” students; others enroll only students referred for corequisite support. Corequisite supports may be structured as a course or as a learning lab and may be offered in-person or online. Thus far there has been limited research on differences in outcomes between these approaches. Despite the variation in how it is structured, the corequisite support model focuses on providing additional instructional time to help students master key concepts and develop skills and habits necessary for success in the college-level course. Faculty may use the extra time to provide “just-in-time” remediation, introducing or reviewing specific skills just as they are needed in the college-level course curriculum. Some studies of corequisite implementation have highlighted the opportunities for faculty to build students’ confidence, support the development of self-regulated learning skills, and address other affective or non-content-related issues (e.g., Rodriguez et al., 2018).

Despite how it is structured, the corequisite support model focuses on providing additional instructional time to help students master key concepts and develop skills and habits necessary for success in an accompanying college-level course.

A second example of a support model that provides valuable implementation lessons is CUNY Start, which provides robust instruction and assistance to students. Unlike students participating in other interventions described thus far, CUNY Start students delay matriculation into college for one semester to enroll in the intensive, multifaceted program. CUNY Start is in this way similar to summer bridge programs and other pre-college approaches. The model includes a carefully designed curriculum taught by highly trained instructors, intensive instruction (12 hours per week per subject area), a cohort model with a low student-to-advisor ratio, and embedded academic supports in writing and math. Advisors and instructors meet weekly to identify student needs and

collaborate on support approaches. Survey findings show that students in CUNY Start are more likely to access tutoring and advising than students in traditional developmental education courses (Scrivener et al., 2018). Results from an experimental study have shown that, after three years, students enrolled in CUNY Start were more likely to complete college-level math (by 5 percentage points) and English (by 4 percentage points) and were more likely to graduate (by 3 percentage points)—even despite formally enrolling in college one semester later than students in the control condition (Weiss et al., 2021). Effects were similar for students across racial/ethnic groups. Close to 65 percent of students in the study were Black or Latinx, and only 6 percent were White. Importantly, findings from the study suggest that multifaceted supports with carefully designed instruction may be important for students with weaker preparation. CUNY Start was found to have a greater effect on students referred to three developmental subjects (math, reading, and writing) rather than fewer subjects, suggesting that the program had a stronger benefit for students with more profound academic needs (Weiss et al., 2021). It is difficult to ascertain what features of the multifaceted program contributed the most to this benefit; indeed, its comprehensive nature (combining intense instruction with embedded academic and nonacademic supports) may have been particularly valuable. Notably, the CUNY Start study showed that students with stronger academic preparation benefited less from the intervention, suggesting that they may have been better served if placed directly into college courses, providing further evidence in support of Principle 1.

Principle 3. Employ contextualized curriculum and student-centered pedagogy.

Summary of the evidence

Available evidence makes it difficult to disentangle the impacts of strong curriculum and pedagogy from other aspects of developmental education reform. This is because in interventions examined in the relevant rigorous studies, improvements to instruction were combined with structural changes that expanded access to college-level courses, shortened developmental education sequences, and/or provided additional supports. However, our review points to the value of two instructional features substantiated elsewhere in the literature: contextualized curriculum and student-centered pedagogy.

Qualitative research on developmental education has identified a tendency for curriculum and instruction to focus on decontextualized skill instruction (e.g., Cox, 2018; Givvin et al., 2011; Grubb, 2013). For example, reading has traditionally been taught separately from writing, and math curriculum has focused on procedures and memorization rather than concepts (Bickerstaff & Raufman, 2017; Quarles & Davis, 2017). By contrast, a contextualized curriculum goes beyond isolated skill development and instead engages students in authentic literacy and numeracy tasks like those they will encounter throughout college (Perin, 2011), foregrounding higher level competencies that students need to master to be successful in college-level courses and beyond (American

A contextualized curriculum engages students in authentic literacy and numeracy tasks like those they will encounter throughout college.

Mathematical Association of Two-Year Colleges [AMATYC], 2018; Edgecombe et al., 2014). In their description of an “accelerated pedagogy” for reformed developmental education contexts, Hern and Snell (2013) described a curriculum that “asks students to engage with issues that matter, wrestle with open-ended problems, and use resources from the class to reach and defend their own conclusions” (p. 7).

In our review, several interventions included contextualized curriculum. For example, mathematics pathways reforms, which align developmental supports to a college-level math course appropriate to each student’s intended program of study, have tended to contextualize math skills in real-world and career-relevant problems, particularly in courses for non-STEM majors (Hartzler & Blair, 2019). An implementation study of the Dana Center Mathematics Pathways (DCMP) found that DCMP courses to prepare students for college-level statistics and quantitative reasoning courses include problems that are contextualized in real-world scenarios, use real datasets, and are linked to other academic subject areas; this contrasts with standard developmental math courses that typically focus on the proper use of formulas, equations, and procedures. In a random assignment evaluation of DCMP, students enrolled in the DCMP were 6 percentage points more likely than control group students to pass college-level math by their sixth semester (Biedzio & Sepanik, 2022). Sixty-six percent of the students in the study were Black or Latinx; students across racial subgroups experienced similar gains from the intervention.

Mathematics pathways reforms have tended to contextualize math skills in real-world and career-relevant problems, particularly in courses for non-STEM majors.

The Integrated Basic Education and Skills Training (I-BEST) program, which has also been evaluated via a random assignment evaluation, offers another example of curricular contextualization. The I-BEST program is intended for adult learners enrolled in either English as a second language or adult basic education classes who intend to pursue occupational certificate or degree programs. As compared to developmental education more broadly, I-BEST serves a distinct student population. But its inclusion of students with low scores on an assessment of adult basic education skills is instructive. The central component of I-BEST is a team-teaching model whereby students receive instruction in an occupational content area concurrent with math, reading, or writing instruction delivered by a second instructor in the same course (Martinson et al., 2018). This approach accelerates student access to credit-bearing courses in their occupational program, and it provides academic instruction that is contextualized within their area of study. The program also offers nonacademic supports in the form of advising and financial assistance. Findings show that students who participated in I-BEST had higher rates of enrollment and completion in college-level math and English. After three years, almost half of students in the treatment group earned a college credential, compared to 17 percent of the control group (most of the credentials earned were short-term certificates) (Martinson et al., 2021). Thirty-three percent of the students in the sample were Black or Latinx.

