CAPR | CENTER FOR THE ANALYSIS OF POSTSECONDARY READINESS

The Long-Term Effectiveness of Multiple Measures Assessment: Evidence From a Randomized Controlled Trial

A CAPR Working Paper

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Abstract

Multiple measures assessment (MMA) has gained considerable momentum over the past decade as an alternative to traditional test-based procedures for placing incoming students into developmental or college-level coursework in math and English at broad-access colleges. Compared to standardized tests, which measure student performance at a single point in time, MMA (which often emphasizes high school GPA as a measure) provides a more holistic picture of students' academic preparation. Despite positive impacts on student outcomes that have been found by recent research on MMA, questions remain about whether the positive effects of MMA are sustained over time. This study—a follow-up to prior research using the same sample of students—employs a randomized controlled trial to investigate whether algorithmic MMA placement used at seven State University of New York (SUNY) community colleges led to better student outcomes, for up to four and a half years after randomization, than a system based on test scores alone.

Nearly 13,000 incoming students who arrived at the seven colleges in fall 2016, spring 2017, and fall 2017 took placement tests and were randomly assigned to be placed using either the status quo method (business-as-usual group) or the alternative, algorithmic MMA method (program group). Using this sample, we estimate the overall treatment effects on placement into, enrollment in, and completion of college-level math and English as well as effects on other outcomes. We conduct similar analyses on race/ethnicity, Pell recipient status, and gender subgroups. We also descriptively examine the proportion of program group students who were bumped up (i.e., their placement changed from a developmental course placement to a college-level course placement) and bumped down (i.e., their placement changed from a college-level course placement to a developmental course placement) by the MMA algorithm, and we perform a cost-effectiveness analysis.

We find that the MMA method used at the colleges improved access to and success in college-level courses and that lower cut scores in English rather than math are associated with larger and longer lasting impacts on completion of college-level coursework. While MMA improved outcomes among student subgroups, it had little to no impact on gaps in outcomes between subgroups. We also find that bumped-up students had substantially better outcomes in both math and English, while bumped-down students had substantially worse outcomes. Our results suggest that increased access to college-level courses is the driving factor in the positive outcomes experienced by program group students and that placement into standalone developmental courses can have detrimental effects on student outcomes. In the discussion of the study's results, we make recommendations for adopting MMA at colleges. Implemented together with other initiatives to support students, MMA can be a first step on the path to success for incoming students.

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1. Introduction

A fundamental challenge facing community colleges and other open-access institutions is how to assess students' skill levels and appropriately place them into college-level math and English courses when they begin their journeys in postsecondary education. Most institutions have long relied on standardized tests to guide their placement decisions (Bailey et al., 2015). While these tests are relatively low in cost and easy to administer, studies have found that they frequently lead to the misplacement of students, including the underplacement of students into developmental education when they could have been successful in college-level courses (Belfield & Crosta, 2012; Scott-Clayton, 2012). Multiple measures assessment (MMA) offers an alternative to strict reliance on standardized placement tests by using measures such as high school GPA, time since high school graduation, high school coursetaking patterns, noncognitive assessment scores, or other factors in addition to or instead of scores earned on standardized tests to provide a more comprehensive assessment of students' readiness for college-level coursework.

Building on prior research (Barnett et al., 2018; Barnett et al., 2020)—see findings from the earlier research in Boxes 1 and 2 below—this study employs a randomized controlled trial (RCT) to examine the long-term effectiveness of MMA up to four and a half years after randomization. The study was conducted in partnership with seven community colleges in the State University of New York (SUNY) system wherein nearly 13,000 students across three cohorts of incoming students (fall 2016, spring 2017, and fall 2017) were randomly assigned to one of two groups: one receiving MMA placement (program group students) and the other receiving the existing test-based placement (business-as-usual group students). The aim is to learn whether MMA yields placement determinations that lead to better student outcomes than a system based on test scores alone.

Box 1

Implementation Findings From the Prior Study

Researchers from the Center for the Analysis of Postsecondary Readiness (CAPR) visited each of the seven participating colleges on two separate occasions in 2016 and 2017 to better understand the processes required to implement the MMA system. Among other activities, each college did the following:

- Organized a group of faculty and staff (the specific composition of which varied by college) to take responsibility for developing the new system;
- Compiled a historical dataset that was sent to the research team in order to create the college's algorithms;
- Had faculty and staff select subject-specific cut scores representing the acceptable minimum probability of success to access college-level courses (generally speaking, lower cut scores were chosen for English as compared to math);
- Developed or improved processes for obtaining high school transcripts for incoming students and for entering transcript information into IT systems in a useful way (which in some cases was time consuming and challenging);
- Created procedures for uploading high school data into a data system where it could be combined with test data at the appropriate time;
- Changed IT systems to capture the placement determinations derived from the use of multiple measures;
- Created new placement reports for use by students and advisors;
- Provided training to testing staff and advisors on how to interpret the new placement determinations and communicate with students about them; and
- Conducted trial runs of the new processes to troubleshoot and avoid problems during actual implementation.

While planning activities were demanding and time consuming (lasting a year or longer), implementation was successfully achieved by all participating colleges. Five colleges achieved this benchmark in time for placement of students entering in fall 2016, while the other two colleges did so in time for new student intake in fall 2017 (Barnett et al., 2018).

Box 2

Impact Findings From the Prior Study

The earlier CAPR impact study tracked students for three terms following testing (Barnett et al., 2020) and yielded the following results:

- Higher rates of placement into college-level English courses (80 percent versus 46 percent) and college-level math courses (44 percent versus 37 percent) among program group students compared to business-as-usual group students;
- Higher rates of college-level English enrollment, completion, and credit attainment among program group students through term 3;
- Higher initial rates of college-level math enrollment and completion among program group students that became statistically nonsignificant in terms 3 and 2, respectively;[1] and
- Sustained positive impacts for college-level credits attempted by program group students through term 3, with program group students earning more credits in terms 1 and 2.

The primary research questions for this follow-up study, which are a continuation of the initial studies, are:

1. With respect to academic outcomes, what are the effects of placing students into courses using the MMA system compared with traditional procedures?

2. Do effects vary for students who were bumped up into college-level courses and bumped down into developmental courses?[2]

3. Do effects vary across different subpopulations of students?

[1] Impact estimates differ slightly between the initial and follow-up studies due to the use of system rather than college data.

[2] Using MMA, the placement of some students in this study changed from a developmental course placement to a college-level course placement (i.e., they were bumped up). Likewise, the placement of some students changed from a college-level course placement to a developmental course placement (i.e., they were bumped down). We discuss this further in future sections.

4. What are the costs associated with using the MMA placement system? Is this system cost-effective?

Our findings reveal that relative to students placed using the business-as-usual (status quo) system, MMA led to:

- Higher rates of enrollment in and completion of college-level English coursework with a grade of C or higher among program group students through nine terms, and much higher rates among those who were bumped up into college-level English courses.

- Higher rates of enrollment in college-level math coursework among program group students through nine terms, although statistically significant gains in completion were not sustained past the first term. Yet students who were bumped up into college-level math experienced much higher rates of enrollment in and completion of college-level math through all nine terms.

- Higher numbers of college-level credits attempted through nine terms and higher numbers earned through three terms among program group students. Students who were bumped up in either subject had even stronger outcomes: They attempted about 5 more and earned about 3 more college-level credits, on average, by the ninth term.

- Higher rates of transfer to four-year institutions and/or credential attainment in the sixth through ninth terms among students who were bumped up into college-level English.

- Much lower rates of enrollment in and completion of college-level math and English among students who were bumped down into developmental courses.

- A total social cost of $140 less per student for MMA placement.

In the following sections, we provide further background information about developmental education and MMA; describe the data and methodological approach used in the study; present findings; provide a cost analysis; discuss the study's findings and implications; and draw conclusions about the utility of MMA.

2. Background

Literature Review

MMA has gained unprecedented momentum over the past decade, with widespread experimentation and adoption as an alternative to traditional test-based placement procedures. The rationale for adopting MMA is to positively impact students' access to college-level coursework by considering a wider range of factors that more accurately capture their readiness for college. Compared to standardized tests, which measure student performance at a single point in time, MMA provides a more holistic picture of students' academic preparation and propensity to be successful in college-level courses. For older students who are further removed from formal education and for students who have test anxiety, the importance placed on the results of placement tests may negatively impact their performance. Further, students may not fully understand how the results of placement testing can affect progress on their short- and long-term academic goals; placement into developmental education may delay access to college-level courses that are prerequisites for required courses in their program of study. By reducing reliance on placement test scores, MMA may serve to remedy incomplete and/or inaccurate assessments of readiness and can help students avoid unnecessary delays in accessing college-level coursework, ultimately increasing their chances of long-term success.

The increased use of MMA over the past decade has been considerable. Prerequisite developmental education that requires students to complete remedial coursework prior to entering college-level coursework has long been criticized for poor success rates and for lengthening the time to degree attainment among the relatively few students who successfully complete prerequisite sequences (Bailey et al., 2010; Clotfelter et al., 2015; Scott-Clayton & Rodriguez, 2015). Traditionally, students were placed into prerequisite developmental courses using a system based on a single test (one for English and one for math). Scott-Clayton's (2012) hallmark paper brought to light the propensity for students to be misplaced by a single-test-based system, and since then, researchers and colleges nationwide have been experimenting with and adopting various versions of multiple measures in an effort to improve students' placements and outcomes. Importantly, if students were being incorrectly placed into developmental courses through status quo placement systems, MMA was viewed as a potential way to overcome the negative consequences often associated with remedial placement, including delayed entry into college-level coursework and increased overall time and costs associated with degree completion.

Box 3

What is MMA?

MMA relies on measures such as high school performance (primarily GPA) or noncognitive indicators in addition to or instead of standardized test scores to determine whether students should be placed into college-level or developmental courses. Once the specific measures are selected, colleges must combine the information in order to yield a math and English placement for each student. Commonly, MMA systems take one of the following forms:

Algorithm: Institutions using an algorithmic approach to MMA rely on a placement formula that weights different factors according to how well they predict success in college-level courses. Students' overall algorithm scores are compared to subject-specific cutoffs or thresholds determined by college faculty and administrators. This is the approach adopted by colleges participating in the current study. (See Appendix B for more information on the development of the algorithm.)

Decision Rules: MMA can also be implemented using a decision rule approach, which includes a sequence of rules that compares students' scores on selected measures against cutoffs or thresholds in a predetermined order. If a student meets the first threshold for placement into a college-level course, a placement is given. If a student does not meet the first threshold, a different measure is used until a placement is determined.

Decision Band: A third form of MMA uses a decision band approach, which applies decision rules only to students falling within a predetermined range on a specified indicator or measure (such as ACT/SAT score or high school GPA). Students above the range are placed into a college-level course; students below the range are placed into a developmental education course (or, increasingly, into a college-level course coupled with a corequisite support course; Cullinan & Lewy, 2021).

In recent years, research has provided evidence that students who are granted access to college-level coursework as a result of MMA complete college-level coursework at higher rates than students who are placed into developmental coursework by standardized tests (Ratledge, 2020; Staples, 2020). An RCT of the use of MMA at Minnesota and Wisconsin community colleges found that multiple measures placement led to increased enrollment in and completion of college-level math and English courses among all students, with improved outcomes for students who were bumped up into college-level coursework (Cullinan & Biedzio, 2021).

Particularly important for historically marginalized groups of higher education students, one quasi-experimental study found that economically disadvantaged students, students with limited English proficiency, and students who tested below college-ready on the Texas Success Initiative Assessment (TSIA) were more likely to be successful when placed into college-level coursework (Daugherty et al., 2021). Likewise, a causal-comparative study in Colorado found that students of color had greater access to college-level math courses using an MMA placement process than placement based on a standardized test (Staples, 2020).

Another study focusing on English language learners (ELLs) found that using multiple measures to place students with limited English proficiency led to a better understanding of their knowledge and skill levels and thus to more accurate placement (Rassen et al., 2021). When examining the predictive utility of various multiple measures, a study in the California State University system concluded that high school GPA was the strongest predictor of student success in first college-level math courses (Bracco et al., 2021). Additionally, a causal-comparative study in Connecticut found that high school GPA was the most accurate placement measure for first-year students entering an introductory college-level English course (Plourd, 2021).

Following the implementation of Assembly Bill 705 in California, a study of students who were placed using grades earned in high school math courses revealed increased rates of completion among students who were given access to transferable, college-level math (compared to the college-level intermediate algebra course that does not typically transfer; Hayward, 2021).

Despite strong evidence for the use of MMA, Ngo et al. (2021) found mixed opinions about it among faculty members. While faculty members in their study expressed satisfaction with traditional placement tests and a hesitancy to part from them, most also believed that grades in high school math courses were the best predictors of success in college-level math, more so than placement tests and overall high school GPA. Taken together, these studies support the use of MMA in general and high school GPA specifically as more accurate predictors of success in college-level coursework. While institutions may face obstacles when adopting MMA, such as lack of faculty buy-in, the strong body of research across multiple contexts and student populations provides evidence that institutions should strongly consider moving away from single measures of readiness for college-level coursework (Bickerstaff et al., 2022).

The growth of MMA, spurred in part by prior research, has played a substantial role in sweeping reforms to developmental education that have been occurring across the country in recent years. Perhaps equally important to placement reforms have been efforts to modify the structure of developmental courses by moving away from prerequisite models and toward corequisite models (Bickerstaff et al., 2022). Corequisite models of developmental education allow students in need of remediation to enroll directly in college-level coursework while taking a supplemental support course in the same subject in the same semester (Edgecombe, 2011). Some states now mandate corequisites as the primary model of developmental education coursework, and in other instances, individual systems or institutions have adopted corequisites without legislative mandates (Whinnery & Odekar, 2021). While this study was conducted in a prerequisite developmental education environment, a primary goal of MMA broadly as well as in this study is to increase immediate access to college-level coursework—a goal it shares with corequisite developmental education.

Description of CAPR and the CAPR–SUNY Partnership

Established in 2014, CAPR is a partnership between research scholars at the Community College Research Center (CCRC) at Teachers College, Columbia University, and MDRC, a nonprofit, nonpartisan education and social policy research organization. Supported by the Institute of Education Sciences at the U.S. Department of Education, CAPR conducts research on MMA and other developmental education reform practices, including corequisite remediation and math pathways (an alternative model of developmental and college-level math aimed at shorting students' time in remediation). CAPR efforts also include field engagement and outreach activities to improve college readiness.

To learn whether MMA placement determinations led to better student outcomes than a system based on test scores alone, CAPR initiated a partnership with the SUNY system and seven community colleges: Cayuga Community College, Jefferson Community College, Niagara County Community College, Onondaga Community College, Rockland Community College, Schenectady County Community College, and Westchester Community College. Of the seven participating colleges, several were interested in assessing the effectiveness of their existing placement system before the project began, while others saw the project as an opportunity to develop greater knowledge of and improve practices in student placement.

All seven colleges have open-access admissions; their only entry requirement is having earned a high school diploma or GED. The colleges tend to have relationships with regional high schools for dual enrollment programs and to facilitate students' college admission and their transition from high school to college. Serving a mostly local student population, each college has a small population of students living on campus or who move to attend the institution. The colleges offer a variety of academic and career-focused programs of study, including well-reputed programs such as culinary arts, electronic communications, music, and nursing. Additionally, at the time of the study, the colleges were engaged in a range of reform initiatives closely linked to their institutional priorities.

3. Methodology

Study Design

Our study employed an RCT to investigate whether MMA placement determinations led to better student outcomes than determinations from a system based on test scores alone. Importantly, an RCT yields the most robust and credible estimates of a program's effects because it makes it possible to determine counterfactual outcomes, that is, what would have happened in the absence of the program. To carry out this study, all participating students underwent the following placement procedures. Entering prospective first-year students arrived at each college for the intake process, and those with waivers based on SAT scores or with other exemptions from both math and English placement testing did not take a placement test at all and went directly into college-level courses; they were not part of the study. Before taking placement tests, the remaining students (some of whom took tests in only one subject area, math or English) were informed about the research, afforded the opportunity to seek additional information, and allowed to opt out if they wished.

Those who continued—nearly 13,000 incoming students who arrived at the seven colleges in the fall 2016, spring 2017, and fall 2017 terms—took placement tests and were randomly assigned to be placed using either the status quo method (business-as-usual group students) or the method using a multiple measures algorithm (program group students). Each institution used college-specific, subject-specific algorithms that weighted different factors (placement test scores, high school GPAs, time since high school graduation, etc.) according to how well they predicted success in college-level math and English courses at each college.[3] After taking placement tests, students were notified of their placements into developmental or college-level courses either by a college staff member or through an online portal, depending on the college. Students did not receive information on which group they were assigned to. Approximately half of the incoming students (the program group) were randomly placed using the new system; the other half (the business-as-usual group) were placed using each college's existing placement system (most often using cut scores from ACCUPLACER tests).

For more information on the development of the algorithm or study procedures, see Appendix B and/or Barnett et al. (2020).

[3] Appendix Tables B.1 and B.2 list the full set of variables used in each college's algorithm for math and English. Subject-specific cut scores, representing the minimum acceptable likelihood of succeeding in a college-level course, are listed in Appendix Table A.3 by college.

Data and Measures

Despite the positive impacts on student outcomes that were found in the earlier CAPR studies on the same sample of students and colleges, questions remained as to whether those impacts would be sustained over time and whether impacts on longer term outcomes might emerge. The current study extends the original tracking period by five semesters through spring 2021. Importantly, follow-up data include transcript data on all participating students from the original study across all SUNY institutions (regardless of whether or not a student took courses at one of the seven participating study colleges).

The data used to place students and track their outcomes in this study come from two main sources: placement records and administrative data from each college. Student-level placement records include indicators for students' status quo placement levels in math and English, as well as information that is needed to determine students' algorithm score or predicted probability of success, regardless of assignment to either the program or business-as-usual group. Placement records from each college contain high school GPAs and scores on individual ACCUPLACER tests. Additional variables included in the placement records vary by college. Examples of additional variables incorporated for certain colleges include the number of years between high school completion and college enrollment, type of diploma (high school diploma vs. GED), SAT scores, and New York State Regents Exam scores.

In addition to placement records, administrative data were collected from the SUNY system office. These data include demographic information such as gender, race/ethnicity, age, financial aid status, semesters enrolled, courses taken (including course levels), credits attempted and earned, and course grades. All participants were tracked for at least nine and up to 11 terms from the time of testing through spring 2021, depending on the term in which they tested.

We study the effect of assignment to the program group on several primary outcomes of interest. First, we estimate subject-specific treatment effects on enrollment and completion of at least one college-level course and total college-level credits attempted and earned. Impact estimates for both outcomes are calculated for math and English separately. Additionally, we examine non-subject-specific outcomes, including total college-level credits attempted and earned, persistence, and credential attainment or transfer to a four-year institution. We also descriptively examine the proportion of program group students that were bumped up (i.e., their placement changed from a developmental course placement to a college-level course placement) and bumped down by the algorithm. Finally, we conduct subgroup analyses by race/ethnicity, Pell recipient status, and gender for the full analytic sample.