The second valuable instructional feature that emerges from the literature is student-centered pedagogy. Rather than primarily lecturing and demonstrating, faculty employing student-

centered pedagogy design classroom activities in ways that help students to contribute ideas, discuss concepts, and justify their thinking. CUNY Start provides an example of both contextualized curriculum and student-centered pedagogy. In the CUNY Start implementation study, the contrast with standard developmental education courses was found to be particularly notable in mathematics. Students in CUNY Start math were more likely than students in the control group (by 38 percentage points) to report on a survey that they worked in groups. Almost all CUNY Start math instructors (97 percent) reported that they asked students to explain their thinking and discuss ideas with fellow students, compared to 64 percent of non-CUNY Start math instructors. Classroom observations found that CUNY Start instructors spent 68 percent of class time leading discussion or facilitating interactive learning, compared to 18 percent of class time in observed non-CUNY Start classes (Scrivener et al., 2018). As noted above, CUNY Start students in both math and English had positive long-term outcomes compared to their peers in the control condition. But dramatic differences in short-term outcomes in math suggest that these instructional features are particularly important in math: CUNY Start students were 32 percentage points more likely than control group students to demonstrate college readiness in math after one semester by taking and successfully passing a developmental education exit exam (Weiss et al., 2021).

Faculty employing student-centered pedagogy design classroom activities in ways that help students to contribute ideas, discuss concepts, and justify their thinking.

Implementation considerations

To introduce contextualized curriculum and student-centered pedagogy, institutions must invest in resources and professional development for faculty. Faculty are likely to be disciplinary experts with limited pre-service training on curriculum or pedagogy development. In both the DCMP and CUNY Start studies, instructors were provided with a detailed curriculum and significant professional development learning opportunities to prepare them to deliver the intervention. Importantly, rather than focusing on a generic set of teaching practices, these learning opportunities made use of the specific curriculum instructors were intending to teach. Disciplinary associations like the American Mathematical Association of Two-Year Colleges (AMATYC) and the Two-Year College English Association (TYCA), among others, may be an important resource in developing and disseminating curricular and pedagogical reforms. Research suggests that professional development to support faculty to adopt new instructional practices share the following features: articulating clear professional learning goals for faculty participants; providing intensive support over time (rather than a one-time workshop); employing skilled facilitators; and providing classroom-embedded support through observation, coaching, or opportunities for guided practice (Condon et al., 2016; Cormier & Bickerstaff, 2020; Raphael & Bickerstaff, 2022).

Principle 4. Use equity-minded approaches for design and implementation.

Summary of the evidence

As noted above, Black and Latinx students are more likely to enroll in developmental courses than their White peers (Chen, 2016; Chen et al., 2020) and are also more likely to leave college without a credential (National Center for Education Statistics, 2018). These trends mirror broader inequities in K-12 and higher education outcomes and underscore the need for colleges to proactively identify and dismantle institutional policies and practices that create barriers to success for students from historically underserved groups. One research question for this review focuses on what is known about how interventions affect different student subpopulations, including racially minoritized students, low-income students, and English learners. None of the interventions examined in the rigorous research we reviewed were described as explicitly designed to meet the needs of a particular racial/ethnic subpopulation or of English learners. Yet, among the 17 rigorous studies in our review, eight looked at the impact of an intervention for different racial/ethnic groups, and two focused on how the interventions affected the experiences of English learners. In most cases, analyses of outcomes for student subpopulations were described as exploratory, so the findings should be interpreted with caution.¹⁴ This suggests the need for a stronger focus on questions of equity when designing rigorous research.¹⁵ In this section, we complement findings from the impact studies with those from descriptive analyses of statewide developmental education reforms that discuss outcomes by race/ethnicity.

State-level data have shown encouraging trends in terms of narrowing outcome gaps between students from historically marginalized groups and White students. In Florida, researchers found that after the implementation of the statewide reform, the gap in college-level course enrollments between White and Latinx students effectively disappeared. Differences in course pass rates between White, Black, and Latinx students narrowed (Park-Gaghan et al., 2020). Descriptive analyses of course enrollment and completion in California found increases in enrollment in and completion of college-level courses for all racial/ethnic groups after statewide reform. In some cases, the increases were larger for Black and Latinx students than for White students, leading to a narrowing of gaps in outcomes (Mejia et al., 2020). Given that students of color and low-income students are generally assigned to traditional developmental education in greater numbers and thus disproportionately affected by its negative impacts, efforts to improve developmental education for all students can disproportionately benefit underserved students.

At the same time, analyses in California suggest the need to pay careful attention to which students have access to reformed course structures. A policy analysis has shown that after implementation of AB 705, Black and Latinx students were more likely to continue to be enrolled

Data on the effects of broad reforms that provide greater access to college-level courses have shown encouraging trends in the narrowing of equity gaps, yet educators need to address which students have access to reformed course structures.

in optional prerequisite developmental courses than the larger student population (Hern et al., 2020). This result can partly be attributed to Black and Latinx students disproportionately attending colleges that have maintained more remedial math offerings (Hern et al., 2020). Additional analysis showed that colleges with fewer students accessing college-level courses had larger racial disparities in college-level course completion outcomes (Mejia et al., 2020). Research on early math pathways implementation in Texas found that colleges tended to enroll disproportionately more White students than Latinx students in the reformed DCMP courses (Schudde & Meiselman, 2019). The examination of statewide developmental reforms thus provides evidence of the benefits of granting students early access to college-level courses and simultaneously suggests the need to critically examine placement and advising policies and practices for racial/ethnic bias (Maldonado, 2019).

In most of the rigorous studies showing positive outcomes that we reviewed, all student groups served by the intervention under examination experienced comparable gains in outcomes, but these gains did not narrow gaps in outcomes by student subpopulation. For example, in the random assignment study of DCMP, students in all racial/ethnic groups in the treatment condition completed the developmental math sequence at higher rates than students in the control condition, but the differences in outcomes by race/ethnicity remained relatively stable. Findings show a comparable 14 to 15 percentage point difference in rates of completion between Black students and White students in both treatment and control conditions. Twenty-two percent of Black students and 36 percent of White students in the control group completed the standard developmental math sequence. Forty percent of Black students and 55 percent of White students in the treatment group completed the DCMP sequence (Zachry Rutschow, Sepanik, et al., 2019). Similar patterns played out in the random assignment studies of corequisite models, multiple measures assessment, and CUNY Start.