The use of transcript data allows us to track students over time and examine when and for how long any differences in outcomes occurred. For example, even those students who were initially placed into the lowest level developmental courses could have had an opportunity to take and pass college-level courses after three terms. The timing of completion of a college-level gatekeeper course can have important implications on a student's postsecondary trajectory and their overall costs of education, including foregone wages due to increased time to credential The data from the extended follow-up period also allow us to determine whether students earned a credential from any SUNY institution or transferred to a four-year institution within the SUNY system. Therefore, we calculate term-specific impacts to show when, if ever, business-as-usual group students and otherwise similar peers placed by the algorithm experienced similar outcomes.

Sample and Summary Statistics

We present findings from three cohorts of students, which include all eligible students who went through intake at a participating college between the fall 2016 and fall 2017 semesters and opted to participate in the study. This sample excludes students who took their first placement test outside of the study intake period and those whose ACCUPLACER or writing scores placed them into an English as a Second Language (ESL) course. (A consort diagram in Appendix C shows the sequential flow of participants throughout the study.)

Table A.1 (located in Appendix A) shows baseline descriptive statistics for the overall sample. Of the 12,796 students who took a placement test at one of the seven partner colleges, 11,311 (about 88 percent) enrolled in at least one developmental or college-level course of any kind between fall 2016 and spring 2021. Overall, the sample includes more men than women (52 percent), with the largest racial/ethnic group being White (43 percent). Eighty-four percent of students were 24 years old or younger, and 45 percent of students received a federal Pell Grant.

Appendix Table A.1 also shows variation in demographic characteristics across colleges. At the most racially diverse college (College 7), which also had the largest population of male students, 26 percent of students in our sample identified as White, 20 percent as Black, and 33 percent as Hispanic. At the least racially diverse college (College 1), 80 percent of students in our sample identified as White, 9 percent as Black, and 5 percent as Hispanic. Using Pell Grant receipt as a proxy for low-income status, average family income also varied across colleges: Sixty-one percent of students from College 6 in our sample received a federal Pell Grant, compared to only 32 percent of students at College 5. At five of the seven colleges, more than 90 percent of students receive financial aid. Typical for most community colleges, many students at the participating colleges are adult learners and/or attend college part-time, with transfer-out rates fluctuating between 18 and 22 percent. Graduation rates vary from 15 to 29 percent.

As shown in Appendix Table A.2, the distribution of students into program group or business-as-usual group status was nearly even (49.4 percent program group vs. 50.6 percent business-as-usual). Of the 6,319 students assigned to the program group, 76 percent took a placement test in math and 83 percent took a placement test in English. The lower rate of math placement testing among program students can be explained by the fact that two of the seven participating colleges did not use the MMA system to place program students into math courses. The random assignment procedure ensures, in expectation, that students assigned to the program group are similar in all ways to those assigned to courses under status quo placement rules. Any differences in student outcomes observed between the groups can thus be attributed to the specific placement procedure encountered. Appendix Table A.2 provides evidence that participants' demographic and academic characteristics, including indicators for missing characteristics, are well balanced across program and business-as-usual groups for the final analytic sample.

Analytic Approach

We use an intent-to-treat analysis to examine the impacts of using the MMA placement algorithm versus the single placement test (status quo). More formally, we estimate ordinary least squares (OLS) regressions of the form:

$$(1) \qquad Y_i = \alpha + \beta R_i + \eta X_i + \lambda \varphi_i + FE + \varepsilon_i$$

where Y_i represents the outcome of interest (such as completing a college-level course, college persistence, or credential attainment/transfer) for individual i; R_i indicates whether the individual was randomly assigned to be placed using the multiple measures approach; X_i is a vector of baseline covariates including gender, race/ethnicity, age, and financial aid status; φ_i represents math and English algorithm calculations for each student (which are essentially two indices for academic preparedness); FE includes both college and cohort fixed effects; ε_i is a random error term; and α, β, η, and λ. are coefficients to be estimated. The coefficient of interest is β, as it represents the effect of assignment to the multiple measures placement system on the outcome of interest. Because of the random assignment process, OLS estimation of β will provide an unbiased estimate of the intent-to-treat effect, and it is not necessary to control for other student characteristics.

However, we include pre-random assignment covariates that are correlated with outcomes in order to improve the precision of impact estimates.

The large scale of this evaluation situates it well to explore variation in effects. In addition to estimating the pooled effects of an alternative placement method for all students, we examine the extent to which the effects vary across different subpopulations of students.

Finally, we engage in exploratory analysis to determine whether the relationships between MMA placement and student outcomes vary among the subset of students whose placement changed or would have changed under the MMA algorithm as compared to the status quo.

4. Results

CAPR's earlier studies, using the virtually same sample, explored the impact of MMA on student outcomes for up to three terms following testing. Here we focus our analyses on terms 4 through 9 to determine whether identified impacts persisted over time and whether MMA had any impact on longer term outcomes. The figures below show term-by-term impact estimates as the percentage-point difference between a mean outcome for business-as-usual and program group students. Accompanying tables can be found in Appendix A. We present analyses on the full sample, on "bump-zone" students (which focuses on program group students whose placements changed because of MMA), and on demographic subgroups of students. As we discuss below, the bump-zone analyses are important because the impact estimates calculated using the full analytic sample may conceal or dilute the potential impact of MMA on math and English outcomes.

We are able to observe impacts for all students up to four and a half years after testing, which allows us to evaluate outcomes even for students who were referred to the lowest levels of developmental education (as some students were placed in multiple-course developmental sequences). By this point, those students could have reasonably caught up to their peers who were placed directly into college-level coursework.

Main Analyses

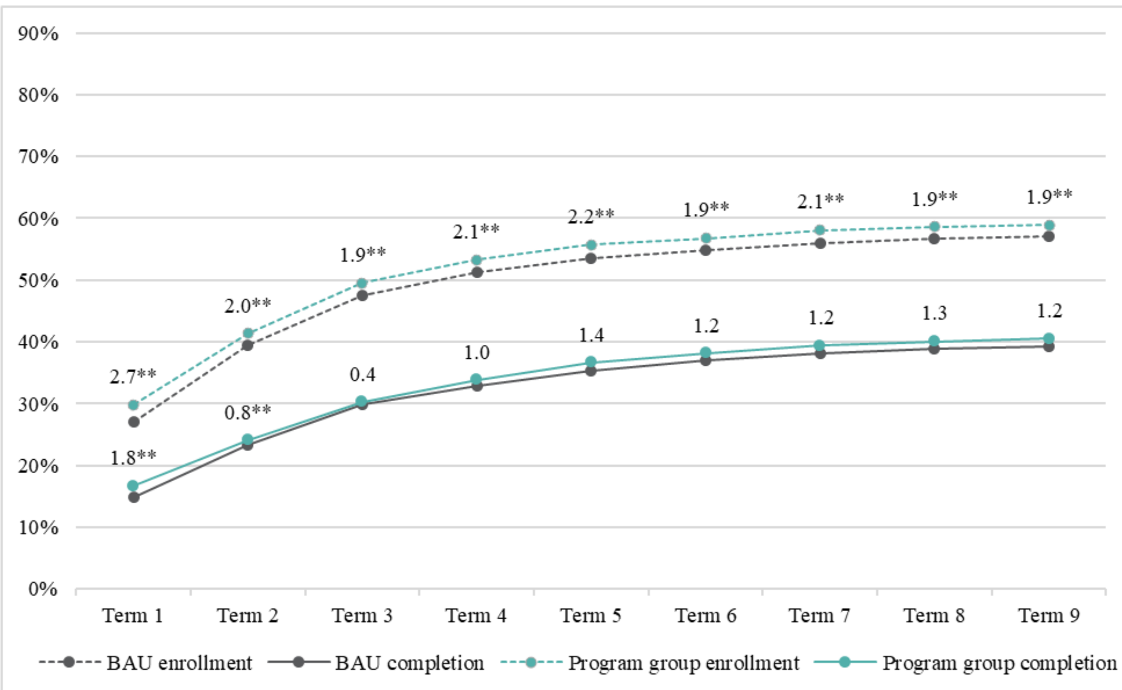
In this section, we present the intent-to-treat results for each outcome of interest in math and English, including enrollment in and completion (with grade C or higher) of a college-level course in each subject area. We also present overall impacts on total college-level credits attempted and earned and on credential attainment or transfer. Because we might expect heterogeneous impacts over time, our figures show impact estimates for one through nine semesters from testing. All results are calculated using a fully specified model that includes college and cohort fixed effects, controls for the set of predefined demographic characteristics, and the calculated math and English algorithm values to control for students' academic preparedness, or each student's predicted probability of success in a college-level course in both subjects. Tables in Appendix A show results for each outcome of interest, some of which are not presented here.

College-Level Math Enrollment and Completion

Compared to business-as-usual group students, program group students, who were 18 percent more likely to be placed into college-level math,[4] were about 2 percentage points more likely to enroll in a college-level math course after nine terms (see Figure 4.1 below). Despite this advantage, observed gains in college-level math completion were not statistically significant after the first term. Moreover, we do not observe any practical differences in the number of college-level math credits attempted or earned in any term, suggesting that MMA, as implemented, likely did not induce students to enroll in or complete additional college-level math courses.

Figure 4.1

College-Level Math Course Outcomes (Among Students in Math Subsample)



NOTE: Data labels represent impact estimates, or the percentage-point difference between the mean outcomes for business-as-usual and program group students.

***$p < .01$, **$p < .05$, *$p < .10$.

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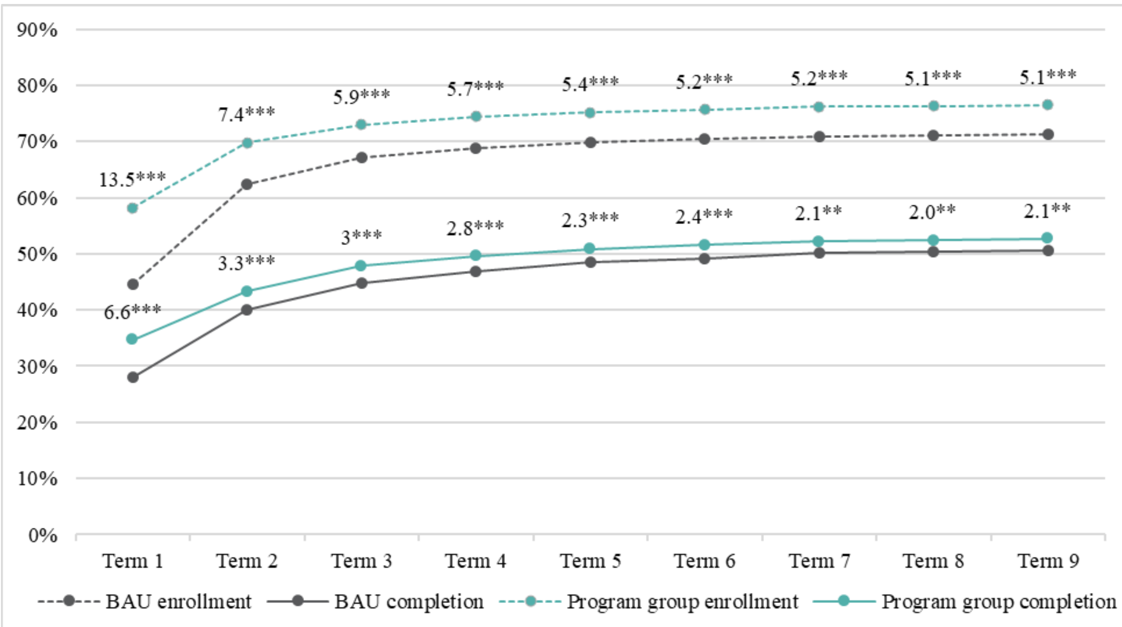
[4] About 43 percent of program group students and 37 percent of business-as-usual group students were placed into college-level math. For impacts on placement into math, see Appendix Table A.4.

College-Level English Enrollment and Completion

Program students, who were 73 percent more likely to be placed into a college-level English course,[5] enrolled in and completed college-level English at a higher rate than their otherwise similar peers. While program group students' advantage over their peers declined over time, after nine terms, program group students were still about 5 percentage points more likely to enroll in and about 2 percentage points more likely to complete a college-level English course (see Figure 4.2 below).

Figure 4.2

College-Level English Course Outcomes (Among Students in English Subsample)



NOTE: Data labels represent impact estimates, or the percentage-point difference between the mean outcomes for business-as-usual and program group students.

***$p < .01$, **$p < .05$, *$p < .10$.

Other Outcomes

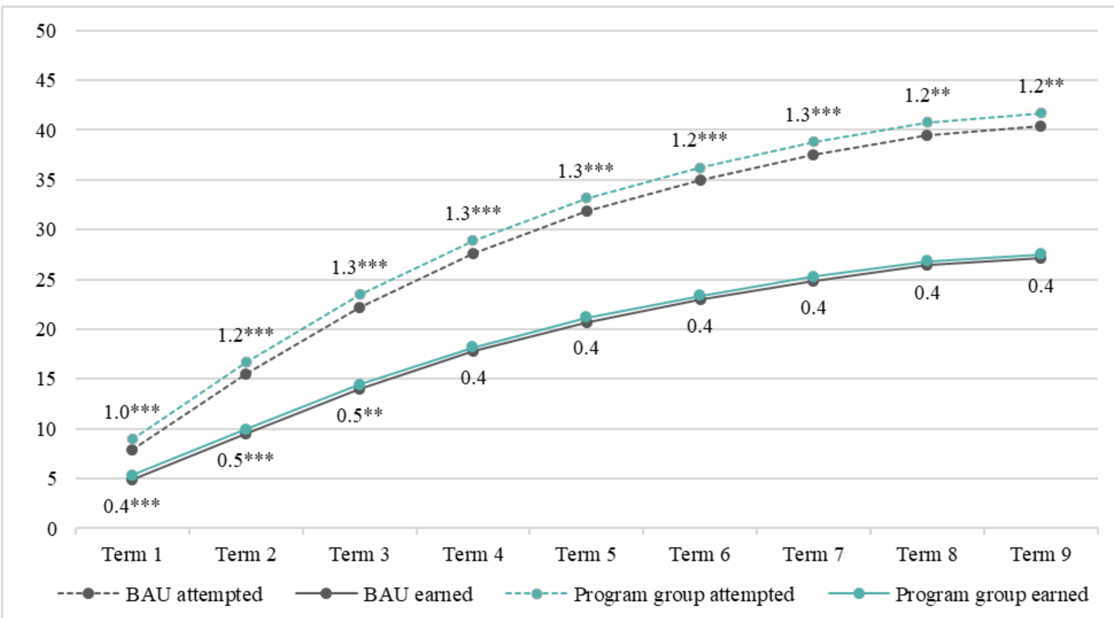
Generally speaking, MMA did not have a statistically significant impact on non-subject-specific outcomes including persistence and credential attainment or transfer

[5] About 80 percent of program group students and 46 percent of business-as-usual group students were placed into college-level English. For impact on placement into English, see Appendix Table A.11.

overall.[6] We also do not find any evidence that MMA affected credential-specific outcomes, including certificate attainment, associate degree attainment,[7] and bachelor's degree attainment, among the whole sample. That said, as shown in Figure 4.3, program group students attempted more college-level credits than their business-as-usual peers, and by term 9, program group students attempted approximately one more college-level credit. We do not observe a statistically significant difference between study groups in the number of college-level credits earned.

Figure 4.3

College-Level Credit Outcomes



NOTE: Data labels represent impact estimates, or the percentage-point difference between the mean outcomes for business-as-usual and program group students.

***$p < .01$, **$p < .05$, *$p < .10$.

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[6] Persistence is defined as continued enrollment from one term to the next; credential attainment or transfer is defined as earning any credential from certificate up to bachelor's degree *or* beginning at a two-year college and transferring to attend a four-year college without returning to enroll at a two-year college for the duration of the study.

[7] For associate degree attainment, we evaluated associate in arts (AA) or associate in science (AS) attainment jointly and associate in applied science (AAS) separately.

Bump-Zone Analyses

Changes in Placement

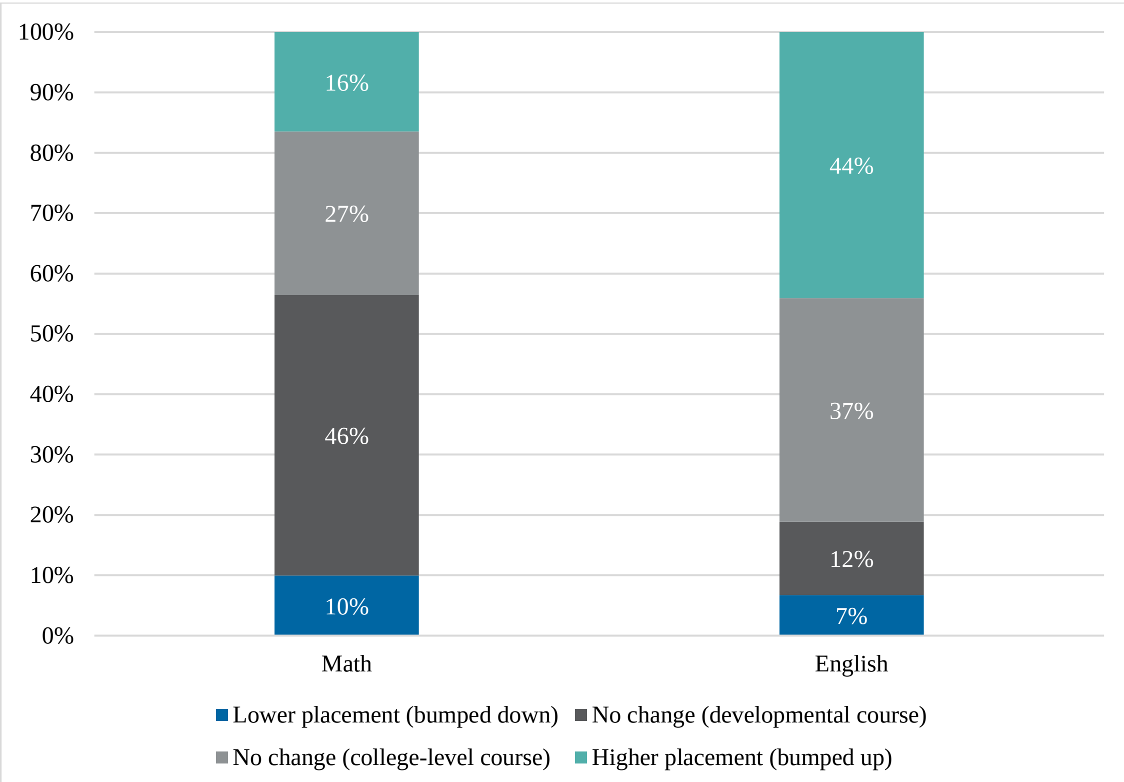
It is important to consider how the introduction of MMA impacted students' placement into developmental versus college-level courses. Because the multiple measures placement system used a different set of criteria than the status quo system, we might expect at least some changes in placement level in math and English among program group students. Importantly, however, any new placement procedure will not change the placement of some students.

As described in Section 3, all 12,796 students in the sample were randomly assigned to one of two study groups. The program group was placed using college-specific algorithms predicting students' probability of success in college-level courses based on several measures including but not limited to high school GPA, and the business-as-usual group was placed using only ACCUPLACER test scores. Importantly, data on placement test scores as well as alternative multiple measures were available for all students regardless of study group assignment. In other words, for each student (whether in the program or business-as-usual group), we know what their placements would have been using the MMA algorithm and what their placements would have been using the status quo procedure. By comparing these two potential placement outcomes, we can determine (1) whether assignment to the program group (i.e., placement by the algorithm) actually changed a student's course placement and, if so, (2) whether the student received a higher or lower placement than they would have under the status quo placement system.

Figure 4.4 shows how the placement of program group students differed from what their placement would have been under the status quo system. Unsurprisingly, because most colleges worked to ensure that the new multiple measures system increased access to college-level courses, placement by the algorithm was more likely to result in a higher placement than a lower placement relative to what students would have received under the status quo system (i.e., by placement test score alone). Among program students who took a math placement test, 26 percent experienced a math placement different from what would have been expected under the status quo placement rules. Sixteen percent were placed into a higher level math course (i.e., a college-level course) than would have been expected under the status quo system, and 10 percent were placed into a lower level math course (i.e., a developmental course). Of those who took a placement test in English, 51 percent of program group students experienced a change in their level of English placement: 44 percent were placed into a higher level course and 7 percent were placed into a lower level course than they would have under the status quo placement system.[8]

Figure 4.4

Change in Placement Among Program Group Students



Importantly, Figure 4.4 also shows that the MMA placement procedure used for program group students did not change course placements for many students: 73 percent of program group students in math and 49 percent of program group students in English received the same placement under the alternative placement system that they would have received under the status quo system. Because these students' placements were not impacted by MMA, their outcomes should not change as a result of the new placement system. Including these students in the estimation of impact estimates therefore dilutes

[8] For more information on how the business-as-usual students' placements would have changed if placed by the algorithm, see Appendix Table A.23.

any impacts observed among students whose experiences were changed by the introduction of MMA.

The possibility that impact estimates calculated using the full analytic sample might conceal or dilute the potential impact MMA has on student outcomes becomes more salient when considering the role that conservative cut scores have in limiting the number of students who could actually benefit from MMA. In the current study context, math faculty were much more likely than English faculty to set conservative cut scores. Because a smaller proportion of math students' placements than English students' placements was changed by study conditions, the main analyses likely dilute the potential impact of MMA among students in the math sample by a larger amount.

In order to better understand whether MMA placements represent an improvement over the status quo—especially in math, where our main analysis failed to reveal significant impacts on college-level course completion after the first term—in this section we limit our analysis to the subset of students whose placement changed depending on their study condition. More specifically, we explore the effects of being bumped up and bumped down by MMA. This approach aligns with other rigorous studies of MMA (see Cullinan et al., 2019; Cullinan & Biedzio, 2021).

Bump-Up Zone

All students in the bump-up zone had algorithm scores that indicated that their predicted probability of success in the college-level course was higher than the minimum acceptable probability of passing a college-level course as determined by faculty at their college (see Appendix Table A.3). These students also had ACCUPLACER scores that fell below the placement test threshold used for test-based placement decisions at their college. This means that, in the bump-up zone sample, all program group students should have been bumped up into college-level courses and all business-as-usual group students should have been placed into developmental education courses, which occurred in most cases.[9]

Math: Enrollment and Completion

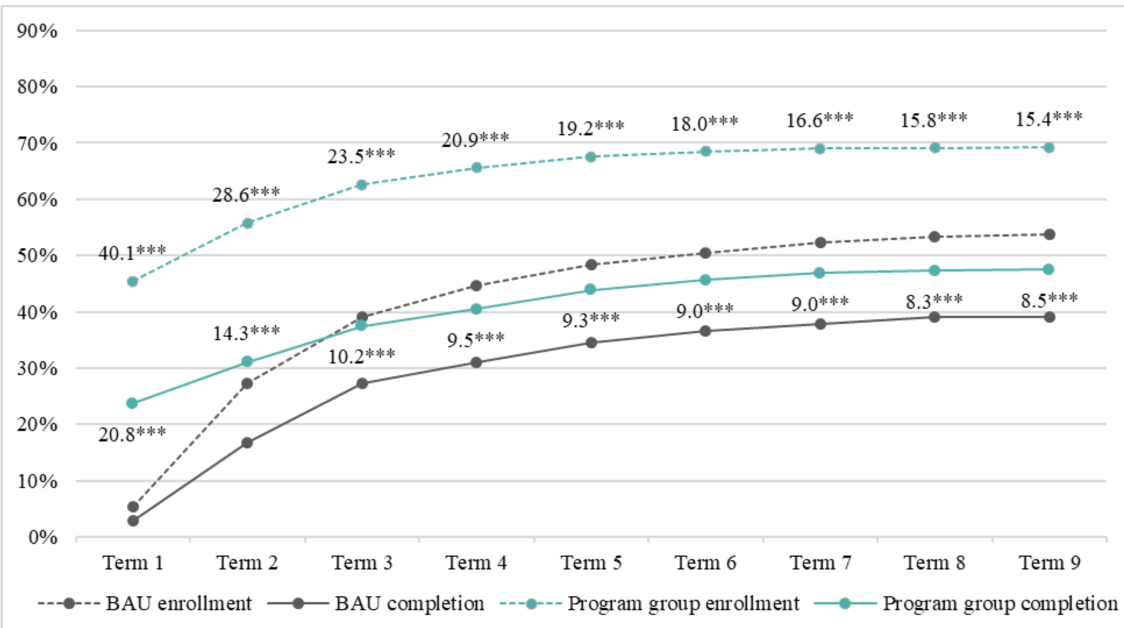
As shown in Figure 4.5, by the ninth term, 54 percent of students in the business-as-usual group had enrolled in college-level math. In the program group, the rate of

[9] Students in the bump-up zone are expected to be observationally equivalent on available characteristics, including, most notably, indicators of academic preparedness. Appendix Table A.24 provides evidence that participants' demographic and academic characteristics are well balanced across program and business-as-usual groups in the bump-up zone subsample.

college-level coursetaking was substantially higher. Among program students in the bump-up zone in math, 69 percent enrolled in a college-level math course within nine terms of testing. In other words, students whose placement was bumped up under the algorithm held a 15-percentage-point advantage in college-level math enrollment as compared to their business-as-usual peers who were placed into developmental education courses despite having algorithm scores that would have placed them in college-level courses.

Figure 4.5

College-Level Math Enrollment and Completion Among Students in Bump-Up Math Zone



NOTE: Data labels represent impact estimates, or the percentage-point difference between the mean outcomes for business-as-usual and program group students.

***$p < .01$, **$p < .05$, *$p < .10$.

Since more program group students in the bump-up zone enrolled in a college-level math course, it is not surprising that program group students also had higher rates of completion. Specifically, program group students in the bump-up zone in math were about 9 percentage points more likely to complete a college-level math course (with a C or higher) by the ninth term.[10]

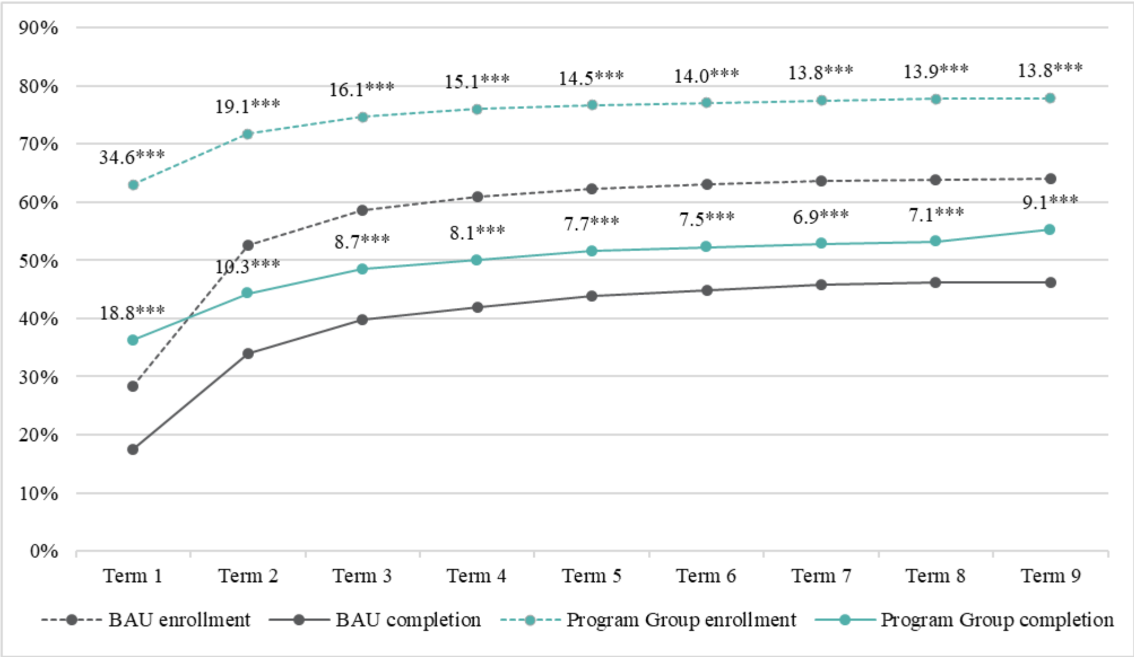
English: Enrollment and Completion

Subject-specific impacts for students in the bump-up zone in English, shown in Figure 4.6, generally follow the same pattern as those observed in the bump-up zone in math. After nine terms, 64 percent of students in the business-as-usual group had enrolled in college-level English, while 78 percent of students in the program group did the same. These gains (about 14 percentage points) are strikingly similar to those observed in the bump-up zone in math (about 15 percentage points). It follows that program group students also had higher rates of completion during the tracking period. Specifically, program group students in the bump-up zone in English were about 9 percentage points more likely to complete a college-level English course (with a C or higher) by the ninth term. Once again, these results mirror the roughly 9-percentage-point increase in college-level math completion observed among students in the bump-up zone in math.

[10] Interestingly, Appendix Table A.29 shows that program group students in the bump-up zone in math were also more likely to enroll in and complete a second college-level math course, even after nine terms. These findings suggest that immediate access and exposure to college-level math may help improve confidence and persistence in higher level math courses, a hypothesis underlying accelerated math pathways reforms (see Sepanik & Barman, forthcoming).

Figure 4.6

College-Level English Enrollment and Completion Among Students in Bump-Up English Zone



NOTE: Data labels represent impact estimates, or the percentage-point difference between the mean outcomes for business-as-usual and program group students.

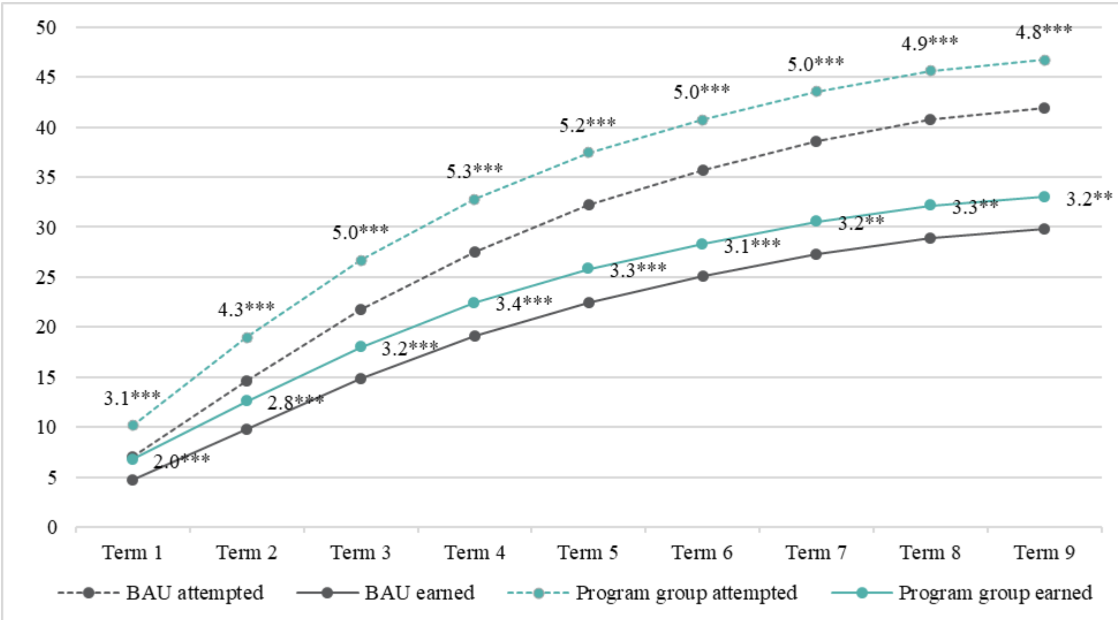
***p < .01, **p < .05, *p < .10.

Other Outcomes

None of the observed statistically significant differences in persistence and credential attainment or transfer were sustained beyond the second and seventh terms, respectively, among students in the bump-up zone in math (see Appendix Tables A.42 and A.44). However, program group students in the bump-up zone in math attempted and earned more college-level credits (in any subject) through all nine terms. As shown in Figure 4.7, by the ninth term, program group students had attempted about 5 and earned about 3 college-level credits more than students placed under the status quo placement system.

Figure 4.7

College-Level Credit Outcomes Among Students in Bump-Up Math Zone



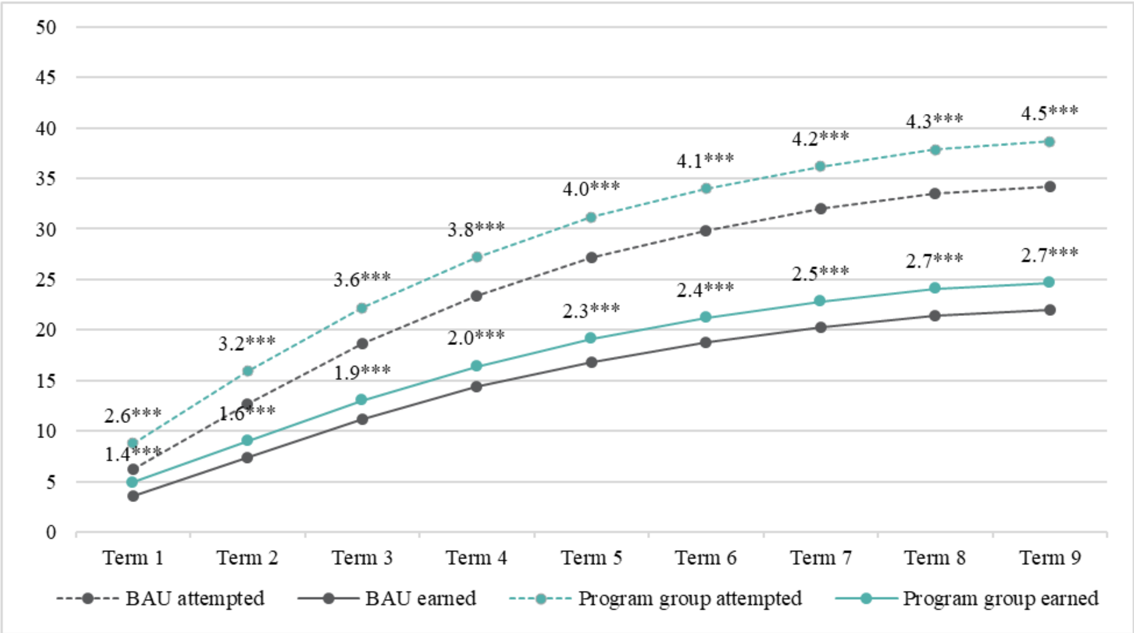
NOTE: Data labels represent impact estimates, or the percentage-point difference between the mean outcomes for business-as-usual and program group students.

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

The findings also show that program group students in the bump-up zone in English attempted and earned more college-level credits (in any subject) than their business-as-usual counterparts. Figure 4.8 shows that statistically significant differences were sustained through all nine terms, at which point program students had attempted about 5 and earned about 3 additional college-level credits. Further, unlike in math, placement by the algorithm among students in the bump-up zone in English had a statistically significant impact on the likelihood of credential attainment or transfer. Specifically, as shown in Figure 4.9, program students were about 3 percentage points more likely to earn any credential or transfer to a four-year institution by the ninth term. While promising, given the exploratory nature of the bump-zone analyses and the increased risk for false positive conclusions arising from multiple hypothesis testing, we interpret these findings with caution.

Figure 4.8

College-Level Credit Outcomes Among Students in Bump-Up English Zone

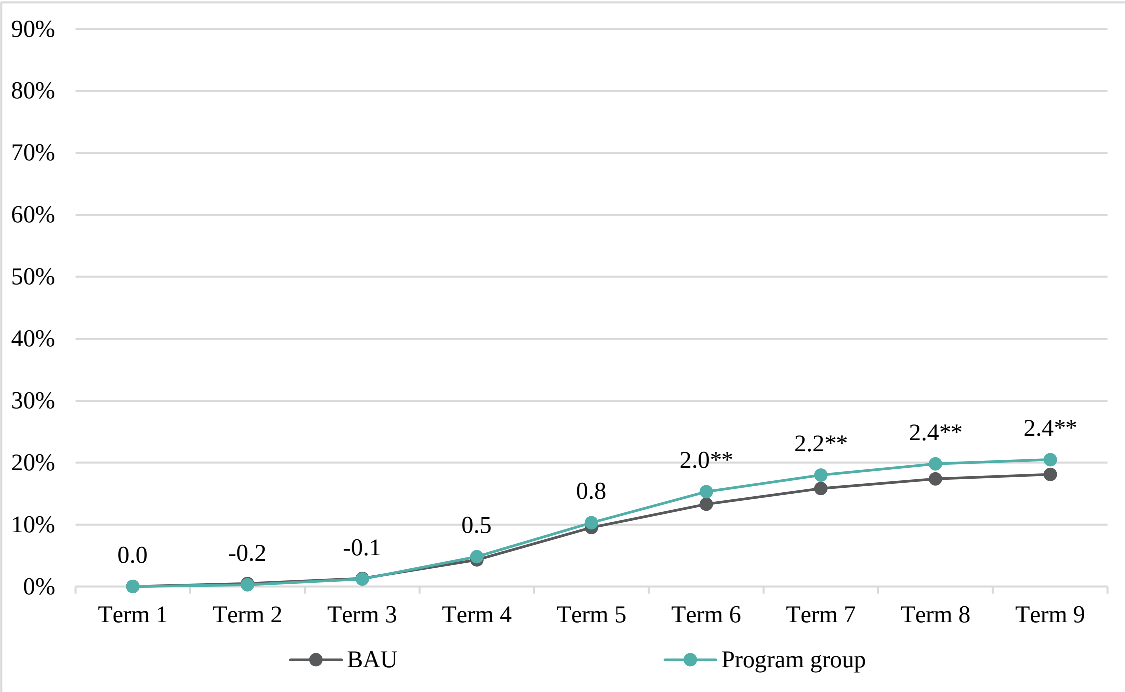


NOTE: Data labels represent impact estimates, or the percentage-point difference between the mean outcomes for business-as-usual and program group students.