Implementation considerations

Despite the positive effects of statewide developmental education reform on racially minoritized students, to achieve equitable outcomes in college-level course completion and other academic progression metrics, institutions must adopt equity-minded, race-conscious approaches in the design and implementation of developmental education reform (see, e.g., Center for Urban Education, 2017). Such approaches seek to identify and address institutional- and classroom-level structures, policies, and practices that create or maintain racial inequities in access to and completion of introductory college-level courses. These include placement practices that divert Black and Latinx students or students from other groups away from college-level courses (Kopko et al., 2022). They may also include classroom practices that serve to disengage or discourage students from particular groups or that fail to address stereotype threat (i.e., a student's fear of confirming a negative stereotype), myths about aptitude grounded in prejudice, or micro-aggressions that insinuate that Black and Latinx students and students from other minoritized groups do not belong in college.

To achieve equitable outcomes in academic progression metrics, institutions must adopt equity-minded, race-conscious approaches to developmental education reform.

In addition to granting students access to college-level courses and providing training to ensure staff are not allowing racial bias to influence their advice to students on course selection, theoretical and empirical literature from K-12 and higher education points to two additional ways to adopt race-conscious practices to support equitable completion of college-level math and English. First, research suggests that culturally affirming classroom strategies are critical to closing equity gaps in course performance and course completion. Culturally affirming strategies include curricular and pedagogical practices that value and emphasize linguistic and cultural pluralism (Ladson-Billings, 1995; Paris & Alim, 2014), that affirm and validate students' enrollment in college by providing encouragement and support (Rendon, 1994), and that actively dispel racialized myths about student ability and build a sense of confidence and belonging (Miller-Cotto & Lewis, 2020; Truscello et al., 2014). A study conducted at a private university found that when Black students' doubts about their sense of belonging were mitigated, their grades and other long-term academic outcomes improved; notably, this intervention had no discernible impact on White students and thus narrowed outcome differences by race (Brady et al., 2020; Walton & Cohen, 2007). When applied in the context of developmental education reform, equity-minded classroom practices may include incorporating culturally relevant concepts into the curriculum, foregrounding the relevance of students' personal experiences, and addressing math anxiety and stereotype threat (Brathwaite et al., 2020; Buck et al., 2021; Roberts, 2021).

Research suggests that culturally affirming classroom strategies are critical to closing equity gaps in course performance and course completion.

Second, culturally affirming out-of-class programming may help to support students' sense of belonging while addressing additional barriers that racially minoritized students face. Several initiatives exist at community colleges and four-year institutions that aim to support the success of male students of color (for a national scan of these programs, see Gardenhire & Cerna, 2016). The Male Student Success Initiative at the Community College of Baltimore County is one such program. It provides male students of color with a number of supports, including staff mentors (also men of color) who guide them toward academic and personal success; regular cohort meetings and related events that strive to develop a sense of brotherhood and community; a culturally contextualized student success course; and leadership and professional development opportunities (Manno et al., 2020). In another example, One Million Degrees, a nonprofit organization and program, provides financial support, academic support, personal coaching, and professional development to low-income, highly motivated high school graduates and returning adult community college students in the Chicago area. The program was found to substantially increase participants' enrollment in college as well as their likelihood of earning an associate degree within three years. The vast majority of the study sample was made up of Black or Latinx students. Roughly 60 percent of the sample were first-generation college students. All were eligible for the Pell or STAR grants (Hallberg et al., 2022). It is important to note that while out-of-class programs tailored to minoritized populations may provide a much-needed community of support, they may not address the broader institutional policies and practices that reinforce inequitable outcomes. Thus, in addition to supporting such programs, institutions must also work to transform the larger campus environment (Museus, 2014).

CONSIDERATIONS ON THE COSTS OF INTERVENTIONS

New interventions typically create additional costs for colleges. Additional staff, including new advisors, time, office space, and materials, represent new costs that are an important factor in decisions about intervention adoption, particularly for resource-strapped community colleges and policymakers who make decisions that affect community colleges. Two interventions may produce similar impacts on student outcomes, but if they have different costs, the cheaper intervention may be preferable. In some cases, an intervention with smaller impacts on student outcomes may even be preferable if it is cheaper and can thus be offered to more students.

Cost-effectiveness is a way of comparing interventions with different costs on a “per outcome” basis. It is calculated by dividing the cost of an intervention by its impact on student outcomes. For example, an intervention that costs \$800 per student and increases introductory college-level (or gateway) course completion by four percentage points has a cost-effectiveness of \$200 per one percentage point increase in gateway course completion. Cost-effectiveness comparisons are useful because an intervention that is more cost-effective produces more improved outcomes for a given amount of money. It is important to understand, however, that cost-effectiveness analyses place equal weight on outcomes for all students, while decision-makers may place additional weight on outcomes achieved by students from historically marginalized groups. Thus, decision-makers may prefer an intervention that is less cost-effective but produces more equitable outcomes.

Among the 17 rigorous studies of developmental education reform included in this review, eight included a cost analysis. Among these eight interventions, three cost under \$200 per student offered the intervention (over the full duration of the intervention): Multiple measures assessment (MMA) in the Midwest, MMA at SUNY, and Dana Center Math Pathways (DCMP). Three cost between \$500 and

\$1,500 per student: Learning communities, CUNY Start, and Texas Summer Bridge. And two cost over \$5,000 per student: I-BEST and CUNY ASAP.²⁰

Cost-effectiveness comparisons require not only a cost analysis but also the same measures of outcome improvement across studies. Six studies estimated impacts on math gateway course completion, five estimated impacts on English gateway course completion, and seven estimated impacts on credits earned. In terms of math gateway course completion, DCMP and MMA in the Midwest were the most cost-effective interventions, costing \$26 and \$37 per one percentage point increase in course completion, respectively.²¹ MMA in the Midwest was the most cost-effective intervention in terms of English gateway course completion at a cost of \$19 per one percentage point increase in course completion, followed by MMA at SUNY at a cost of \$50 per one percentage point increase in course completion. In terms of credits earned, MMA in the Midwest was the most cost-effective intervention at \$165 per additional credit earned.

The three most cost-effective interventions in terms of gateway course completion and credits earned—MMA in the Midwest, MMA at SUNY, and DCMP²²—are also the least costly interventions we reviewed, costing less than \$200 per student offered the intervention. These cost-effectiveness findings suggest that these three “low cost, moderate impact” interventions may be a good place for colleges to start when deciding how to invest resources; however, more significant investments in “high cost, high impact” interventions, such as ASAP and I-BEST, may be necessary to achieve substantial improvements in student outcomes. More cost-effectiveness research is needed on other interventions and strategies, such as the use of corequisite support courses, granting students direct access to college-level courses without support, and guided pathways.²³

Principle 5. Implement developmental education reforms alongside comprehensive, sustained supports to improve long-term outcomes.