***$p < .01$, **$p < .05$, *$p < .10$.

Figure 4.9

Credential Attainment or Transfer Among Students in Bump-Up English Zone



NOTES: Data labels represent impact estimates, or the percentage-point difference between the mean outcomes for business-as-usual and program group students. Credential attainment or transfer is defined as earning any credential from certificate up to bachelor's degree *or* beginning at a two-year college and transferring to attend a four-year college without returning to enroll at a two-year college.

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

Bump-Down Zone

Contrary to the bump-up zone students, all students in the bump-down zone had a predicted probability of success in the college-level course that was lower than the minimum acceptable probability of passing a college-level course as determined by faculty at their college (see Appendix Table A.3). These students also had ACCUPLACER scores that fell above the placement test threshold used for test-based placement decisions at their college, meaning that these students' test scores indicated that they were ready for college-level coursework. According to these criteria, all program group students in the bump-down zone sample should have been bumped down into developmental education courses, and all business-as-usual group students in the sample should have been placed into college-level courses. This happened in most cases.[11]

Math: Enrollment and Completion

By the ninth term, 78 percent of students in the business-as-usual group had enrolled in a college-level math course. As Figure 4.10 shows, in the program group, the rate of college-level coursetaking was substantially lower, with only 62 percent of students having taken a college-level math course by the ninth term. In other words, among students in the bump-down zone in math, placement by the algorithm led to a 16-percentage-point decrease in the probability of college-level math enrollment during the study period. Program group students were also 5 percentage points less likely than their business-as-usual peers to pass college-level math (with a grade of C or higher) within nine terms.[12]

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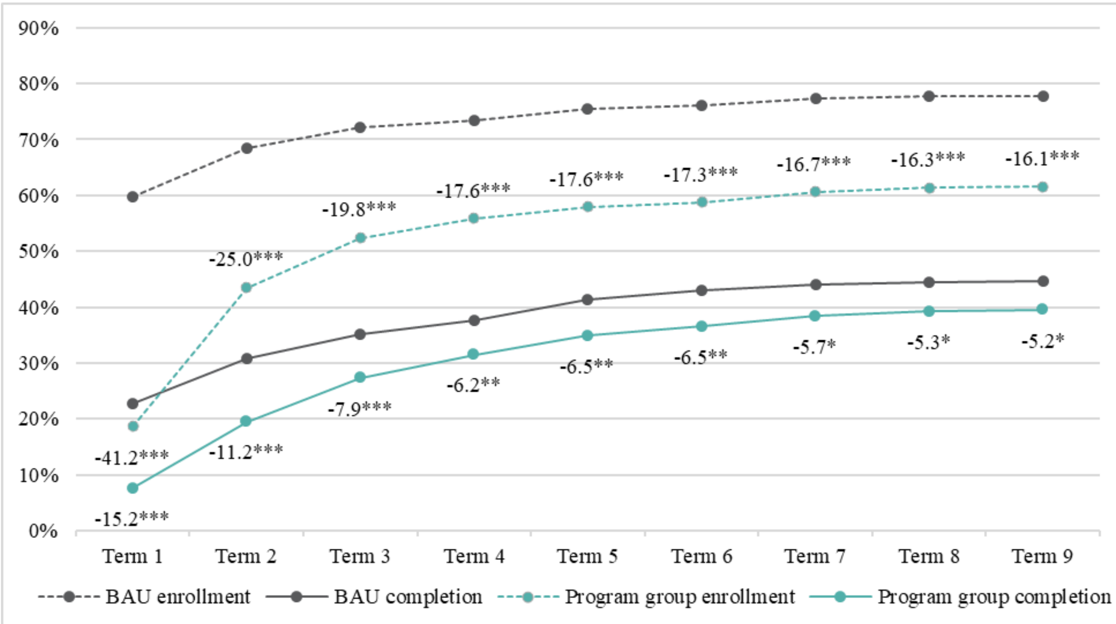
[11] Students in the bump-down zone are expected to be observationally equivalent on available characteristics, including, most notably, indicators of academic preparedness. Appendix Table A.25 provides evidence that participants' demographic and academic characteristics are well balanced across program and business-as-usual groups in the bump-down zone subsample.

[12] Contrary to what is seen in the bump-up zone analysis, program group students who were bumped down in math enrolled in a second college-level math course at lower rates than their business-as-usual peers who were granted immediate access to college-level courses (see Appendix Table A.48). Although program students in the bump-down zone were no less likely to complete a second college-level math course, the negative impact observed on course enrollment supports the potential relationship between access to college-level math and confidence, comfort, and continued interest in mathematics described elsewhere (see Sepanik et al., forthcoming).

Figure 4.10

College-Level Math Enrollment and Completion Among Students in Bump-Down Math Zone



NOTE: Data labels represent impact estimates, or the percentage-point difference between the mean outcomes for business-as-usual and program group students.

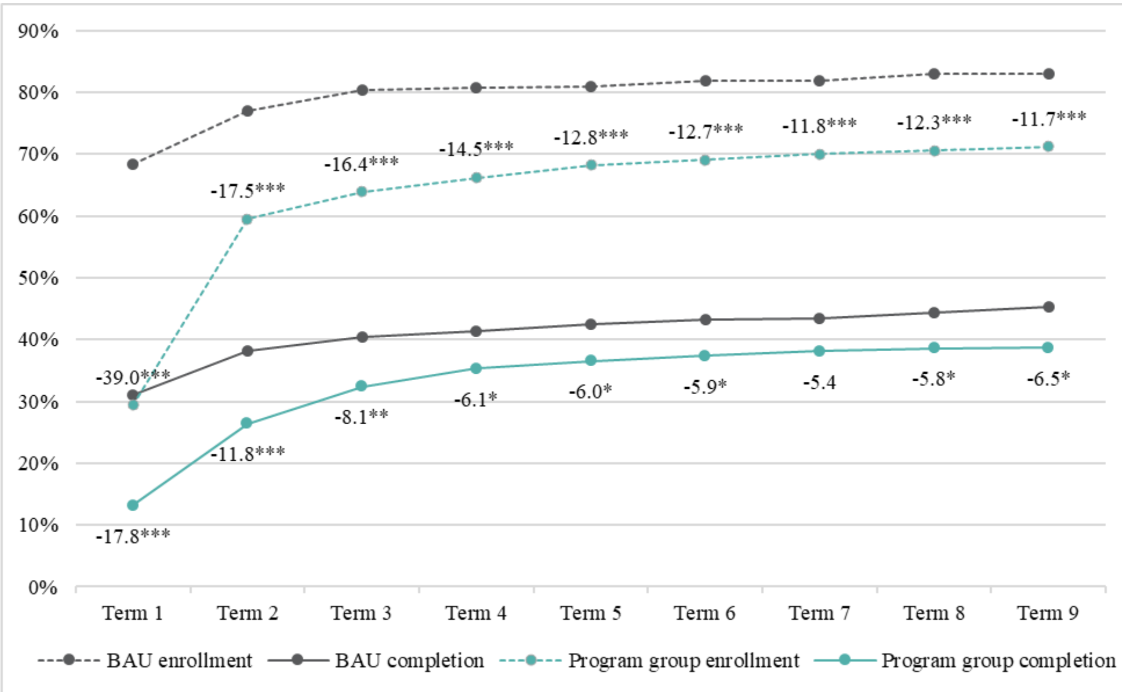
***p < .01, **p < .05, *p < .10.

English: Enrollment and Completion

As shown in Figure 4.11, by the ninth term, 83 percent of students in the business-as-usual group had enrolled in a college-level English course. In the program group, the rate of college-level coursetaking was substantially lower, with only 71 percent enrolling in a college-level English course by the ninth term. This 12-percentage-point difference between study groups is slightly smaller than the difference observed in the bump-down zone in math. Program group students were also 7 percentage points less likely to pass college-level English (with a grade of C or higher) by the ninth term (which is slightly more than the difference observed in the bump-down zone in math).

Figure 4.11

College-Level English Enrollment and Completion Among Students in Bump-Down English Zone



NOTE: Data labels represent impact estimates, or the percentage-point difference between the mean outcomes for business-as-usual and program group students.

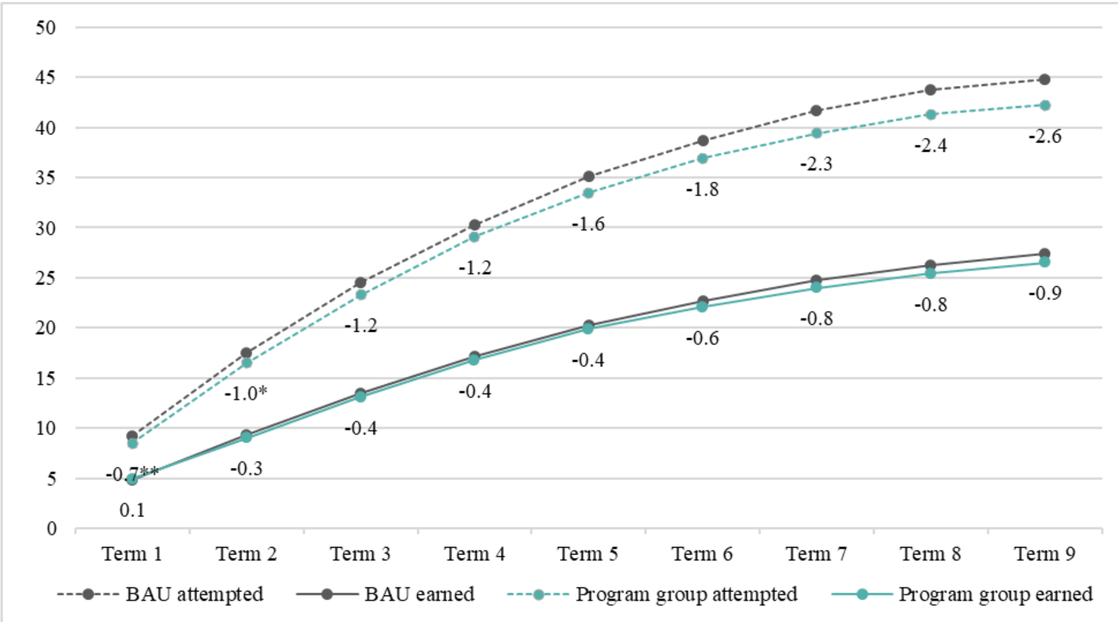
***$p < .01$, **$p < .05$, *$p < .10$.

Other Outcomes

Generally speaking, we do not find statistically significant differences between program and business-as-usual group students in the bump-down zone in math for non-subject-specific outcomes. Statistically significant differences in college-level credits attempted (in any subject) were sustained through term 2, as shown in Figure 4.12; however, we do not find evidence that students in the bump-down math zone earned significantly more or less college-level credits than their business-as-usual peers in any term.

Figure 4.12

College-Level Credit Outcomes Among Students in Bump-Down Math Zone



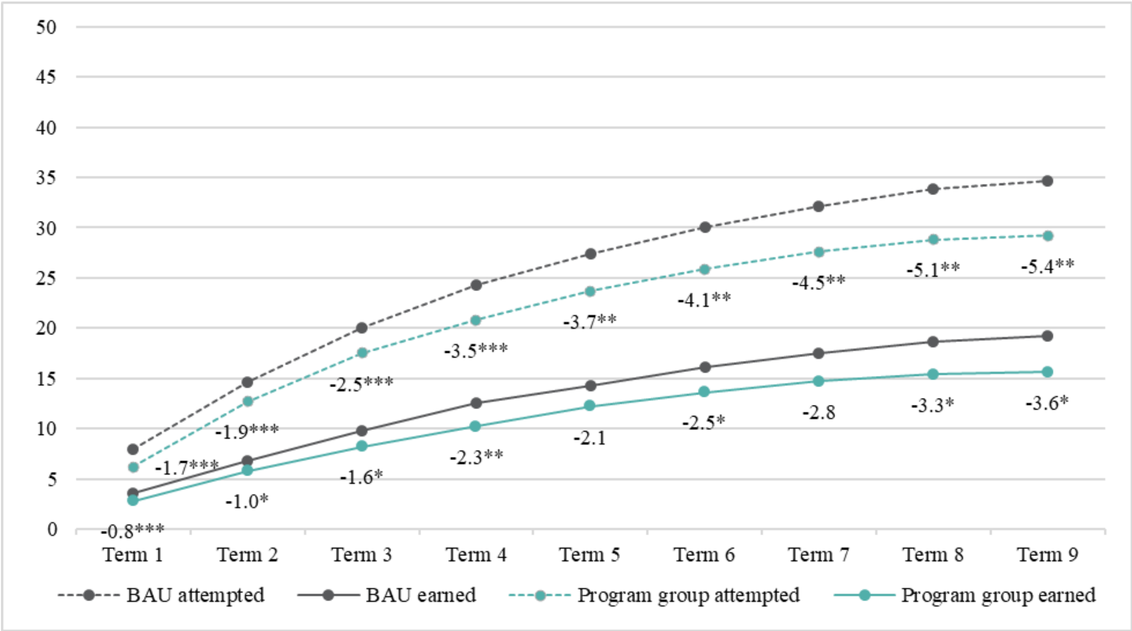
NOTE: Data labels represent impact estimates, or the percentage-point difference between the mean outcomes for business-as-usual and program group students.

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

Contrary to what was observed in the bump-up zone in English, program group students in the bump-down zone attempted and earned fewer college-level credits (in any subject) than their business-as-usual counterparts. Figure 4.13 shows that statistically significant differences were observed through the duration of the tracking period, and by term 9, program group students had attempted about 5 fewer and earned about 4 fewer college-level credits.

Figure 4.13

College-Level Credit Outcomes Among Students in Bump-Down English Zone



NOTE: Data labels represent impact estimates, or the percentage-point difference between the mean outcomes for business-as-usual and program group students.

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

Subgroup Analyses

To test whether program assignment led to differential treatment effects, we also conduct subgroup analyses by race/ethnicity, Pell recipient status,[13] and gender for the full analytic sample.[14] Additionally, we test the significance of the interaction between treatment status and each subgroup to understand whether MMA had any impact on existing equity gaps. For detailed information, see Tables A.64–A.67 in Appendix A.

[13] Importantly, Pell recipient status limits analysis to those students who enrolled in any course at the college ("enrolled students")—a post-random assignment characteristic. As a result, these analyses are no longer causal and may produce biased estimates of treatment effects.

[14] Due to small sample sizes, subgroup analyses are not conducted on students in the bump-up or bump-down zones.

College-Level Math Completion

Female program students were the only subgroup to experience sustained, statistically significant gains in completion of college-level math. While the magnitude of the observed impact decreased over time, after nine terms, program group students were still 2 percentage points more likely to complete a college-level math course (with a grade C or higher). Importantly, there is no evidence that completion gaps in college-level math narrowed or widened as a result of multiple measures for any of the included subgroups, including those observed between male and female students.

College-Level English Completion

In English, female, Pell-recipient, and Black students placed by the algorithm were more likely to complete a college-level English course (with a grade of C or higher) after nine terms. That said, statistical significance testing of interaction effects fail to reveal differential impacts on completion of college-level English, suggesting that after nine terms, MMA did not reduce any disparities between gender subgroups, Pell status subgroups, or race/ethnicity subgroups in the rate of completion.[15]

Other Outcomes

All subgroups experienced an increase in total college-level credits earned, though the duration of those statistically significant impacts varied. In all cases, gains were relatively small in magnitude (i.e., fewer than 2 credits earned). Similar to the main findings presented above, subgroup analyses do not reveal sustained statistically significant impacts of MMA on credential attainment or transfer.

[15] Although not presented here, estimated interaction effects for each subgroup are available upon request.

5. Cost-Effectiveness

The current study suggests that MMA has positive impacts on student outcomes. However, to fully understand the policy and practice implications of these findings, it is important to understand the economic implications of replacing traditional placement systems with MMA. To this end, we analyze the resources that participating colleges invested in an alternative placement system in relation to that system's estimated effects to establish whether MMA is affordable, cost-effective, and efficient for students, colleges, and society.

To examine costs, we follow the standard approach for the economic evaluation of social programs (Levin et al., 2018). To begin, we itemize all the resources required to implement the alternative placement system and the business-as-usual system to calculate direct costs. Next, we calculate the indirect costs that arise from students taking different pathways through college. To calculate cost-effectiveness (from the societal, college, and student perspectives), we must identify an appropriate measure of effectiveness for each placement system. For this long-term follow-up study, we posit that credentials earned after nine terms is the most valid measure of effectiveness. The cost estimate for the alternative placement system is relative to the cost of business-as-usual testing for placement. Relative to the status quo, there are new resource requirements for the alternative system with respect to (1) administrative set-up and the collecting of data for the placement algorithms in math and English, (2) creating the algorithms, and (3) applying the algorithms at the time of placement testing. For both systems, there are costs of (4) administering placement tests. We calculate these direct costs for six colleges (resource data was insufficient at the seventh college) using the ingredients method (Levin et al., 2018).

Across the six colleges, the total cost to fully implement the new MMA placement system was $1,407,560 (all costs are in present-value 2023 dollars) for 12,796 students in three cohorts. However, this amount includes the cost of administering placement tests, which is estimated to have cost $511,840 for the three cohorts. Therefore, the net cost of implementing the alternative system was $895,720 for three cohorts, or $70 per student. This is lower than what was calculated in the prior study report (Barnett et al., 2018) because once the alternative placement system became fully operational (for the spring 2017 and fall 2017 cohorts), the ongoing operating costs fell substantially.

To determine indirect costs and cost-effectiveness, we use the program effects on credits attempted in both developmental and college-level math and English coursework, as well as credits earned in college-level math and English courses. Program group students enrolled in 1.5 fewer developmental education credits (36 percent fewer) than business-as-usual group students. This represents substantial savings for students. But program group students also enrolled in 1.2 more college-level math and English credits. In total, students placed under the alternative system attempted 0.3 fewer credits (college-level and developmental) than students placed under the status quo. Indirect costs are the costs of providing all attempted developmental and college-level credits in math and English. On average, the cost per developmental credit attempted is approximately equal to the cost per college-level credit (developmental classes are typically smaller than college-level classes, but faculty pay per class is lower). Funding per credit is divided between public support and student tuition and fees; we calculate tuition and fees as 39 percent of total expenditures per credit. The results for this cost-effectiveness analysis[16] from the societal or social perspective are shown in Table 1.

Table 1

Cost-Effectiveness Analysis: Social Perspective

Per-student Costs	Business-as-Usual Placement	MMA Placement	Difference
Direct cost: Placement	$40	$110	$70
Indirect cost: Attempted developmental credits	$2,810	$1,800	-$1,010
Indirect cost: Attempted college-level credits	$27,060	$27,860	$800
Total cost	$29,910	$29,770	-$140
Earned credential	21%	21%	
Cost per credential earned	$142,430	$141,760	

NOTES: Indirect costs assume that the marginal cost of course offerings = average cost. The finding that MMA net cost is lower than business-as-usual holds if the marginal cost of instructional credits is at least one third of the average cost.

[16] The Integrated Postsecondary Education Data System (IPEDS) of the National Center for Education Statistics provides data on college expenditures and instructional activity credit hours. We calculate costs per credit by taking the IPEDS total expenses for the participating colleges (including developmental course costs) and dividing by the IPEDS instructional activity credit hours, a number which—unfortunately for this purpose—does not include developmental credits. Because developmental courses are included in the numerator but not the denominator, costs per credit using IPEDS data are likely to be overestimated. See Romano et al. (2019).

The total cost of the alternative system is $140 less per student than the status quo—students took fewer developmental education credits (saving $1,010) that more than offset the direct cost of the alternative placement system and the extra indirect cost of providing more attempted college-level credits (at $70 and $800, respectively). Although there is no statistically significant impact on non-subject-specific college-level credits earned or on credentials earned, the program is more cost-effective than business-as-usual for those outcomes. The alternative MMA placement system costs society less for the same result.

From the student perspective, the alternative placement system is clearly more cost-effective. For students, the only cost was the tuition and fees they paid for credits attempted. As students took 0.3 fewer credits under the alternative system, they saved $80. However, because students generally do not want to take developmental education, it may be more valid to focus on their developmental education savings from the alternative system. If students took 1.5 fewer developmental education credits, they saved $390 in tuition and fees (3 percent of their total spending on college).

For colleges, the determination of cost-effectiveness depends on net revenues. Colleges must pay to implement the alternative placement system; this additional cost must then be recouped by increases in net revenues (revenues over costs) from additional coursework. Estimating these costs and revenues at each college is difficult. Although the alternative placement system increased college-level credits attempted in nine terms and earned in the first three terms, because of the reduction in developmental credits attempted, it is unlikely that the alternative system is cost-effective from the college perspective.

6. Discussion

Summary and Implications of Findings

MMA improved access to and success in college-level courses. Relative to the status quo, students placed using MMA experienced higher rates of enrollment in college-level coursework regardless of subject area, and program students in English experienced higher rates of college-level English course completion through nine terms. These impacts were greater for students who were bumped up under the algorithm, with bumped-up students in English even earning a credential, particularly an associate degree, or transferring at higher rates. That said, while simply placing students into college-level courses can sometimes make the difference in college completion, generally speaking, the results of this study suggest that MMA alone may not be enough to have substantial effects on longer term student outcomes. Indeed, typical of postsecondary interventions, many of the positive impacts of MMA in this study decreased in magnitude over time.

Lower cut scores in English were associated with larger and longer lasting course completion impacts. After nine terms, program group students remained more likely to enroll in and complete college-level English, whereas impacts on college-level math completion were short lived. By the ninth term, 59 percent of program group students had enrolled in college-level math, whereas 77 percent had enrolled in college-level English. The much higher college-level English enrollment rate led to a 53 percent college-level English completion rate among program group students by term 9 (which is 2 percentage points higher than among business-as-usual group students). Statistically significant impacts on completion of college-level math are observed only through the first term. By term 9, only 41 percent of program group students completed college-level math. While other differences may have been relevant, we generally attribute the higher enrollment and completion rates in English to the lower or more liberal cut scores chosen by faculty—they resulted in more students gaining access to college-level coursework. In math, cut scores were set higher, preventing many students from gaining immediate access to college-level math and requiring more enrollment in developmental courses.

MMA had little to no impact on differences in outcomes within student demographic groups. In conducting subgroup analyses by race/ethnicity, Pell recipient status, and gender, we do not observe the closing of gaps in outcomes between subgroups. While we find improved outcomes among individual subgroups, we do not find evidence suggesting that those improvements affected disparities between groups. Rather, the existing disparities between subgroups remained, despite the outcome gains experienced by some subgroups. With few exceptions, this suggests that MMA alone is not sufficient to remediate long-standing disparities that occur in higher education.

Generally speaking, bumped-up students had substantially better outcomes, while bumped-down students had substantially worse outcomes. This is the case regardless of subject considered. The negative effect of bumping down students was similar in magnitude to the positive effect of bumping up students (around 5–9 percentage points on completing the college-level course by term 9). In other words, students bumped down by the algorithm would have benefitted as much from college-level placement as those bumped up by the algorithm. Importantly, exploratory bump-zone analyses also indicate that MMA may have had an impact on credential attainment. These findings suggest that greater access to college-level courses rather than greater placement accuracy may be the mechanism by which MMA improves student success.

Bumping up students in math was just as effective as bumping up students in English. Interestingly, the bump-zone impacts are of similar magnitude in math and English; that is, bumping up students in math had very similar positive effects as bumping up students in English, and bumping down students had similar negative effects in both subjects. In contrast, we observe very different impacts across subjects in the full sample analysis. Recall, however, that cut scores were more conservative in math than in English, resulting in fewer changed placements under the algorithm. Bump-zone findings confirm that MMA's potential to improve student outcomes is not subject dependent; rather, it is dependent on decisions made about how a new system changes students' placements relative to the status quo.

Societal and student costs of MMA were lower than the status quo. The total cost of the alternative system was $140 less per student than the status quo—students took fewer developmental education credits (saving $1,010) that more than offset the direct cost of the alternative placement system and the extra indirect cost of providing more attempted college-level credits (at $70 and $800, respectively). For students, the only cost was the tuition and fees they paid for credits attempted. As students took 0.3 fewer credits under the alternative system, they saved $80. Because students generally do not want to take developmental education courses, it may also be useful to focus on their developmental education savings under the alternative system. If students took 1.5 fewer developmental education credits, they saved $390 in tuition and fees (3 percent of their total spending on college). However, for colleges, the lost tuition revenue may have made MMA less cost-effective.

Recommendations

The results presented here support the use of MMA rather than traditional test-based systems. Below we provide some specific lessons from this research.

MMA should be used to expand access to college-level courses by giving many more students college-level placements. Findings from the current study suggest that increased access to college-level courses improves students' chances of completing college-level math and English courses. MMA's potential to improve student outcomes is explained by the redistribution of students from developmental courses to college-level courses. Unlike the algorithm approach used here, MMA systems that incorporate decision rules (see Box 3) place students according to the measure that gives them access to the highest level course. Implemented in this way, MMA will help improve overall access to college-level courses and can also help combat existing inequities in placement that reflect historical disparities such as racial gaps in standardized testing. By adopting MMA, colleges can help ensure that placement determinations are not dependent on assessments or measures that place specific groups of students at a disadvantage.

To bolster long-term student success, MMA should be implemented alongside additional student supports. Although research has shown that many students will succeed in college-level courses when given the chance to enroll in them, generally speaking, we find that the magnitude of the impacts of MMA on student outcomes decreases over time. Relatedly, we observe differences in the treatment effects on enrollment in and completion of college-level courses, suggesting that MMA has a greater impact on access than on success. Research has shown that reforms that are the most effective in improving student outcomes, such as City University of New York's Accelerated Study in Associate Programs (CUNY ASAP; Kolenovic et al., 2013), attend to various aspects of the college experience from point of entry through to college completion. Ensuring that students placed by MMA are adequately supported through multiple interventions, such as just-in-time tutoring, wraparound services, and intrusive advising, can help sustain the gains achieved by replacing the status quo placement system.

MMA's potential to improve equity requires deliberate consideration of the experiences of underserved populations. When taken at face value, results from the subgroup analyses we present in this report may seem discouraging. While some subgroups had improved outcomes, equity gaps were largely unaffected—they neither widened nor narrowed. It is important to recognize that MMA systems, as implemented in the current study and in most other contexts researched to date, have not been designed specifically to address disparities by race/ethnicity, socioeconomic status, or gender. While the use of MMA may improve overall student outcomes, there is a risk that a particular system could be designed and implemented in a way that could further disadvantage certain groups of students. In the current study, for example, MMA algorithms incorporated high school GPA from official high school transcripts, which may have been unavailable or inaccessible for some students, such as older and immigrant students. To account for such exigencies, colleges should consider ways to design and implement placement models that address practices and policies that may disadvantage certain groups of students. Suggestions include selecting inclusive placement measures, such as self-reported high school GPA or student self-assessment scores, that allow students from any academic or linguistic background to benefit from the redesigned system. What is more, MMA can be implemented alongside post-placement support programs that are tailored to meet the needs of specific populations as they navigate college.

Coupling MMA with corequisite reforms can further increase access to college-level coursework and provide more students with the opportunity to succeed. The findings from this study overwhelmingly suggest that increased access to college-level courses was the driving factor in the observed impacts on student success. Indeed, students who were predicted to have low probabilities of success in a college-level course did better when placed directly into those courses as compared to when they were required to take developmental coursework. Importantly, however, the MMA system under study here had no bearing on the curriculum or pedagogical approach taken up inside classrooms. In other words, even though MMA changed the composition of students enrolling in college-level courses, the classroom experience was not changed to meet the needs of those new students. To promote student success, colleges can further remove barriers to college-level courses by offering corequisite developmental courses in place of standalone developmental courses. Providing newly eligible students with extra content and support through corequisite courses could lead to further improvements in student outcomes than those observed in the current study (Logue et al., 2016; Logue et al., 2019; Mejia et al., 2019; Miller et al., 2021; Park-Gaghan et al., 2022; Ran & Lin, 2022).

7. Conclusion

In an effort to better place students into college-level math and English courses, institutions nationwide are increasingly adopting MMA by supplementing placement test scores or abandoning placement tests altogether. Indeed, research to date shows that MMA improves overall rates of college-level placement and completion of math and English courses when compared to the outcomes of students placed by traditional test-only placement systems. The long-term follow-up study described in this report—focusing on algorithmic MMA at seven SUNY community colleges—adds to this body of research by showing that the positive relationship between multiple measures placement and student outcomes can persist up to four and a half years from testing. Equally important, the results suggest that increased access to college-level courses is the driving factor in the positive outcomes experienced by program group students and that placement into standalone developmental courses can have detrimental effects on student outcomes. Implemented together with other initiatives to support students, MMA can be a first step on the path to success for incoming college students.

Appendix A. Supplementary Tables

Appendix Table A.1
Baseline Student Characteristics by College

Characteristics	Overall		College 1		College 2		College 3		College 4		College 5		College 6		College 7	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev	Mean	Std. Dev.	Mean	Std. Dev.
Gender (%)																
Female	48	50	58	49	54	50	53	50	48	50	52	50	55	50	41	49
Gender missing	4	20	0	4	0	5	0	0	0	5	0	2	0	0	12	32
Race/ethnicity (%)																
American Indian/Native American	1	10	1	9	1	10	1	12	2	12	0	5	1	8	1	9
Asian	2	15	1	8	1	11	1	10	2	15	5	21	7	26	2	14
Black	20	40	9	28	15	36	20	40	23	42	20	40	32	47	20	40
Hispanic	20	40	5	21	9	29	5	22	11	31	28	45	13	34	33	47
Pacific Islander	0	4	0	0	0	6	0	0	0	2	0	6	0	4	0	5
White	43	50	80	40	64	48	57	49	52	50	37	48	41	49	26	44
More than one race/ethnicity	4	18	1	11	3	18	5	21	5	23	3	17	3	18	3	17
Non-resident alien	0	6	1	8	1	11	1	8	0	5	0	2	0	0	0	5
Race/ethnicity unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Race/ethnicity missing	9	28	3	16	4	19	10	29	3	17	6	23	2	15	15	36
Age																
Age at test	21	6	21	6	23	8	22	7	20	6	22	7	25	9	20	5
Age at test missing (%)	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0
24 and Younger (%)	84	36	86	35	73	44	79	41	88	32	82	38	62	49	91	29
25 and Older (%)	14	35	13	33	25	43	20	40	10	30	16	36	35	48	8	27
Pell Grant (%)																
Pell Grant recipient	45	50	53	50	48	50	51	50	44	50	32	47	61	49	43	50
Pell Grant recipient Missing	12	32	9	28	13	33	12	33	12	32	7	25	15	36	13	34
Tested math (%)	75	43	98	14	88	33	90	30	0	0	97	16	0	0	94	23
Tested English (%)	83	37	65	48	86	34	55	50	100	0	57	50	100	0	97	16
Tested math and English (%)	58	49	63	48	74	44	45	50	0	0	54	50	0	0	92	28
Enrolled any course (%)	88	32	91	28	87	33	88	33	88	32	93	25	85	36	87	34
Total	12,796		688		1,226		1,874		1,995		1,797		497		4,719	

Appendix Table A.2
Post-Randomization Characteristics by Treatment Assignment

Characteristics	Business-as-Usual Mean	Program Mean	Treatment Difference	*p* value	Observations
Gender					
Female	47.8%	48.1%	0.3%	0.7	12,796
Gender missing	4.3%	4.4%	-0.1%	0.7	12,796
Race/ethnicity					
American Indian/Native American	1.0%	0.9%	0.0%	0.8	12,796
Asian	2.4%	2.3%	0.1%	0.7	12,796
Black	19.5%	20.3%	-0.8%	0.2	12,796
Hispanic	19.6%	20.8%	-1.2%	0.1	12,796
Pacific Islander	0.2%	0.2%	0.0%	0.7	12,796
White	43.8%	42.6%	1.2%	0.2	12,796
More than one race/ethnicity	3.8%	3.2%	0.6%	0.1	12,796
Non-resident alien	0.4%	0.4%	0.0%	1.0	12,796
Race/ethnicity unknown	0.0%	0.0%	0.0%		12,796
Race/ethnicity missing	8.8%	8.6%	0.1%	0.8	12,796
Age					
Age at test	21.2	21.0	0.2	0.1	12,796
Age at test missing	0.0%	0.0%	0.0%	0.3	12,796
Pell Grant					
Pell Grant recipient	44.5%	44.6%	-0.1%	0.9	12,796
Pell Grant recipient missing	11.3%	11.9%	-0.5%	0.3	12,796
GED					
GED recipient	8.3%	6.9%	1.5%	0.0	12,796
GED recipient missing	0.0%	0.0%	0.0%		12,796
GPA					
HS GPA (100 scale)	78.0	78.2	-0.2	0.2	7,961
HS GPA missing	38.2%	37.4%	0.9%	0.3	12,796
Accuplacer					
Algebra	50.8	50.7	0.1	0.8	9,510
Arithmetic	46.2	46.6	-0.4	0.5	7,318
College-level math	34.3	33.9	0.4	0.7	846
Reading	72.2	71.8	0.4	0.3	10,280
Sentence skill	75.9	75.6	0.2	0.7	5,063
Writing	6.0	6.1	0.0	0.8	7,061
Tested math	74.3%	76.2%	-1.8%	0.0	12,796
Tested English	83.4%	83.0%	0.4%	0.6	12,796
Tested math and English	57.7%	59.2%	-1.4%	0.1	12,796
Enrolled any course	88.7%	88.1%	0.5%	0.3	12,796
Total	6,477	6,319			12,796

Appendix Table A.3
Subject-Specific Cut Scores by College

	Math	English
College 1	26%	61%
College 2	73%	67%
College 3	40%	45%
College 4		54%
College 5	60%	60%
College 6		50%
College 7	45%	63%

Appendix Table A.4
Impact on Placement Into College-Level Math

	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
	36.9%	0.7%	43.4%	0.8%	6.5 ppt	***
Observations	4,665		4,893			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.5
Impact on Enrollment in College-Level Math

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	27.1%	0.6%	29.8%	0.8%	2.7 ppt	**
Term 2	39.4%	0.7%	41.4%	0.9%	2.0 ppt	**
Term 3	47.6%	0.7%	49.5%	0.9%	1.9 ppt	**
Term 4	51.2%	0.7%	53.3%	0.9%	2.1 ppt	**
Term 5	53.5%	0.7%	55.7%	0.9%	2.2 ppt	**
Term 6	54.9%	0.7%	56.8%	0.9%	1.9 ppt	**
Term 7	56.0%	0.7%	58.1%	0.9%	2.1 ppt	**
Term 8	56.7%	0.7%	58.6%	0.9%	1.9 ppt	**
Term 9	57.0%	0.7%	58.9%	0.9%	1.9 ppt	**
Observations	4,665		4,893			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.6
Impact on Completion of College-Level Math (With Grade C or Higher)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	14.9%	0.5%	16.7%	0.7%	1.8 ppt	**
Term 2	23.3%	0.6%	24.1%	0.8%	0.8 ppt	
Term 3	29.9%	0.7%	30.3%	0.9%	0.4 ppt	
Term 4	32.9%	0.7%	33.9%	0.9%	1.0 ppt	
Term 5	35.3%	0.7%	36.7%	0.9%	1.4 ppt	
Term 6	37.0%	0.7%	38.2%	0.9%	1.2 ppt	
Term 7	38.2%	0.7%	39.4%	0.9%	1.2 ppt	
Term 8	38.8%	0.7%	40.1%	0.9%	1.3 ppt	
Term 9	39.3%	0.7%	40.5%	0.9%	1.2 ppt	
Observations	4,665		4,893			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.7
Impact on Enrollment in Second College-Level Math

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.1%	0.0%	0.0%	0.1%	-0.1 ppt	
Term 2	12.3%	0.5%	12.9%	0.6%	0.6 ppt	
Term 3	20.7%	0.6%	21.6%	0.8%	0.9 ppt	
Term 4	26.5%	0.6%	27.2%	0.8%	0.7 ppt	
Term 5	29.8%	0.7%	30.8%	0.9%	1.0 ppt	
Term 6	31.8%	0.7%	32.7%	0.9%	0.9 ppt	
Term 7	33.1%	0.7%	34.2%	0.9%	1.1 ppt	
Term 8	33.9%	0.7%	35.2%	0.9%	1.3 ppt	
Term 9	34.3%	0.7%	35.5%	0.9%	1.2 ppt	
Observations	4,665		4,893			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.8
Impact on Completion of Second College-Level Math (With Grade C or Higher)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.1%	0.0%	0.1%	0.0%	0.0 ppt	
Term 2	6.5%	0.4%	6.7%	0.5%	0.2 ppt	
Term 3	11.2%	0.5%	11.6%	0.6%	0.4 ppt	
Term 4	14.3%	0.5%	14.4%	0.7%	0.1 ppt	
Term 5	16.0%	0.5%	16.5%	0.7%	0.5 ppt	
Term 6	17.0%	0.5%	17.5%	0.7%	0.5 ppt	
Term 7	17.8%	0.6%	18.2%	0.8%	0.4 ppt	
Term 8	18.2%	0.6%	18.8%	0.8%	0.6 ppt	
Term 9	18.4%	0.6%	18.9%	0.8%	0.5 ppt	
Observations	4,665		4,893			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.9
Impact on College-Level Math Credits Attempted

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	1.0	0.0	1.0	0.0	0.1	**
Term 2	1.8	0.0	1.9	0.0	0.1	
Term 3	2.6	0.1	2.7	0.1	0.1	
Term 4	3.2	0.1	3.3	0.1	0.1	
Term 5	3.7	0.1	3.8	0.1	0.1	
Term 6	4.0	0.1	4.1	0.1	0.1	
Term 7	4.2	0.1	4.3	0.1	0.1	
Term 8	4.4	0.1	4.5	0.1	0.1	
Term 9	4.4	0.1	4.6	0.1	0.1	
Observations	4,665		4,893			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.10
Impact on College-Level Math Credits Earned