Summary of the evidence

As the research above indicates, several reforms to developmental education help students to enroll in and pass college-level courses and make progress in college. However, fewer interventions have been shown to increase long-term outcomes such as graduation. Rigorous evaluations of short-term interventions such as first-year, semester-long learning communities and summer bridge programs find that they modestly increase developmental course completion and semester-to-semester persistence while the intervention is in place. However, evidence of these impacts typically fades a semester or two after the intervention ends (Barnett et al., 2012; Visher et al., 2012). More recent reforms such as multiple measures assessment and corequisite remediation, which fundamentally change students' placements, course requirements, and classroom experiences, lead to more substantial and longer lasting impacts on completion of college-level courses. In our review, six of the nine rigorous studies that examined degree attainment after at least two years found a positive impact on this measure—and three of these six studies were evaluations of multifaceted interventions.¹⁶ These results suggest that a discrete reform to one early dimension of the student experience (i.e., developmental education) is not likely to do much to improve graduation rates. This is not surprising given that developmental interventions take place early in a student's college experience and are thus likely to have a greater impact on more proximal outcomes such as completion of introductory college-level courses.

Reforms that address multiple barriers to student success and that support students throughout their entire time in college can have a substantial impact on long-term outcomes such as degree attainment.

Implementing developmental education reforms alongside comprehensive supports that address multiple barriers to student success and span students' entire time in college is likely necessary to move the needle on college completion. A growing body of evidence suggests that reforms that address multiple barriers to student success and that support students throughout their entire time in college can have a substantial impact on long-term outcomes such as degree attainment. One example is the City University of New York's Accelerated Study in Associate Programs (CUNY ASAP), a multifaceted program that provides full-time students with advising, financial, and academic support for three years. A random assignment evaluation found that the program nearly *doubled* the three-year graduation rate (an increase of 18 percentage points) for students in developmental education. These impacts on degree completion were large and positive for all racial/ethnic groups, and close to 80 percent of students in the study were Black or Latinx (Scrivener et al., 2015; Miller & Weiss, 2021).¹⁷ CUNY Start, the intensive pre-matriculation program described under Principle 2, is designed as a pathway into ASAP, and a close relationship exists between the two programs (Kim et al., 2020). In fact, CUNY Start's modest impact on graduation can largely be explained by increased participation in the CUNY

ASAP program (Weiss et al., 2021). In addition, CUNY Start increases the number of students who are deemed college-ready or nearly so, thereby increasing the number of students eligible to participate in CUNY ASAP (Weiss et al., 2021).¹⁸ The relationship between CUNY Start and CUNY ASAP suggests the importance of pairing developmental education reforms that help students make progress in college-level English and math with other effective, long-lasting student success programs.

Another comprehensive approach to student success is guided pathways—a popular whole-college reform strategy that emphasizes well-structured programs of study, student goal-setting and academic planning, and enhanced advising to help students begin and stay on a clear path to graduation and a career (Jenkins et al., 2021). Guided pathways is a framework for integrating multiple interventions to support students throughout their college experience. Within this framework, developmental education reforms like corequisite remediation are viewed as on-ramps to well-designed and well-supported academic and career pathways rather than as strategies that would be expected to improve student graduation rates on their own. In Tennessee, for instance, colleges across the state have implemented corequisite remediation and math pathways alongside several other guided pathways reforms, such as redesign of their advising practices. Descriptive evidence from Tennessee and other states suggests that implementation of whole-college reforms aligned with the guided pathways approach is associated with increases in credit accumulation and completion of college-level courses for students in their first year (Jenkins, Brown, et al., 2018; Jenkins, Lahr, et al., 2018).¹⁹

Guided pathways is a framework for integrating multiple interventions to support students throughout their college experience.

Implementation considerations

Given the scope and scale of comprehensive reforms, institutions need to invest considerable time and staff capacity to implement them. Implementation research emphasizes the importance of creating planning and implementation teams that bring together a broad range of faculty, staff, and administrators from departments and offices across an institution, including enrollment management, academic affairs, information technology, and others. Institutions should also invest in robust data management systems and regularly review data on student progress to inform ongoing improvement (CUNY Office of Academic Affairs, 2020; Cormier et al., 2020; Jenkins et al., 2019).

Comprehensive reforms such as ASAP also require more financial resources than discrete, short-term interventions (see box on cost considerations on p. 18). This can pose a particular challenge for community colleges, which tend to receive less state funding per student than public four-year colleges and universities (The Institute for College Access and Success, 2019). Despite the need for additional investments in community colleges, many colleges have been able to scale and sustain whole-college reforms by reallocating resources that have been spent on less effective programs and practices and by integrating reformed practices into existing operations (Jenkins et al., 2020; Headlam, 2018).

4 Summary and Directions for Future Research

Our review of recent rigorous studies on developmental education reform points not only to a set of interventions with strong evidence of effectiveness but also to a broader set of principles that can guide states and institutions in designing their own approaches to improving early college outcomes. To follow these principles, colleges should broaden access to college-level courses, keeping in mind that a subset of students may need embedded academic and nonacademic supports to be successful. Within college-level and corequisite developmental courses, evidence suggests that students will benefit from contextualized and student-centered instructional approaches. To implement these changes, institutions will need to invest time and resources to engage faculty and staff in planning for implementation. This includes training on how beliefs among college personnel about student needs and barriers, as well as student potential, can serve to undermine or support reform planning and implementation. Thoughtfully designed professional learning opportunities focused on curriculum and pedagogy—including culturally sustaining curriculum and instruction—are necessary, as are learning activities on mindset and implicit bias. Interventions that are designed and implemented in a race-neutral fashion may benefit all groups but are unlikely to fully mitigate policies and practices that perpetuate outcome differences by race/ethnicity. Institutions should therefore use an equity-minded approach to examine who has access to college-level courses and to implement culturally affirming classroom instruction and learning environments. Finally, given that we have limited evidence that discrete reforms to developmental education can meaningfully improve graduation rates, reformers should look to pair these evidence-based approaches to developmental education reform with long-term multifaceted supports that help students throughout their tenure at college.

A secondary goal of this review is to identify areas for future research. Based on our analysis of the landscape of experimental, quasi-experimental, descriptive, and implementation research, we identify five questions for future study.