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.5	0.0	0.6	0.0	0.0	*
Term 2	1.0	0.0	1.0	0.0	0.0	
Term 3	1.4	0.0	1.4	0.1	0.0	
Term 4	1.7	0.0	1.7	0.1	0.0	
Term 5	1.9	0.0	2.0	0.1	0.1	
Term 6	2.1	0.1	2.1	0.1	0.1	
Term 7	2.2	0.1	2.3	0.1	0.1	
Term 8	2.3	0.1	2.4	0.1	0.1	
Term 9	2.3	0.1	2.4	0.1	0.1	
Observations	4,665		4,893			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.11
Impact on Placement Into College-Level English

	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
	46.2%	0.7%	79.9%	0.8%	33.7 ppt	***
Observations	5,248		5,360			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.12
Impact on Enrollment in College-Level English

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	44.7%	0.7%	58.2%	0.8%	13.5 ppt	***
Term 2	62.4%	0.7%	69.8%	0.7%	7.4 ppt	***
Term 3	67.1%	0.6%	73.0%	0.7%	5.9 ppt	***
Term 4	68.8%	0.6%	74.5%	0.7%	5.7 ppt	***
Term 5	69.8%	0.6%	75.2%	0.7%	5.4 ppt	***
Term 6	70.5%	0.6%	75.7%	0.6%	5.2 ppt	***
Term 7	71.0%	0.6%	76.2%	0.6%	5.2 ppt	***
Term 8	71.2%	0.6%	76.3%	0.6%	5.1 ppt	***
Term 9	71.4%	0.6%	76.5%	0.6%	5.1 ppt	***
Observations	5,248		5,360			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Table A.13
Impact on Completion of College-Level English (With Grade C or Higher)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	28.1%	0.6%	34.7%	0.8%	6.6 ppt	***
Term 2	40.0%	0.7%	43.3%	0.9%	3.3 ppt	***
Term 3	44.9%	0.7%	47.9%	0.9%	3.0 ppt	***
Term 4	46.8%	0.7%	49.6%	0.9%	2.8 ppt	***
Term 5	48.6%	0.7%	50.9%	0.9%	2.3 ppt	***
Term 6	49.2%	0.7%	51.6%	0.9%	2.4 ppt	***
Term 7	50.1%	0.7%	52.2%	0.9%	2.1 ppt	**
Term 8	50.4%	0.7%	52.4%	0.9%	2.0 ppt	**
Term 9	50.6%	0.7%	52.7%	0.9%	2.1 ppt	**
Observations	5,248		5,360			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.14
Impact on Enrollment in Second College-Level English

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.5%	0.1%	0.3%	0.1%	-0.2 ppt	
Term 2	28.4%	0.6%	35.6%	0.8%	7.2 ppt	***
Term 3	41.9%	0.7%	46.5%	0.9%	4.6 ppt	***
Term 4	46.5%	0.7%	50.4%	0.9%	3.9 ppt	***
Term 5	49.1%	0.7%	52.5%	0.9%	3.4 ppt	***
Term 6	50.2%	0.7%	53.5%	0.9%	3.3 ppt	***
Term 7	51.1%	0.7%	54.4%	0.9%	3.3 ppt	***
Term 8	51.6%	0.7%	54.8%	0.9%	3.2 ppt	***
Term 9	51.8%	0.7%	55.1%	0.9%	3.3 ppt	***
Observations	5,248		5,360			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.15
Impact on Completion of Second College-Level English (With Grade C or Higher)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.3%	0.1%	0.3%	0.1%	0.0 ppt	
Term 2	17.6%	0.5%	21.2%	0.7%	3.6 ppt	***
Term 3	26.2%	0.6%	27.6%	0.8%	1.4 ppt	*
Term 4	28.7%	0.6%	29.6%	0.8%	0.9 ppt	
Term 5	30.4%	0.6%	31.1%	0.8%	0.7 ppt	
Term 6	30.9%	0.6%	31.6%	0.8%	0.7 ppt	
Term 7	31.4%	0.6%	32.1%	0.9%	0.7 ppt	
Term 8	31.7%	0.6%	32.3%	0.9%	0.6 ppt	
Term 9	31.9%	0.6%	32.5%	0.9%	0.6 ppt	
Observations	5,248		5,360			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.16
Impact on College-Level English Credits Attempted

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	1.4	0.0	1.8	0.0	0.4	***
Term 2	2.7	0.0	3.2	0.0	0.4	***
Term 3	3.5	0.0	3.9	0.0	0.4	***
Term 4	4.0	0.0	4.3	0.1	0.3	***
Term 5	4.3	0.1	4.6	0.1	0.3	***
Term 6	4.5	0.1	4.8	0.1	0.3	***
Term 7	4.6	0.1	4.9	0.1	0.3	***
Term 8	4.7	0.1	5.0	0.1	0.3	***
Term 9	4.7	0.1	5.1	0.1	0.3	***
Observations	5,248		5,360			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.17
Impact on College-Level English Credits Earned

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.9	0.0	1.0	0.0	0.2	***
Term 2	1.7	0.0	1.9	0.0	0.2	***
Term 3	2.1	0.0	2.3	0.0	0.1	***
Term 4	2.4	0.0	2.5	0.1	0.1	**
Term 5	2.6	0.0	2.7	0.1	0.1	*
Term 6	2.7	0.0	2.8	0.1	0.1	*
Term 7	2.7	0.0	2.8	0.1	0.1	*
Term 8	2.8	0.0	2.9	0.1	0.1	*
Term 9	2.8	0.0	2.9	0.1	0.1	*
Observations	5,248		5,360			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.18
Impact on College-Level Credits Attempted

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	7.9	0.1	8.9	0.1	1.0	***
Term 2	15.5	0.1	16.7	0.1	1.2	***
Term 3	22.2	0.2	23.5	0.2	1.3	***
Term 4	27.6	0.3	28.9	0.3	1.3	***
Term 5	31.9	0.3	33.1	0.4	1.3	***
Term 6	35.0	0.4	36.2	0.4	1.2	***
Term 7	37.5	0.4	38.8	0.5	1.3	***
Term 8	39.5	0.4	40.8	0.5	1.2	**
Term 9	40.5	0.4	41.7	0.5	1.2	**
Observations	6,319		6,477			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.18
Impact on College-Level Credits Attempted

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	7.9	0.1	8.9	0.1	1.0	***
Term 2	15.5	0.1	16.7	0.1	1.2	***
Term 3	22.2	0.2	23.5	0.2	1.3	***
Term 4	27.6	0.3	28.9	0.3	1.3	***
Term 5	31.9	0.3	33.1	0.4	1.3	***
Term 6	35.0	0.4	36.2	0.4	1.2	***
Term 7	37.5	0.4	38.8	0.5	1.3	***
Term 8	39.5	0.4	40.8	0.5	1.2	**
Term 9	40.5	0.4	41.7	0.5	1.2	**
Observations	6,319		6,477			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.19
Impact on College-Level Credits Earned

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	4.9	0.1	5.3	0.1	0.4	***
Term 2	9.5	0.1	9.9	0.2	0.5	***
Term 3	14.0	0.2	14.4	0.2	0.5	**
Term 4	17.8	0.2	18.2	0.3	0.4	
Term 5	20.7	0.3	21.2	0.4	0.4	
Term 6	23.0	0.3	23.4	0.4	0.4	
Term 7	24.9	0.4	25.3	0.5	0.4	
Term 8	26.4	0.4	26.8	0.5	0.4	
Term 9	27.1	0.4	27.5	0.5	0.4	
Observations	6,319		6,477			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.20
Impact on Continuous Persistence

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	81.5%	0.5%	81.8%	0.4%	0.3 ppt	
Term 2	61.6%	0.6%	62.1%	0.8%	0.5 ppt	
Term 3	45.0%	0.6%	45.2%	0.8%	0.2 ppt	
Term 4	36.1%	0.6%	36.3%	0.8%	0.2 ppt	
Term 5	24.2%	0.5%	24.5%	0.7%	0.3 ppt	
Term 6	17.9%	0.5%	17.8%	0.7%	-0.1 ppt	
Term 7	10.9%	0.4%	11.4%	0.5%	0.5 ppt	
Term 8	8.3%	0.3%	8.8%	0.5%	0.5 ppt	
Term 9	2.5%	0.2%	2.4%	0.3%	-0.1 ppt	
Observations	6,319		6,477			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.21
Impact on Credential Attainment in Term 9

Outcome	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Certificate	1.0%	0.1%	0.9%	0.2%	-0.1 ppt	
AA/AS	14.0%	0.4%	13.9%	0.6%	-0.1 ppt	
AAS	5.8%	0.3%	5.7%	0.4%	-0.1 ppt	
Bachelor's	2.4%	0.2%	2.6%	0.3%	0.2 ppt	
Observations	6,319		6,477			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.22
Impact on Credential Attainment or Transfer

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.0%	0.0%	0.0%	0.0%	0.0 ppt	
Term 2	0.6%	0.1%	0.5%	0.1%	-0.1 ppt	
Term 3	2.1%	0.2%	2.2%	0.2%	0.1 ppt	
Term 4	7.6%	0.3%	7.1%	0.4%	-0.5 ppt	
Term 5	13.5%	0.4%	13.1%	0.6%	-0.4 ppt	
Term 6	17.9%	0.5%	17.7%	0.6%	-0.2 ppt	
Term 7	20.7%	0.5%	20.5%	0.7%	-0.2 ppt	
Term 8	22.7%	0.5%	22.3%	0.7%	-0.4 ppt	
Term 9	23.7%	0.5%	23.4%	0.7%	-0.3 ppt	
Observations	6,319		6,477			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.23
Placement Zones for All Students

	Program Group	Business-as-Usual Group
Bump-Up Zone	*College-Level* Math: n = 805 English: n = 2,364	*Developmental* Math: n = 786 English: n = 2,232
No Change Zone (College-level)	*College-Level* Math: n = 1,328 English: n = 1,984	*College-Level* Math: n = 1,256 English: n = 1,908
No Change Zone (Developmental)	*Developmental* Math: n = 2,272 English: n = 651	*Developmental* Math: n = 2,167 English: n = 729
Bump-Down Zone	*Developmental* Math: n = 488 English: n = 361	*College-Level* Math: n = 456 English: n = 379

Appendix Table A.24
Post-Randomization Characteristics by Bump-Up Subject

	Bump-Up Math					Bump-Up English				
Characteristics	Business-as-Usual Mean	Program Mean	Treatment Difference	*p* value	Observations	Business-as-Usual Mean	Program Mean	Treatment Difference	*p* value	Observations
Gender										
Female	58.1%	62.7%	4.6%	0.1	1,591	47.2%	46.2%	-1.0%	0.5	4,596
Gender missing	0.4%	1.0%	0.6%	0.1	1,591	4.5%	4.8%	0.4%	0.6	4,596
Race/Ethnicity										
American Indian/Native American	0.9%	0.8%	-0.1%	0.8	1,591	0.9%	1.0%	0.1%	0.8	4,596
Asian	1.4%	1.8%	0.4%	0.5	1,591	2.9%	2.9%	-0.1%	0.9	4,596
Black	18.9%	16.5%	-2.3%	0.2	1,591	25.0%	23.2%	-1.7%	0.2	4,596
Hispanic	20.2%	19.0%	-1.3%	0.5	1,591	21.0%	20.1%	-0.9%	0.4	4,596
Pacific Islander	0.2%	0.1%	-0.1%	0.6	1,591	0.3%	0.2%	-0.1%	0.6	4,596
White	49.2%	48.9%	-0.3%	0.9	1,591	37.0%	38.7%	1.7%	0.2	4,596
More than one race/ethnicity	2.2%	4.1%	1.8%	0.0	1,591	3.0%	3.4%	0.4%	0.4	4,596
Non-resident alien	0.4%	0.6%	0.3%	0.5	1,591	0.3%	0.4%	0.1%	0.5	4,596
Race/ethnicity unknown	0.0%	0.0%	0.0%		1,591	0.0%	0.0%	0.0%		4,596
Race/ethnicity missing	5.5%	7.4%	1.9%	0.1	1,591	8.9%	9.6%	0.7%	0.4	4,596
Age										
Age at test	22.3	22.8	0.5	0.2	1,591	21.6	21.7	0.1	0.5	4,596
Age at test missing	0.0%	0.0%	0.0%		1,591	0.0%	0.0%	0.0%		4,596
Pell Grant										
Pell Grant recipient	43.1%	42.9%	-0.2%	0.9	1,591	45.9%	44.2%	-1.7%	0.2	4,596
Pell Grant recipient missing	9.6%	9.2%	-0.4%	0.8	1,591	13.3%	13.7%	0.4%	0.7	4,596
GED										
GED Recipient	9.6%	10.4%	0.9%	0.6	1,591	8.8%	8.9%	0.1%	0.9	4,596
GED recipient, missing	0.0%	0.0%	0.0%		1,591	0.0%	0.0%	0.0%		4,596
GPA										
HS GPA (100 Scale)	81.5	81.2	-0.3	0.3	1,150	77.8	77.7	-0.1	0.7	2,474
HS GPA missing	28.0%	27.5%	-0.5%	0.8	1,591	45.7%	46.7%	1.0%	0.5	4,596
Accuplacer										
Algebra	0.0	0.0	0.0	0.0	0	50.3	50.8	0.5	0.5	4,499
Arithmetic	37.1	37.3	0.3	0.8	1,446	42.2	42.1	-0.1	0.9	3,315
College-level math	0.0	0.0	0.0	0.0	0	34.8	34.6	-0.2	0.8	614
Reading	73.2	73.9	0.7	0.6	1,314	64.7	65.6	0.9	0.1	4,417
Sentence skill	76.4	76.1	-0.3	0.8	692	66.5	66.6	0.2	0.8	2,500
Writing	5.3	5.4	0.1	0.6	1,030	4.7	4.7	0.0	0.8	2,897
Total	786	805			1,591	2,232	2,364			4,596

Appendix Table A.25
Post-Randomization Characteristics by Bump-Down Subject

	Bump-Down Math					Bump-Down English				
Characteristics	Business-as-Usual Mean	Program Mean	Treatment Difference	*p* value	Observations	Business-as-Usual Mean	Program Mean	Treatment Difference	*p* value	Observations
Gender										
Female	40.2%	40.6%	0.4%	0.9	944	43.2%	43.0%	-0.2%	1.0	740
Gender missing	6.1%	6.4%	0.2%	0.9	944	8.3%	3.2%	-5.1%	0.0	740
Race/Ethnicity										
American Indian/Native American	0.4%	0.9%	0.5%	0.4	944	1.4%	0.5%	-0.9%	0.2	740
Asian	1.4%	1.3%	-0.1%	0.9	944	0.3%	2.1%	1.8%	0.0	740
Black	20.3%	18.6%	-1.6%	0.5	944	18.8%	19.5%	0.7%	0.8	740
Hispanic	28.3%	22.8%	-5.5%	0.1	944	22.4%	25.9%	3.4%	0.3	740
Pacific Islander	0.2%	0.0%	-0.2%	0.3	944	0.3%	0.0%	-0.3%	0.3	740
White	35.2%	40.4%	5.1%	0.1	944	39.3%	41.2%	1.8%	0.6	740
More than one race/ethnicity	3.1%	4.6%	1.5%	0.2	944	3.0%	3.7%	0.6%	0.6	740
Non-resident alien	1.0%	0.4%	-0.6%	0.3	944	0.3%	0.5%	0.3%	0.6	740
Race/ethnicity unknown	0.0%	0.0%	0.0%		944	0.0%	0.0%	0.0%		740
Race/ethnicity missing	9.8%	11.0%	1.1%	0.6	944	13.9%	6.3%	-7.5%	0.0	740
Age										
Age at test	19.0	19.1	0.1	0.4	944	19.8	20.4	0.5	0.1	740
Age at test missing	0.0%	0.0%	0.0%		944	0.0%	0.0%	0.0%		740
Pell Grant										
Pell Grant recipient	47.3%	43.2%	-4.1%	0.2	944	46.8%	52.5%	5.7%	0.1	740
Pell Grant recipient missing	9.8%	9.2%	-0.6%	0.7	944	15.5%	10.3%	-5.2%	0.0	740
GED										
GED recipient	2.9%	3.9%	1.1%	0.4	944	8.9%	12.1%	3.3%	0.1	740
GED recipient, missing	0.0%	0.0%	0.0%		944	0.0%	0.0%	0.0%		740
GPA										
HS GPA (100 scale)	75.8	76.2	0.4	0.4	631	73.9	73.7	-0.2	0.6	635
HS GPA missing	31.6%	34.9%	3.3%	0.3	944	11.9%	16.4%	4.4%	0.1	740
Accuplacer										
Algebra	66.4	67.4	1.0	0.3	940	46.4	45.2	-1.2	0.4	646
Arithmetic	58.5	55.7	-2.8	0.2	573	43.8	43.0	-0.8	0.7	429
College-level math	31.3	31.9	0.6	0.8	116	30.1	31.9	1.7	0.6	39
Reading	74.8	74.1	-0.7	0.6	796	76.6	78.6	2.0	0.2	729
Sentence skill	77.5	78.9	1.3	0.7	160	90.4	91.1	0.6	0.6	378
Writing	6.5	6.4	-0.1	0.4	709	7.5	7.5	0.0	1.0	429
Total	456	488			944	379	361			740

Appendix Table A.26
Impact on Placement Into College-Level Math
(Among Students in the Bump-Up Math Zone Only)

	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
	0.7%	0.3%	92.9%	1.0%	92.2 ppt	***
Observations	786		805			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.27
Impact on Enrollment in College-Level Math (Among Students in the Bump-Up Math Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	5.3%	0.8%	45.4%	1.9%	40.1 ppt	***
Term 2	27.2%	1.5%	55.8%	2.2%	28.6 ppt	***
Term 3	39.1%	1.7%	62.6%	2.2%	23.5 ppt	***
Term 4	44.7%	1.7%	65.6%	2.2%	20.9 ppt	***
Term 5	48.4%	1.8%	67.6%	2.2%	19.2 ppt	***
Term 6	50.5%	1.8%	68.5%	2.2%	18.0 ppt	***
Term 7	52.4%	1.8%	69.0%	2.2%	16.6 ppt	***
Term 8	53.3%	1.8%	69.1%	2.2%	15.8 ppt	***
Term 9	53.8%	1.8%	69.2%	2.2%	15.4 ppt	***
Observations	786		805			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.28
Impact on Completion of College-Level Math (With Grade C or Higher)
(Among Students in the Bump-Up Math Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	2.9%	0.6%	23.7%	1.6%	20.8 ppt	***
Term 2	16.8%	1.3%	31.1%	2.0%	14.3 ppt	***
Term 3	27.3%	1.6%	37.5%	2.2%	10.2 ppt	***
Term 4	31.0%	1.6%	40.5%	2.3%	9.5 ppt	***
Term 5	34.6%	1.7%	43.9%	2.3%	9.3 ppt	***
Term 6	36.6%	1.7%	45.6%	2.3%	9.0 ppt	***
Term 7	37.9%	1.7%	46.9%	2.3%	9.0 ppt	***
Term 8	39.0%	1.7%	47.3%	2.3%	8.3 ppt	***
Term 9	39.0%	1.7%	47.5%	2.3%	8.5 ppt	***
Observations	786		805			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.29
Impact on Enrollment in Second College-Level Math
(Among Students in the Bump-Up Math Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.0%	0.0%	0.0%	0.0%	0.0 ppt	
Term 2	2.6%	0.6%	19.4%	1.5%	16.8 ppt	***
Term 3	14.3%	1.2%	28.5%	2.0%	14.2 ppt	***
Term 4	22.2%	1.5%	35.0%	2.1%	12.8 ppt	***
Term 5	26.4%	1.6%	37.4%	2.2%	11.0 ppt	***
Term 6	28.9%	1.6%	39.8%	2.2%	10.9 ppt	***
Term 7	30.9%	1.6%	41.0%	2.3%	10.1 ppt	***
Term 8	31.9%	1.7%	41.8%	2.3%	9.9 ppt	***
Term 9	32.4%	1.7%	41.9%	2.3%	9.5 ppt	***
Observations	786		805			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.30
Impact on Completion of Second College-Level Math (With Grade C or Higher)
(Among Students in the Bump-Up Math Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.0%	0.0%	0.0%	0.0%	0.0 ppt	
Term 2	1.4%	0.4%	9.8%	1.2%	8.4 ppt	***
Term 3	8.8%	1.0%	14.4%	1.6%	5.6 ppt	***
Term 4	12.7%	1.2%	17.5%	1.8%	4.8 ppt	***
Term 5	15.1%	1.3%	19.3%	1.9%	4.2 ppt	**
Term 6	16.7%	1.3%	20.7%	1.9%	4.0 ppt	**
Term 7	17.9%	1.4%	21.5%	1.9%	3.6 ppt	*
Term 8	18.4%	1.4%	22.1%	2.0%	3.7 ppt	*
Term 9	18.7%	1.4%	22.1%	2.0%	3.4 ppt	*
Observations	786		805			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.31
Impact on College-Level Math Credits Attempted
(Among Students in the Bump-Up Math Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.2	0.0	1.4	0.1	1.2	***
Term 2	1.0	0.1	2.4	0.1	1.4	***
Term 3	1.8	0.1	3.2	0.1	1.4	***
Term 4	2.5	0.1	3.8	0.2	1.4	***
Term 5	2.9	0.1	4.3	0.2	1.4	***
Term 6	3.2	0.1	4.6	0.2	1.4	***
Term 7	3.4	0.2	4.8	0.2	1.4	***
Term 8	3.6	0.2	4.9	0.2	1.4	***
Term 9	3.6	0.2	5.0	0.2	1.4	***
Observations	786		805			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.32
Impact on College-Level Math Credits Earned
(Among Students in the Bump-Up Math Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.1	0.0	0.7	0.1	0.6	***
Term 2	0.6	0.0	1.2	0.1	0.6	***
Term 3	1.1	0.1	1.6	0.1	0.5	***
Term 4	1.4	0.1	1.9	0.1	0.5	***
Term 5	1.6	0.1	2.2	0.1	0.6	***
Term 6	1.8	0.1	2.4	0.2	0.6	***
Term 7	1.9	0.1	2.5	0.2	0.6	***
Term 8	2.0	0.1	2.6	0.2	0.6	***
Term 9	2.0	0.1	2.6	0.2	0.6	***
Observations	786		805			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.33
Impact on Placement Into College-Level English
(Among Students in the Bump-Up English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
	4.9%	0.4%	97.6%	0.5%	92.7 ppt	***
Observations	2,232		2,364			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.34
Impact on Enrollment in College-Level English
(Among Students in the Bump-Up English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	28.4%	0.9%	63.0%	1.2%	34.6 ppt	***
Term 2	52.6%	1.0%	71.7%	1.2%	19.1 ppt	***
Term 3	58.6%	1.0%	74.7%	1.1%	16.1 ppt	***
Term 4	60.9%	1.0%	76.0%	1.1%	15.1 ppt	***
Term 5	62.2%	1.0%	76.7%	1.1%	14.5 ppt	***
Term 6	63.1%	1.0%	77.1%	1.0%	14.0 ppt	***
Term 7	63.7%	1.0%	77.5%	1.0%	13.8 ppt	***
Term 8	63.9%	1.0%	77.8%	1.0%	13.9 ppt	***
Term 9	64.1%	1.0%	77.9%	1.0%	13.8 ppt	***
Observations	2,232		2,364			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.35
Impact on Completion of College-Level English (With Grade C or Higher)
(Among Students in the Bump-Up English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	17.5%	0.8%	36.3%	1.2%	18.8 ppt	***
Term 2	34.0%	1.0%	44.3%	1.3%	10.3 ppt	***
Term 3	39.8%	1.0%	48.5%	1.3%	8.7 ppt	***
Term 4	41.9%	1.0%	50.0%	1.3%	8.1 ppt	***
Term 5	43.9%	1.0%	51.6%	1.3%	7.7 ppt	***
Term 6	44.8%	1.0%	52.3%	1.3%	7.5 ppt	***
Term 7	45.9%	1.0%	52.8%	1.3%	6.9 ppt	***
Term 8	46.1%	1.0%	53.2%	1.3%	7.1 ppt	***
Term 9	46.2%	1.0%	55.3%	1.3%	9.1 ppt	***
Observations	2,232		2,364			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.36
Impact on Enrollment in Second College-Level English
(Among Students in the Bump-Up English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.6%	0.2%	0.5%	0.2%	-0.1 ppt	
Term 2	16.3%	0.8%	37.1%	1.2%	20.8 ppt	***
Term 3	33.0%	1.0%	46.8%	1.3%	13.8 ppt	***
Term 4	38.7%	1.0%	50.5%	1.3%	11.8 ppt	***
Term 5	41.9%	1.0%	52.9%	1.3%	11.0 ppt	***
Term 6	43.4%	1.0%	53.6%	1.3%	10.2 ppt	***
Term 7	44.4%	1.0%	54.5%	1.3%	10.1 ppt	***
Term 8	44.8%	1.0%	54.9%	1.3%	10.1 ppt	***
Term 9	45.1%	1.0%	55.3%	1.3%	10.2 ppt	***
Observations	2,232		2,364			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.37
Impact on Completion of Second College-Level English (With Grade C or Higher)
(Among Students in the Bump-Up English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.3%	0.1%	0.3%	0.2%	0.0 ppt	
Term 2	9.9%	0.6%	20.5%	1.0%	10.6 ppt	***
Term 3	20.9%	0.9%	26.5%	1.2%	5.6 ppt	***
Term 4	23.8%	0.9%	28.5%	1.2%	4.7 ppt	***
Term 5	25.9%	0.9%	30.3%	1.3%	4.4 ppt	***
Term 6	26.5%	0.9%	30.7%	1.3%	4.2 ppt	***
Term 7	27.3%	0.9%	31.1%	1.3%	3.8 ppt	***
Term 8	27.6%	0.9%	31.4%	1.3%	3.8 ppt	***
Term 9	27.9%	0.9%	31.8%	1.3%	3.9 ppt	***
Observations	2,232		2,364			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.38
Impact on College-Level English Credits Attempted
(Among Students in the Bump-Up English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.9	0.0	1.9	0.0	1.0	***
Term 2	2.1	0.0	3.3	0.1	1.2	***
Term 3	2.9	0.1	4.0	0.1	1.0	***
Term 4	3.4	0.1	4.4	0.1	1.0	***
Term 5	3.7	0.1	4.6	0.1	1.0	***
Term 6	3.9	0.1	4.8	0.1	0.9	***
Term 7	4.0	0.1	4.9	0.1	0.9	***
Term 8	4.0	0.1	5.0	0.1	1.0	***
Term 9	4.1	0.1	5.0	0.1	1.0	***
Observations	2,232		2,364			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.39
Impact on College-Level English Credits Earned
(Among Students in the Bump-Up English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.5	0.0	1.1	0.0	0.6	***
Term 2	1.3	0.0	1.9	0.1	0.6	***
Term 3	1.8	0.1	2.2	0.1	0.4	***
Term 4	2.0	0.1	2.4	0.1	0.4	***
Term 5	2.2	0.1	2.6	0.1	0.4	***
Term 6	2.3	0.1	2.7	0.1	0.4	***
Term 7	2.4	0.1	2.8	0.1	0.4	***
Term 8	2.4	0.1	2.8	0.1	0.4	***
Term 9	2.4	0.1	2.9	0.1	0.5	***
Observations	2,232		2,364			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.40
Impact on College-Level Credits Attempted (Among Students in the Bump-Up Zone)

Term	Bump-Up Math						Bump-Up English					
	Business-as-Usual Group		Program Group		Estimated Effects		Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	7.1	0.2	10.2	0.2	3.1	***	6.2	0.1	8.8	0.1	2.6	***
Term 2	14.6	0.3	19.0	0.4	4.3	***	12.7	0.2	15.9	0.2	3.2	***
Term 3	21.7	0.5	26.7	0.7	5.0	***	18.6	0.3	22.2	0.4	3.6	***
Term 4	27.5	0.7	32.8	0.9	5.3	***	23.4	0.4	27.2	0.5	3.8	***
Term 5	32.2	0.9	37.5	1.1	5.2	***	27.1	0.5	31.2	0.6	4.0	***
Term 6	35.7	1.0	40.7	1.2	5.0	***	29.8	0.6	34.0	0.7	4.1	***
Term 7	38.6	1.1	43.6	1.4	5.0	***	32.0	0.6	36.2	0.8	4.2	***
Term 8	40.7	1.2	45.6	1.5	4.9	***	33.5	0.7	37.8	0.8	4.3	***
Term 9	41.9	1.2	46.7	1.6	4.8	***	34.2	0.7	38.7	0.9	4.5	***
Observations	786		805				2,232		2,364			

NOTES: Heteroskedastic robust standard errors in columns 2, 4, 8, and 10. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.41
Impact on College-Level Credits Earned (Among Students in the Bump-Up Zone)

Term	Bump-Up Math						Bump-Up English					
	Business-as-Usual Group		Program Group		Estimated Effects		Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	4.7	0.2	6.7	0.2	2.0	***	3.5	0.1	4.9	0.1	1.4	***
Term 2	9.8	0.3	12.5	0.5	2.8	***	7.4	0.2	9.0	0.2	1.6	***
Term 3	14.8	0.5	18.0	0.7	3.2	***	11.1	0.3	13.0	0.4	1.9	***
Term 4	19.1	0.7	22.4	0.9	3.4	***	14.3	0.4	16.4	0.5	2.0	***
Term 5	22.5	0.8	25.8	1.1	3.3	***	16.9	0.4	19.2	0.6	2.3	***
Term 6	25.1	0.9	28.3	1.2	3.1	***	18.8	0.5	21.2	0.6	2.4	***
Term 7	27.3	1.0	30.5	1.3	3.2	**	20.3	0.5	22.8	0.7	2.5	***
Term 8	28.9	1.1	32.2	1.4	3.3	**	21.4	0.6	24.1	0.8	2.7	***
Term 9	29.8	1.1	33.0	1.5	3.2	**	21.9	0.6	24.7	0.8	2.7	***
Observations	786		805				2,232		2,364			

NOTES: Heteroskedastic robust standard errors in columns 2, 4, 8, and 10. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.42
Impact on Continuous Persistence (Among Students in the Bump-Up Zone)

Term	Bump-Up Math						Bump-Up English					
	Business-as-Usual Group		Program Group		Estimated Effects		Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance	Mean	Santard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	83.8%	1.3%	84.6%	1.3%	0.8 ppt		78.5%	0.9%	78.5%	0.8%	0.0 ppt	
Term 2	62.3%	1.7%	66.7%	2.2%	4.4 ppt	**	56.3%	1.1%	57.4%	1.3%	1.1 ppt	
Term 3	47.7%	1.8%	50.9%	2.4%	3.2 ppt		40.9%	1.0%	41.4%	1.4%	0.5 ppt	
Term 4	39.2%	1.7%	40.9%	2.4%	1.7 ppt		31.9%	1.0%	33.2%	1.3%	1.3 ppt	
Term 5	26.5%	1.6%	27.4%	2.2%	0.9 ppt		21.6%	0.9%	22.2%	1.2%	0.6 ppt	
Term 6	20.2%	1.4%	18.6%	2.0%	-1.6 ppt		15.6%	0.8%	16.0%	1.0%	0.4 ppt	
Term 7	11.8%	1.2%	11.8%	1.6%	0.0 ppt		9.0%	0.6%	9.8%	0.8%	0.8 ppt	
Term 8	8.5%	1.0%	8.8%	1.4%	0.3 ppt		6.2%	0.5%	7.4%	0.7%	1.2 ppt	
Term 9	2.8%	0.6%	2.5%	0.8%	-0.3 ppt		2.0%	0.3%	2.1%	0.4%	0.1 ppt	
Observations	786		805				2,232		2,364			

NOTES: Heteroskedastic robust standard errors in columns 2, 4, 8, and 10. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.43
Impact on Credential Attainment in Term 9 (Among Students in the Bump-Up Zone)

Outcome	Bump-Up Math						Bump-Up English					
	Business-as-Usual Group		Program Group		Estimated Effects		Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Certificate	2.6%	0.6%	1.5%	0.7%	-1.1 ppt		0.9%	0.2%	0.7%	0.3%	-0.2 ppt	
AA/AS	15.7%	1.3%	17.5%	1.8%	1.8 ppt		10.0%	0.6%	12.5%	0.9%	2.5 ppt	***
AAS	7.7%	0.9%	8.4%	1.3%	0.7 ppt		5.3%	0.5%	5.4%	0.6%	0.1 ppt	
Bachelor's	2.1%	0.5%	3.2%	0.8%	1.1 ppt		1.5%	0.3%	1.7%	0.4%	0.2 ppt	
Observations	786		805				2,232		2,364			

NOTES: Heteroskedastic robust standard errors in columns 2, 4, 8, and 10. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects. ***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.44
Impact on Credential Attainment or Transfer (Among Students in the Bump-Up Zone)

Term	Bump-Up Math						Bump-Up English					
	Business-as-Usual Group		Program Group		Estimated Effects		Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.0%	0.0%	0.0%	0.0%	0.0 ppt		0.0%	0.0%	0.0%	0.1%	0.0 ppt	
Term 2	0.5%	0.3%	0.2%	0.3%	-0.3 ppt		0.5%	0.1%	0.3%	0.2%	-0.2 ppt	
Term 3	1.9%	0.5%	2.5%	0.8%	0.6 ppt		1.3%	0.2%	1.2%	0.3%	-0.1 ppt	
Term 4	7.9%	1.0%	10.1%	1.4%	2.2 ppt		4.3%	0.4%	4.8%	0.6%	0.5 ppt	
Term 5	13.3%	1.2%	17.0%	1.8%	3.7 ppt	**	9.5%	0.6%	10.3%	0.9%	0.8 ppt	
Term 6	18.9%	1.4%	23.1%	2.0%	4.2 ppt	**	13.3%	0.7%	15.3%	1.0%	2.0 ppt	**
Term 7	22.4%	1.5%	26.8%	2.1%	4.4 ppt	**	15.8%	0.8%	18.0%	1.1%	2.2 ppt	**
Term 8	25.8%	1.6%	29.2%	2.2%	3.4 ppt		17.4%	0.8%	19.8%	1.1%	2.4 ppt	**
Term 9	27.2%	1.6%	29.9%	2.2%	2.7 ppt		18.1%	0.8%	20.5%	1.1%	2.4 ppt	**
Observations	786		805				2,232		2,364			

NOTES: Heteroskedastic robust standard errors in columns 2, 4, 8, and 10. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.45
Impact on Placement Into College-Level Math (Among Students in the Bump-Down Math Zone Only)

	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
	99.6%	0.4%	8.1%	1.1%	-91.5 ppt	***
Observations	456		488			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.46
Impact on Enrollment in College-Level Math (Among Students in the Bump-Down Math Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	59.8%	2.2%	18.6%	2.7%	-41.2 ppt	***
Term 2	68.5%	2.1%	43.5%	2.8%	-25.0 ppt	***
Term 3	72.2%	2.1%	52.4%	2.7%	-19.8 ppt	***
Term 4	73.5%	2.0%	55.9%	2.7%	-17.6 ppt	***
Term 5	75.5%	2.0%	57.9%	2.6%	-17.6 ppt	***
Term 6	76.1%	2.0%	58.8%	2.6%	-17.3 ppt	***
Term 7	77.3%	1.9%	60.6%	2.5%	-16.7 ppt	***
Term 8	77.7%	1.9%	61.4%	2.5%	-16.3 ppt	***
Term 9	77.7%	1.9%	61.6%	2.5%	-16.1 ppt	***
Observations	456		488			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.47
Impact on Completion of College-Level Math (With Grade C or Higher)
(Among Students in the Bump-Down Math Zone Only)

Outcome	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	22.8%	1.9%	7.6%	2.3%	-15.2 ppt	***
Term 2	30.7%	2.1%	19.5%	2.8%	-11.2 ppt	***
Term 3	35.2%	2.2%	27.3%	2.9%	-7.9 ppt	***
Term 4	37.7%	2.2%	31.5%	3.0%	-6.2 ppt	**
Term 5	41.4%	2.2%	34.9%	3.0%	-6.5 ppt	**
Term 6	43.0%	2.3%	36.5%	3.0%	-6.5 ppt	**
Term 7	44.1%	2.3%	38.4%	3.0%	-5.7 ppt	*
Term 8	44.5%	2.3%	39.2%	3.0%	-5.3 ppt	*
Term 9	44.7%	2.3%	39.5%	3.0%	-5.2 ppt	*
Observations	456		488			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.48
Impact on Enrollment in Second College-Level Math
(Among Students in the Bump-Down Math Zone Only)

Outcome	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.4%	0.3%	0.0%	0.3%	-0.4 ppt	
Term 2	25.5%	2.0%	8.6%	2.4%	-16.9 ppt	***
Term 3	38.2%	2.2%	24.2%	2.9%	-14.0 ppt	***
Term 4	42.6%	2.3%	30.6%	3.0%	-12.0 ppt	***
Term 5	45.2%	2.3%	34.4%	3.0%	-10.8 ppt	***
Term 6	47.7%	2.3%	36.9%	3.1%	-10.8 ppt	***
Term 7	48.6%	2.3%	37.5%	3.1%	-11.1 ppt	***
Term 8	49.0%	2.3%	38.3%	3.1%	-10.7 ppt	***
Term 9	49.7%	2.3%	38.5%	3.1%	-11.2 ppt	***
Observations	456		488			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$

Appendix Table A.49
Impact on Completion of Second College-Level Math (With Grade C or Higher)
(Among Students in the Bump-Down Math Zone Only)