Colleges should broaden access to college-level courses, keeping in mind that a subset of students may need embedded academic and nonacademic supports to be successful.

How can reforms to developmental education lead to more equitable outcomes?

One of the key research questions guiding this review has been: What is known about approaches to increase success and equity for different student populations, including racially minoritized students, low-income students, students with lower levels of academic preparation, and English language learners? Analyses of statewide policy have shown that large-scale efforts to broaden

access to college-level courses can narrow outcome differences, as students of color who were more likely to be referred to developmental education previously benefit more from reforms that disrupt the traditional system. At the same time, the available studies largely show that differences in college-level math and English completion by race/ethnicity and income continue to persist, even in reformed contexts. Therefore, additional research is needed to uncover the specific policies and practices in institutions and classrooms that serve as barriers to racially minoritized students. Researchers should seek to evaluate the impacts of interventions that are designed and implemented in race-conscious, equity-minded ways. These may include interventions tailored to meet the needs of particular student groups or classroom-level strategies to create an inclusive, culturally sustaining learning environment. Finally, many rigorous studies in our review did not disaggregate data by student subgroup; most did not include large enough samples to generate confirmatory outcomes for racial/ethnic subgroups, and only two included outcomes for students identified as English learners. Future evaluations should be designed to understand potential differential impacts on a range of student subgroups.

Researchers should seek to evaluate the impacts of interventions that are designed and implemented in race-conscious, equity-minded ways.

What barriers face students who are not successful in college-level courses? What supports will promote success for students with the greatest academic needs?

The available evidence strongly suggests that outcomes improve and become more equitable when students are granted early access to college-level courses, but not all students pass their introductory college-level courses in math and English, even with corequisite support.²⁴ Therefore, researchers should investigate the specific barriers facing students who are not successful in college-level courses; current evidence suggests that students likely face both academic and nonacademic challenges. Comparatively less is known about students with greater academic needs. Many of the rigorous studies included in this review included only students who would have placed into the highest level of developmental education. Most did not look at differential outcomes by students' prior academic performance, although exploratory analyses suggest that CUNY Start and DCMP are more effective for students with greater levels of academic need (as measured by placement test performance); I-BEST was also shown to be effective in serving students with greater needs. The relatively small body of evidence on lower-scoring students may fuel faculty and staff concern that students with greater academic needs will not be successful in college-level classes—a perception that has hindered the scale-up of evidence-based reforms.

Additional exploratory work is needed to understand the obstacles facing students. Future evaluations should focus on the types of support and combinations of academic and nonacademic support that improve outcomes in college-level math and English and on optimal approaches for implementing corequisite supports. Research suggests that high-quality instruction is important,

but few rigorous studies focus on curriculum and pedagogy. In addition, more evidence is needed to clarify the best way to identify those students who will benefit from a corequisite course and other tiered supports in comparison to those who can be successful in a standalone college-level course.

How much does it cost to implement effective reforms?

A key question for colleges seeking to implement these strategies is the cost, both for planning and launching new approaches and for maintaining and refining new interventions over time. Institutional leaders have long desired sound guidance on how to deploy their limited resources more effectively. Eight of the 17 rigorous studies in our review included a cost analysis, suggesting an overall need for more cost research, with a particular focus on cost effectiveness. Available analyses show the costs of implementing interventions but do not provide information on the broader costs to institutions of increasing access to college-level courses (e.g., for retraining and redeploying faculty and for offering different course types). Institutional leaders may need additional research and support to make sound financial decisions. The need to consider cost is amplified in the current climate, as institutions face considerable funding uncertainty, declining enrollment and tuition revenue, and unstable economic consequences from COVID-19. Interventions thought to be cost-prohibitive are unlikely to be implemented by colleges, even if they show positive effects. Policymakers also need more general information on how the shifts away from prerequisite developmental education and toward college-level courses with tiered supports impact revenues and expenditures.

How can developmental education be paired with longer-term supports to improve graduation rates?

There is a growing recognition that developmental education reform alone is not enough to move the needle on college completion but may serve as a core component in broader reform strategies. Among the 17 rigorous studies in our sample, nine followed students for three years or longer, and the remaining followed students for less time. The field would benefit from more longitudinal studies that follow students for longer periods of time and take into account students' prior academic preparation and career goals; they could thus provide information on whether interventions have substantial effects on graduation and transfer rates and perhaps on labor market outcomes.

Developmental education reform alone may not move the needle on college completion, but it can serve as a core component in a broader reform strategy.

Student success initiatives aimed at increasing completion rates, particularly at community colleges, are growing. Yet, despite this growth, research on the varied approaches used to integrate developmental education reforms, such as corequisite support courses, with broader reform frameworks, such as guided pathways, remains limited. Implementation research could shed light on how to effectively integrate

developmental education reforms with other prominent student success initiatives. Providing sustained academic and nonacademic support through tutoring, advising, and other means could help support students in a more holistic fashion all the way to graduation. A move away from discrete reforms to a broader redesign of the student experience will place different demands on institutions for planning and implementation and may require different incentives, supports, and accountability structures.

What are the impacts of emerging implementation strategies?

In response to a wealth of research showing the ways that the traditional system of developmental education stymies student progress, faculty, institutional leaders, and intermediary organizations have worked at an extraordinary pace to transform developmental education. Despite the growing number of studies published in recent years, the research has not kept pace with emerging practices and policy strategies. Implementation research should continue to investigate whether and how state policy actions promote improvement and innovation.

The COVID-19 pandemic has also accelerated changes in practice, necessitating new research (Bickerstaff et al., 2021). Guided self-placement, in which students select which course level they would like to enroll in, is one strategy in need of further research. When in-person testing became infeasible in 2020, many states and institutions piloted self-placement approaches, and in many contexts those practices have continued (Brathwaite et al., 2022; Morton, 2022). More research is needed on what types of support or guidance help students select the best course and how to guard against biases that may disproportionately guide minoritized students into prerequisite or corequisite courses they do not need (Kosiewicz & Ngo, 2020). In addition, institutions are currently offering online and hybrid courses at rates unheard of before the pandemic. Research conducted before the pandemic indicated that online courses often are harmful for students with greater academic needs and exacerbate outcome differences by race/ethnicity (Xu & Jaggars, 2014). Research is needed on how students referred to developmental education are performing in online corequisite courses and in introductory college-level courses and how to implement online courses to maximize student learning and success.

Guided self-placement, in which students select which course level they would like to enroll in, is one strategy in need of further research.

5 Conclusion

Over the past decade, policymakers, administrators, and educators in community colleges and other broad-access postsecondary institutions have implemented widespread changes to traditional systems of prerequisite, multi-course developmental education. These reforms have been accelerated by policy incentives and requirements in a growing number of states, largely in response to the growing number of studies on the effects of developmental education reform. In this review, we draw on both impact and implementation studies published between 2010 and 2021—with a special focus on 17 studies that meet strong standards for causal evidence—to advance five principles for developmental education reform and related implementation considerations. The review makes clear that changes to assessment and placement practices, curriculum and pedagogy, and supports provided to students in developmental education can lead to meaningful improvements in student outcomes. The review also reveals directions for useful future research, which should include greater focus on persistent opportunity and outcome gaps by race/ethnicity, the needs of students who are not successful in college-level courses, and comprehensive strategies to promote transfer and credential completion.

Changes to assessment and placement practices, curriculum and pedagogy, and supports provided to students in developmental education can lead to meaningful improvements in student outcomes.

Notes

1. Among students who began college in 2015-16 and attended public four-year doctorate-granting institutions, 26 percent took a developmental course.
2. These include Carnegie Math Pathways, Complete College America, the Charles A. Dana Center, and Strong Start to Finish, among others.
3. Sponsored by the Institute on Education Sciences, the WWC is well known for identifying well-designed, trustworthy education research that provides meaningful findings to inform decision-making.
4. The search terms were derived from the WWC (n.d.) developmental education evidence review protocol, which outlines parameters for conducting a systematic review of the evidence on developmental education, including key search terms. Search terms included: *developmental education*, *corequisite*, *remedial education*, and *basic skills* combined with *effectiveness*, *intervention*, and *impact*.
5. Several developmental education scholars examined an early list of the studies we found that met the inclusion criteria and suggested other relevant studies, which we also considered. We also included a rigorous study of CUNY ASAP, a program that while not a reform to how developmental education is delivered has led to strong outcomes for students referred to developmental education.
6. Experimental studies—in which students are randomly assigned to a program group that receives an intervention or to a control group that does not receive the intervention—are the most rigorous, as they control for observable and unobservable confounding factors, instilling confidence that any changes in student outcomes are caused by the intervention. Although considered less rigorous than experimental studies, some quasi-experimental study designs can provide unbiased estimates of the effect of an intervention. This is especially true for regression discontinuity designs, which estimate the effect of an intervention by comparing outcomes for students who score just above and just below the threshold for placement into developmental-level or college-level courses. If key conditions are met, there is a reasonable assumption that students near the threshold are virtually identical, expect for their assignment to the intervention.
7. We relied on the WWC because of the systematic approach and well-established standards it uses to assess the quality of education research. WWC standards determine the extent to which a study provides causal evidence that a difference in student outcomes is due to the intervention. Only well-implemented randomized controlled trials (experimental evaluations) can be designated as “meeting standards without reservations,” which is the highest WWC rating. Randomized controlled trials with attrition issues and strong quasi-experimental studies can receive a “meets standards with reservations” rating. For these studies, there is a lower (but still high) degree of confidence that a difference in outcomes can be attributed to the intervention.
8. The inclusion criteria for studies in the 2016 WWC practice guide (Bailey et al., 2016) and the current review are slightly different. The practice guide included some studies of interventions that involved developmental students but were not primarily developmental education reforms (e.g., enhanced advising and performance-based monetary incentives). The practice guide identified 10 studies that met WWC standards (with or without reservations) to support its recommendations; three of those studies were published after 2010 and also appear in this review, including a study of CUNY ASAP, a program not strictly limited to developmental education students.
9. We used a p value of less than .1 (meaning that there is less than a 10 percent chance that an estimated effect occurred by chance) as a threshold for impacts with statistical significance.
10. Forty-three percent of program students completed college-level English and 26 percent completed college-level math within three semesters (Cullinan & Biedzio, 2021). A small number of students in the Barnett et al. (2020) study were bumped down through the MMA intervention. Bumping students down into developmental courses through MMA resulted in lower rates of college-level course completion for such students, even after three semesters.

11. In one rigorous study with positive outcomes, students in college-level math participated in weekly tutoring rather than a corequisite course (Douglas, Edwards, & McKay, 2020).
12. Barnett et al.'s (2020) study on MMA did not look at effects for racial/ethnic subpopulations for students who were bumped up into a college-level math or English course.
13. See, for example, two recent quasi-experimental studies showing that some students have stronger outcomes in college-level courses without corequisite support (Bowman, 2021; Ran & Lin, 2022).
14. Subgroup analyses are often considered exploratory when the sample sizes for the subpopulations are small, there is limited statistical power to identify an impact, and there is not a strong rationale for higher impacts in one group as compared to another.
15. The intent of the intervention should inform the design of the study. If the goal of the intervention is to improve equity by narrowing disparities in academic outcomes by race/ethnicity, income, or English language status, the sample sizes and analytic plan should, to the extent possible, be constructed to determine whether that goal is met.
16. Six of the nine studies of reforms to developmental education that looked at credential receipt after two years found positive impacts: I-BEST (Martinson et al., 2021), CUNY Start (Weiss et al., 2021), CUNY ASAP (Scrivener et al., 2015), corequisite remediation within statistics pathways (Logue et al., 2019), AMP-UP: Accelerated Mathematics Sequence (Douglas, McKay, & Edwards, 2020), and accelerated developmental writing courses at CUNY (Hodara & Jaggars, 2014). I-BEST, CUNY Start, and CUNY ASAP are multifaceted programs. See Appendix Table A1 for additional details.
17. A replication of the CUNY ASAP program in Ohio, which serves students with and without developmental requirements, also doubled graduation rates (Miller et al., 2020).
18. CUNY ASAP requires that students have no more than two developmental course requirements across all subjects.
19. A quasi-experimental study of guided pathways, with findings expected in early 2023, will provide more rigorous evidence on the effectiveness of this reform framework (Community College Research Center, 2021).
20. These cost estimates reflect national average prices in 2021 dollars. To estimate the costs of these interventions at a specific college, please use MDRC's Intervention Return on Investment (ROI) Tool for Community Colleges (<https://www.mdrc.org/intervention-roi-tool>).
21. The cost-effectiveness analysis used the estimated impacts for the full sample for MMA in the Midwest and MMA at SUNY, rather than the estimated impacts for only students in the bump-up zone, because the intervention cannot be targeted to only students in the bump-up zone.
22. DCMP's costs were almost entirely fixed, so cost per student is highly dependent on the number of students offered the program.
23. Ongoing operational costs for guided pathways, mostly for additional advisors and student success courses, have been estimated at \$350 per full-time equivalent student per year (Belfield, 2020; Jenkins & Belfield, 2020).
24. Studies of corequisite courses that document course pass rates tend to show college-level course success rates of between 65 and 80 percent (Logue et al., 2019; Miller et al., 2022).

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APPENDIX TABLE A1. Selected Rigorous Studies of Developmental Education Interventions

Name of Intervention/ Study	Description	Length of Study Follow- Up Period	Outcomes	Program- Comparison Group Difference ^a	Impacts on Student Subgroups	Direct Cost ^b	Cost Effectiveness
<i>Corequisite Remediation</i>							
AMP-UP: Developmental Math Waivers <i>Douglas, Edwards, & McKay (2020)</i>	RCT at one New Jersey community college (Union County). Students assessed as needing developmental math receive a waiver to enroll in a college-level math course & participate in required weekly tutoring. Comparison group: Students in prerequisite developmental math courses with optional access to tutoring.	3 years	<ul style="list-style-type: none"> Completion of a college-level math course (%) Degree receipt (%) 	11.4*** 1.1	N/A	N/A	N/A
Corequisite English Remediation in Texas <i>Miller et al. (2022)</i>	RCT at five Texas community colleges. Students assessed as needing developmental English enroll in college-level English & receive supplemental instruction. Comparison group: Students in prerequisite developmental English courses.	2 years	<ul style="list-style-type: none"> Completion of a college-level English course, C or higher (%) Total credits earned Persistence (%) 	18.4*** 1.5* -2.2	Comparable impacts for all subgroups considered (including by race/ethnicity & English language learner status).	N/A ^c	N/A
Corequisite Math Remediation at CUNY <i>Logue et al. (2019)</i>	RCT at three New York City community colleges. Students assessed as needing developmental math enroll in a college-level statistics course & receive weekly supplemental instruction. Comparison group: Students in prerequisite developmental algebra courses.	Varies	<ul style="list-style-type: none"> Completion of a college-level math course (%) Total credits earned (1 yr) Degree receipt (%) (3 yrs) 	19.2*** 4.4*** 8.1**	Comparable impacts for all racial/ethnic subgroups considered.	N/A	N/A
<i>Instructional Technology</i>							
ModMath <i>Weiss & Headlam (2019)</i>	RCT at one Texas community college of a computer-assisted, self-paced, developmental math course. The course is divided into three five-week modules. Comparison group: Students in a semester-long, lecture-based course.	3 semesters	<ul style="list-style-type: none"> Completion of developmental math requirements (%) Completion of a college-level math course (%) 	0.4 -2.3	Comparable impacts for subgroups based on assessed level of developmental need.	N/A	N/A
<i>Math Pathways</i>							
Dana Center Mathematics Pathways <i>Biedzio & Sepanik (2022)</i>	RCT at four Texas community colleges. Students assessed as needing developmental math enroll in a one-semester developmental math course, followed by a college-level course in statistics or quantitative reasoning, depending on the student's program of study. Courses include student-centered, contextualized instruction. Comparison group: Most students enrolled in a two-semester developmental math sequence leading to college-level algebra.	3 years	<ul style="list-style-type: none"> Completion of developmental math requirements (%) (3 semesters) Passed a college-level math course (%) Total credits earned Degree receipt (%) 	23.5*** 6.0** -0.1 1.8	Comparable impacts for all racial/ethnic subgroups considered. Exploratory evidence suggests that the program was more effective for students assessed as having greater developmental need.	\$158/student receiving the intervention ^d	<ul style="list-style-type: none"> Completion of college-level math: \$26/percentage point (ppt) increase Credits earned: N/A
Dana Center Mathematics Pathways <i>Schudde & Keisler (2019)</i>	Quasi-experimental study in 20 Texas community colleges. See program description above. Comparison group: Most students enrolled in a two-semester developmental math sequence leading to college-level algebra.	3 years	<ul style="list-style-type: none"> Completion of a college-level math course (%) College-level credits earned Degree receipt (%) 	36*** 5.9** 0.0	N/A	N/A	N/A
Dana Center Mathematics Pathways <i>Schudde & Meiselman (2019)</i>	Quasi-experimental study in 27 Texas community colleges. See program description above. Comparison group: Most students enrolled in a two-semester developmental math sequence leading to college-level algebra.	Varies	<ul style="list-style-type: none"> Completion of developmental math requirements (%) Completion of a college-level math course (%) (1 yr) College-level credits earned (1 yr) 	4*** 6*** 1.1***	N/A	N/A	N/A

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Name of Intervention/ Study	Description	Length of Study Follow- Up Period	Outcomes	Program- Comparison Group Difference ^a	Impacts on Student Subgroups	Direct Cost ^b	Cost Effectiveness
<i>Multiple Measures Assessment^c</i>							
Multiple Measures Assessment at SUNY <i>Barnett et al. (2020)</i>	RCT at seven New York community colleges of the use of multiple measures of college readiness, including GPA, to determine student placement into developmental or college-level courses. Comparison group: Students who are placed into developmental courses using their placement test score but who would have been placed into a college-level course using multiple measures.	3 semesters	<ul style="list-style-type: none"> • Completion of a college-level math course, C or higher (%) • Completion of a college-level English course, C or higher (%) • College-level credits earned • Degree receipt (%) 	9.6*** 8.7*** 3.9*** 1	N/A ^f	\$144/ student receiving the intervention	<ul style="list-style-type: none"> • Completion of college-level math: \$360/ppt increase • Completion of college-level English: \$50/ppt increase • Credits earned: \$603/additional credit
Multiple Measures Assessment in the Midwest <i>Cullinan & Biedizio (2021)</i>	RCT at five Midwestern community colleges of the use of multiple measures of college readiness, including GPA, to determine student placement into developmental or college-level courses. Comparison group: Students who are placed into developmental courses using their placement test score but who would have been placed into a college-level course using multiple measures.	3 semesters	<ul style="list-style-type: none"> • Completion of a college-level math course, C or higher (%) • Completion of a college-level English course, C or higher (%) • College-level credits earned, C or higher (math) • College-level credits earned, C or higher (English) 	11.0*** 16.3*** 1.5** 1.3**	Comparable impacts for all racial/ethnic subgroups considered.	\$33/student receiving the intervention	<ul style="list-style-type: none"> • Completion of college-level math: \$37/ppt increase • Completion of college-level English: \$19/ppt increase • Credits earned: \$165/additional credit
<i>Summer Bridge/Early Start Courses</i>							
CUNY Start <i>Weiss et al. (2021)</i>	RCT at four New York City community colleges of a full-time, one-semester pre-matriculation program that emphasizes student-centered teaching & a contextualized curriculum. Students receive advising support & take a student success seminar. Comparison group: Students with access to standard courses & services.	3 years	<ul style="list-style-type: none"> • Completion of developmental math requirements (%) • Completion of developmental writing requirements (%) • Completion of a college-level math course (%) • Completion of a college-level English course (%) • College-level credits earned • Degree receipt (%) 	18*** 5.5*** 5.2*** 4.4** 1.4 3.1**	Comparable impacts for all racial/ethnic subgroups considered. Exploratory evidence suggests that the program was more effective for students with developmental needs in three subject areas (math, reading, & writing) rather than in fewer areas.	\$1,371/ student receiving the intervention	<ul style="list-style-type: none"> • Completion of college-level math: \$264/ppt increase • Completion of college-level English: \$312/ppt increase • Credits earned: \$1,016/additional credit
Summer Bridge Demonstration in Texas <i>Barnett et al. (2012)</i>	RCT at eight Texas colleges of summer bridge programs. Students take developmental courses for four to five weeks in the summer before they matriculate. The program offers support services & a financial incentive. Comparison group: Students with access to standard college services & developmental courses.	2 years	<ul style="list-style-type: none"> • Completion of a college-level math course (%) • Completion of a college-level English course (%) • Total credits earned 	3.5 3.3 -0.5	N/A	\$1,319/ student receiving the intervention	<ul style="list-style-type: none"> • Completion of college-level math: \$377/ppt increase • Completion of college-level English: \$400/ppt increase

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Name of Intervention/ Study	Description	Length of Study Follow-Up Period	Outcomes	Program-Comparison Group Difference ^a	Impacts on Student Subgroups	Direct Cost ^b	Cost Effectiveness
<i>Other</i>							
AMP-UP: Accelerated Mathematics Sequence <i>Douglas, McKay, & Edwards (2020)</i>	RCT at one New Jersey community college (Bergen). Students take an intensive 7.5-week developmental math course, followed by an intensive 7.5-week college-level math course, allowing them to complete college-level math in one semester. Comparison group: Students in prerequisite developmental math course sequences, which can take up to three semesters.	Varies	<ul style="list-style-type: none"> • Completion of a college-level math course (%) (2 yrs) • College credits earned (2 yrs) • Degree receipt (%) (3 yrs) 	33*** 6.2* 9.0*	N/A	N/A	N/A
Beacon Mentoring Program <i>Visher et al. (2010)</i>	RCT at one Texas community college of a one-semester, light-touch mentoring program in which college employees serve as mentors to students in developmental math. Comparison group: Students in developmental math with access to typical college services but not the mentoring program.	1 semester	<ul style="list-style-type: none"> • Completion of developmental math course (%) • Total credits earned 	3.1 0.5***	N/A	N/A	N/A
CUNY ASAP <i>Scrivener et al. (2015)</i>	RCT at three New York City community colleges of a comprehensive, three-year program for students in developmental education. Program components include advising, tutoring, financial support, & a requirement to enroll full-time. Comparison group: Students assessed as having developmental needs who have access to standard college services & no requirement to enroll full-time.	3 years	<ul style="list-style-type: none"> • Total credits earned • Degree receipt (%) 	8.7*** 18.3***	Impacts are large & positive for all racial/ethnic groups. Exploratory evidence suggests that the size of impacts is smaller for Latinx students, though still large & positive.	\$13,077/ student receiving the intervention ^g	• Credits earned: \$1,503/ additional credit
CUNY Accelerated Developmental Writing Courses <i>Hodara & Jaggars (2014)</i>	Quasi-experimental study at three New York City community colleges of a shortened developmental writing course that emphasizes group discussion & writing in response to readings. Comparison group: Students in a two-course developmental writing sequence that emphasizes grammar rules.	Varies	<ul style="list-style-type: none"> • Completion of a college-level English course (%) (3 yrs) • Total credits earned (3 yrs) • Degree receipt (%) (5 yrs) 	6.1*** 2.1*** 2.2***	N/A	N/A	N/A
I-BEST <i>Martinson et al. (2021)</i>	RCT at three Washington State community colleges. I-BEST offers concurrent, contextualized instruction in workforce training & basic math, reading, & English skills for one to two semesters. Students also receive advising services & financial support. Comparison Group: Students with access to other education & training opportunities & typical college services.	3 years	<ul style="list-style-type: none"> • Completion of a college-level math course, C or higher (%) • Completion of a college-level English course, C or higher (%) • Total credits earned (academic & workforce) • Receipt of any college credential (%) • Receipt of credential longer than 1 year (%) 	8.6*** 4.3 10.9*** 31.0*** 2.4	N/A	\$5,362/ student receiving the intervention	<ul style="list-style-type: none"> • Completion of college-level math: \$623/ ppt increase • Completion of college-level English: \$1,247/ppt increase • Credits earned: \$492/ additional credit
Learning Communities Demonstration <i>Visher et al. (2012)</i>	RCT at six community colleges in five states of one-semester learning communities, in which small groups of developmental students enroll in at least two courses together. Comparison group: Students in standalone developmental courses.	3 semesters	<ul style="list-style-type: none"> • Completion of developmental course sequence (%) • Total credits earned 	2.5 0.5	Comparable impacts for all subgroups considered (by race/ethnicity, gender, & English language learner status).	\$583/ student receiving the intervention	• Credits earned: \$1,166/ additional credit

^a ***p < .01, **p < .05, *p < .10.

^b These cost estimates reflect national average prices in 2021 dollars.

^c A forthcoming article estimates the costs of the corequisite models examined in the study (Cunha et al., forthcoming).

^d DCMP's costs were almost entirely fixed, so direct cost per student is highly dependent on the number of students offered the program.

^e Impacts reported are for students in the bump-up zone, who were placed into college-

level courses using multiple measures assessment but would have been placed into developmental courses using their placement test score alone.

^f Barnett et al. (2020) include impacts on student subgroups for the full sample but not for students in the bump-up zone.

^g CUNY ASAP costs have declined since the cost study was conducted. In the replication of ASAP in Ohio, the direct cost per student was \$6,526, which translates into \$767 per additional credit earned (Miller et al, 2020).

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