Outcome	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.2%	0.2%	0.0%	0.2%	-0.2 ppt	
Term 2	9.1%	1.4%	3.2%	1.6%	-5.9 ppt	***
Term 3	15.2%	1.7%	11.2%	2.2%	-4.0 ppt	*
Term 4	17.0%	1.8%	13.9%	2.4%	-3.1 ppt	
Term 5	18.1%	1.8%	16.7%	2.5%	-1.4 ppt	
Term 6	19.0%	1.8%	17.6%	2.5%	-1.4 ppt	
Term 7	19.4%	1.8%	17.9%	2.5%	-1.5 ppt	
Term 8	19.9%	1.9%	17.9%	2.6%	-2.0 ppt	
Term 9	20.3%	1.9%	17.9%	2.6%	-2.4 ppt	
Observations	456		488			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.50
Impact on College-Level Math Credits Attempted
(Among Students in the Bump-Down Math Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	2.1	0.1	0.7	0.1	-1.5	***
Term 2	3.4	0.1	1.8	0.2	-1.5	***
Term 3	4.4	0.2	2.9	0.2	-1.6	***
Term 4	5.0	0.2	3.5	0.3	-1.5	***
Term 5	5.6	0.2	4.0	0.3	-1.6	***
Term 6	5.9	0.3	4.3	0.3	-1.6	***
Term 7	6.2	0.3	4.6	0.3	-1.6	***
Term 8	6.4	0.3	4.7	0.4	-1.6	***
Term 9	6.5	0.3	4.8	0.4	-1.7	***
Observations	456		488			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.51
Impact on College-Level Math Credits Earned
(Among Students in the Bump-Down Math Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.8	0.1	0.3	0.1	-0.5	***
Term 2	1.2	0.1	0.8	0.1	-0.5	***
Term 3	1.7	0.1	1.3	0.2	-0.4	**
Term 4	1.9	0.1	1.5	0.2	-0.4	**
Term 5	2.2	0.2	1.8	0.2	-0.4	**
Term 6	2.3	0.2	1.9	0.2	-0.4	*
Term 7	2.5	0.2	2.1	0.2	-0.4	*
Term 8	2.6	0.2	2.2	0.2	-0.4	*
Term 9	2.7	0.2	2.3	0.2	-0.4	*
Observations	456		488			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.52
Impact on Placement Into College-Level English
(Among Students in the Bump-Down English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
	100.0%	0.1%	3.5%	1.0%	-96.5 ppt	***
Observations	379		361			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.53
Impact on Enrollment in College-Level English
(Among Students in the Bump-Down English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	68.4%	2.4%	29.4%	3.2%	-39.0 ppt	***
Term 2	77.0%	2.2%	59.5%	2.9%	-17.5 ppt	***
Term 3	80.3%	2.0%	63.9%	2.7%	-16.4 ppt	***
Term 4	80.7%	2.0%	66.2%	2.7%	-14.5 ppt	***
Term 5	81.0%	2.0%	68.2%	2.6%	-12.8 ppt	***
Term 6	81.8%	2.0%	69.1%	2.6%	-12.7 ppt	***
Term 7	81.8%	2.0%	70.0%	2.5%	-11.8 ppt	***
Term 8	82.9%	1.9%	70.6%	2.5%	-12.3 ppt	***
Term 9	82.9%	1.9%	71.2%	2.4%	-11.7 ppt	***
Observations	379		361			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.54
Impact on Completion of College-Level English (With Grade C or Higher)
(Among Students in the Bump-Down English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	31.0%	2.4%	13.2%	3.0%	-17.8 ppt	***
Term 2	38.2%	2.5%	26.4%	3.4%	-11.8 ppt	***
Term 3	40.5%	2.5%	32.4%	3.5%	-8.1 ppt	**
Term 4	41.4%	2.5%	35.3%	3.5%	-6.1 ppt	*
Term 5	42.5%	2.6%	36.5%	3.5%	-6.0 ppt	*
Term 6	43.3%	2.6%	37.4%	3.5%	-5.9 ppt	*
Term 7	43.5%	2.6%	38.1%	3.5%	-5.4 ppt	
Term 8	44.4%	2.6%	38.6%	3.5%	-5.8 ppt	*
Term 9	45.2%	2.6%	38.7%	3.5%	-6.5 ppt	*
Observations	379		361			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.55
Impact on Enrollment in Second College-Level English
(Among Students in the Bump-Down English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	1.1%	0.5%	-0.1%	0.6%	-1.2 ppt	**
Term 2	41.4%	2.5%	15.4%	3.2%	-26.0 ppt	***
Term 3	48.6%	2.6%	32.9%	3.5%	-15.7 ppt	***
Term 4	52.8%	2.6%	36.6%	3.5%	-16.2 ppt	***
Term 5	54.6%	2.5%	38.7%	3.5%	-15.9 ppt	***
Term 6	56.1%	2.5%	40.1%	3.5%	-16.0 ppt	***
Term 7	56.9%	2.5%	40.7%	3.5%	-16.2 ppt	***
Term 8	56.9%	2.5%	41.0%	3.5%	-15.9 ppt	***
Term 9	57.2%	2.5%	41.0%	3.5%	-16.2 ppt	***
Observations	379		361			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.56
Impact on Completion of Second College-Level English (With Grade C or Higher)
(Among Students in the Bump-Down English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.5%	0.4%	-0.2%	0.4%	-0.7 ppt	
Term 2	18.5%	2.0%	8.6%	2.6%	-9.9 ppt	***
Term 3	22.1%	2.2%	17.1%	3.0%	-5.0 ppt	*
Term 4	23.7%	2.2%	19.1%	3.1%	-4.6 ppt	
Term 5	24.8%	2.2%	20.5%	3.1%	-4.3 ppt	
Term 6	25.1%	2.3%	21.2%	3.1%	-3.9 ppt	
Term 7	25.4%	2.3%	21.2%	3.2%	-4.2 ppt	
Term 8	25.4%	2.3%	21.2%	3.2%	-4.2 ppt	
Term 9	25.6%	2.3%	21.1%	3.2%	-4.5 ppt	
Observations	379		361			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.57
Impact on College-Level English Credits Attempted
(Among Students in the Bump-Down English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	2.1	0.1	0.9	0.1	-1.2	***
Term 2	3.6	0.1	2.2	0.2	-1.3	***
Term 3	4.4	0.2	3.1	0.2	-1.3	***
Term 4	4.8	0.2	3.6	0.2	-1.3	***
Term 5	5.1	0.2	3.9	0.3	-1.2	***
Term 6	5.4	0.2	4.2	0.3	-1.2	***
Term 7	5.5	0.2	4.3	0.3	-1.2	***
Term 8	5.6	0.2	4.4	0.3	-1.2	***
Term 9	5.7	0.2	4.5	0.3	-1.2	***
Observations	379		361			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.58
Impact on College-Level English Credits Earned
(Among Students in the Bump-Down English Zone Only)

Term	Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	1.0	0.1	0.4	0.1	-0.6	***
Term 2	1.6	0.1	1.0	0.1	-0.7	***
Term 3	2.0	0.1	1.4	0.2	-0.6	***
Term 4	2.2	0.2	1.6	0.2	-0.5	***
Term 5	2.3	0.2	1.8	0.2	-0.5	**
Term 6	2.4	0.2	1.9	0.2	-0.5	**
Term 7	2.5	0.2	2.0	0.2	-0.5	*
Term 8	2.5	0.2	2.1	0.3	-0.5	*
Term 9	2.6	0.2	2.1	0.3	-0.5	*
Observations	379		361			

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.59
Impact on College-Level Credits Attempted (Among Students in the Bump-Down Zone)

Term	Bump-Down Math						Bump-Down English					
	Business-as-Usual Group		Program Group		Estimated Effects		Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	9.2	0.2	8.5	0.3	-0.7	**	7.9	0.3	6.2	0.3	-1.7	***
Term 2	17.5	0.5	16.5	0.5	-1.0	*	14.6	0.5	12.7	0.6	-1.9	***
Term 3	24.5	0.7	23.3	0.8	-1.2		20.0	0.7	17.5	0.9	-2.5	***
Term 4	30.3	0.9	29.1	1.1	-1.2		24.3	1.0	20.8	1.2	-3.6	***
Term 5	35.1	1.1	33.5	1.4	-1.6		27.4	1.2	23.7	1.5	-3.7	**
Term 6	38.7	1.3	36.9	1.6	-1.8		30.0	1.4	25.9	1.8	-4.1	**
Term 7	41.7	1.5	39.4	1.8	-2.3		32.1	1.6	27.6	2.0	-4.5	**
Term 8	43.7	1.6	41.3	1.9	-2.4		33.9	1.7	28.8	2.2	-5.1	**
Term 9	44.8	1.6	42.2	2.0	-2.6		34.6	1.8	29.2	2.2	-5.4	**
Observations	456		488				379		361			

NOTES: Heteroskedastic robust standard errors in columns 2, 4, 8, and 10. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.60
Impact on College-Level Credits Earned (Among Students in the Bump-Down Zone)

Term	Bump-Down Math						Bump-Down English					
	Business-as-Usual Group		Program Group		Estimated Effects		Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	4.8	0.2	4.9	0.3	0.0		3.6	0.2	2.8	0.3	-0.8	***
Term 2	9.3	0.4	9.0	0.6	-0.2		6.8	0.4	5.8	0.6	-1.0	*
Term 3	13.5	0.7	13.1	0.9	-0.3		9.8	0.7	8.2	0.8	-1.6	*
Term 4	17.2	0.9	16.8	1.1	-0.4		12.5	0.9	10.2	1.1	-2.2	**
Term 5	20.3	1.0	19.9	1.3	-0.4		14.3	1.0	12.2	1.3	-2.1	
Term 6	22.7	1.2	22.1	1.5	-0.6		16.1	1.2	13.6	1.5	-2.5	*
Term 7	24.8	1.3	24.0	1.6	-0.8		17.5	1.3	14.7	1.7	-2.8	
Term 8	26.2	1.4	25.4	1.8	-0.8		18.7	1.4	15.4	1.8	-3.3	*
Term 9	27.4	1.5	26.5	1.9	-0.9		19.2	1.5	15.6	1.9	-3.6	*
Observations	456		488				379		361			

NOTES: Heteroskedastic robust standard errors in columns 2, 4, 8, and 10. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.61
Impact on Continuous Persistence (Among Students in the Bump-Down Zone)

Term	Bump-Down Math						Bump-Down English					
	Business-as-Usual Group		Program Group		Estimated Effects		Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	82.0%	1.8%	84.3%	1.7%	2.3 ppt		80.5%	2.1%	82.6%	2.0%	2.1 ppt	
Term 2	64.8%	2.2%	64.8%	2.8%	0.0 ppt		55.9%	2.6%	57.2%	3.4%	1.3 ppt	
Term 3	46.2%	2.3%	45.5%	3.1%	-0.7 ppt		34.6%	2.5%	36.3%	3.5%	1.7 ppt	
Term 4	37.1%	2.3%	38.7%	3.1%	1.6 ppt		27.9%	2.3%	22.9%	3.2%	-5.0 ppt	
Term 5	26.4%	2.1%	26.6%	2.8%	0.2 ppt		17.4%	2.0%	18.5%	2.9%	1.1 ppt	
Term 6	19.3%	1.9%	19.0%	2.5%	-0.3 ppt		14.6%	1.8%	12.7%	2.6%	-1.9 ppt	
Term 7	11.7%	1.5%	11.3%	2.0%	-0.4 ppt		10.5%	1.6%	7.7%	2.2%	-2.8 ppt	
Term 8	8.5%	1.3%	7.3%	1.7%	-1.2 ppt		8.6%	1.5%	6.2%	2.0%	-2.4 ppt	
Term 9	2.9%	0.8%	1.6%	0.9%	-1.3 ppt		1.6%	0.7%	0.8%	0.9%	-0.8 ppt	
Observations	456		488				379		361			

NOTES: Heteroskedastic robust standard errors in columns 2, 4, 8, and 10. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.62
Impact on Credential Attainment in Term 9 (Among Students in the Bump-Down Zone)

Outcome	Bump-Down Math						Bump-Down English					
	Business-as-Usual Group		Program Group		Estimated Effects		Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Certificate	0.4%	0.3%	1.1%	0.6%	0.7 ppt		1.0%	0.5%	0.5%	0.5%	-0.5 ppt	
AA/AS	11.8%	1.5%	15.4%	2.2%	3.6 ppt	*	8.7%	1.5%	6.5%	2.0%	-2.2 ppt	
AAS	5.7%	1.1%	3.6%	1.4%	-2.1 ppt		3.5%	1.0%	2.8%	1.3%	-0.7 ppt	
Bachelor's	1.1%	0.5%	1.0%	0.6%	-0.1 ppt		1.1%	0.5%	0.5%	0.7%	-0.6 ppt	
Observations	786		805				379		361			

NOTES: Heteroskedastic robust standard errors in columns 2, 4, 8, and 10. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.63
Impact on Credential Attainment or Transfer (Among Students in the Bump-Down Zone)

Term	Bump-Down Math						Bump-Down English					
	Business-as-Usual Group		Program Group		Estimated Effects		Business-as-Usual Group		Program Group		Estimated Effects	
	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance	Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 1	0.0%	0.0%	0.0%	0.0%	0.0 ppt		0.0%	0.0%	0.0%	0.0%	0.0 ppt	
Term 2	0.2%	0.2%	0.5%	0.4%	0.3 ppt		0.0%	0.0%	0.3%	0.3%	0.3 ppt	
Term 3	1.9%	0.6%	1.7%	0.9%	-0.2 ppt		1.1%	0.5%	1.5%	0.9%	0.4 ppt	
Term 4	6.5%	1.2%	4.7%	1.5%	-1.8 ppt		5.1%	1.1%	1.9%	1.4%	-3.2 ppt	**
Term 5	11.3%	1.5%	10.0%	2.0%	-1.3 ppt		9.1%	1.5%	5.1%	1.9%	-4.0 ppt	**
Term 6	16.4%	1.7%	15.7%	2.3%	-0.7 ppt		11.3%	1.6%	7.9%	2.2%	-3.4 ppt	
Term 7	20.4%	1.9%	18.7%	2.5%	-1.7 ppt		13.7%	1.8%	9.2%	2.4%	-4.5 ppt	*
Term 8	21.2%	1.9%	21.5%	2.6%	0.3 ppt		15.1%	1.8%	10.4%	2.5%	-4.7 ppt	*
Term 9	22.3%	2.0%	21.9%	2.6%	-0.4 ppt		15.9%	1.9%	11.2%	2.6%	-4.7 ppt	*
Observations	456		488				379		361			

NOTES: Heteroskedastic robust standard errors in columns 2, 4, 8, and 10. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix Table A.64
Impact on Completion of College-Level Math by Subgroup
(Among Students in the Math Subsample)

Term	Observations	Business-as-Usual Group		Program Group		Estimated Effects	
		Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Gender							
Male	4,984						
Term 1		14.6%	0.7%	15.4%	0.9%	0.8 ppt	
Term 2		21.6%	0.8%	22.2%	1.1%	0.6 ppt	
Term 3		27.6%	0.9%	26.9%	1.1%	-0.7 ppt	
Term 4		30.3%	0.9%	29.8%	1.2%	-0.5 ppt	
Term 5		32.4%	0.9%	32.3%	1.2%	-0.1 ppt	
Term 6		33.8%	0.9%	33.6%	1.2%	-0.2 ppt	
Term 7		34.8%	1.0%	34.7%	1.2%	-0.1 ppt	
Term 8		35.3%	1.0%	35.4%	1.2%	0.1 ppt	
Term 9		35.6%	1.0%	35.7%	1.2%	0.1 ppt	
Female	4,574						
Term 1		15.2%	0.7%	17.9%	1.0%	2.7 ppt	***
Term 2		25.1%	0.9%	26.0%	1.2%	0.9 ppt	
Term 3		32.2%	1.0%	33.8%	1.3%	1.6 ppt	
Term 4		35.6%	1.0%	38.0%	1.3%	2.4 ppt	*
Term 5		38.4%	1.0%	41.2%	1.3%	2.8 ppt	**
Term 6		40.4%	1.0%	43.0%	1.3%	2.6 ppt	*
Term 7		41.7%	1.0%	44.2%	1.3%	2.5 ppt	*
Term 8		42.5%	1.0%	45.1%	1.4%	2.6 ppt	*
Term 9		43.2%	1.0%	45.4%	1.4%	2.2 ppt	*
Pell Recipient							
No	4,206						
Term 1		19.7%	0.9%	23.3%	1.2%	3.6 ppt	***
Term 2		29.9%	1.0%	31.9%	1.3%	2.0 ppt	
Term 3		37.9%	1.1%	39.4%	1.4%	1.5 ppt	
Term 4		41.9%	1.1%	43.4%	1.4%	1.5 ppt	
Term 5		44.9%	1.1%	46.9%	1.4%	2.0 ppt	
Term 6		46.7%	1.1%	48.7%	1.4%	2.0 ppt	
Term 7		48.0%	1.1%	49.9%	1.5%	1.9 ppt	
Term 8		48.5%	1.1%	51.0%	1.5%	2.5 ppt	*
Term 9		49.0%	1.1%	51.2%	1.5%	2.2 ppt	
Yes	4,241						
Term 1		13.8%	0.7%	14.2%	1.0%	0.4 ppt	
Term 2		22.6%	0.9%	22.3%	1.2%	-0.3 ppt	
Term 3		29.4%	1.0%	28.7%	1.3%	-0.7 ppt	
Term 4		32.2%	1.0%	32.7%	1.4%	0.5 ppt	
Term 5		34.7%	1.0%	35.6%	1.4%	0.9 ppt	

(continued)

Appendix Table A.64 (continued)

Term	Observations	Business-as-Usual Group		Program Group		Estimated Effects	
		Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 6		36.7%	1.0%	37.1%	1.4%	0.4 ppt	
Term 7		38.0%	1.1%	38.4%	1.4%	0.4 ppt	
Term 8		38.9%	1.1%	39.2%	1.4%	0.3 ppt	
Term 9		39.5%	1.1%	39.7%	1.4%	0.2 ppt	
Race/ethnicity							
White	3,873						
Term 1		17.2%	0.8%	20.3%	1.2%	3.1 ppt	***
Term 2		28.1%	1.0%	29.0%	1.3%	0.9 ppt	
Term 3		35.7%	1.1%	35.9%	1.4%	0.2 ppt	
Term 4		39.4%	1.1%	39.4%	1.5%	0.0 ppt	
Term 5		42.0%	1.1%	43.0%	1.5%	1.0 ppt	
Term 6		43.5%	1.1%	45.0%	1.5%	1.5 ppt	
Term 7		44.7%	1.1%	46.4%	1.5%	1.7 ppt	
Term 8		45.3%	1.1%	47.0%	1.5%	1.7 ppt	
Term 9		45.7%	1.1%	47.2%	1.5%	1.5 ppt	
Black	1,812						
Term 1		11.8%	1.1%	10.5%	1.4%	-1.3 ppt	
Term 2		18.4%	1.3%	16.9%	1.7%	-1.5 ppt	
Term 3		24.0%	1.4%	22.6%	1.9%	-1.4 ppt	
Term 4		26.1%	1.5%	26.8%	1.9%	0.7 ppt	
Term 5		28.2%	1.5%	29.3%	2.0%	1.1 ppt	
Term 6		29.7%	1.5%	30.6%	2.0%	0.9 ppt	
Term 7		30.7%	1.6%	31.6%	2.1%	0.9 ppt	
Term 8		31.7%	1.6%	32.4%	2.1%	0.7 ppt	
Term 9		32.3%	1.6%	32.9%	2.1%	0.6 ppt	
Hispanic	2,177						
Term 1		18.5%	1.2%	18.4%	1.5%	-0.1 ppt	
Term 2		26.4%	1.4%	25.6%	1.7%	-0.8 ppt	
Term 3		33.2%	1.5%	31.6%	1.8%	-1.6 ppt	
Term 4		36.0%	1.5%	36.4%	1.9%	0.4 ppt	
Term 5		39.4%	1.5%	39.6%	1.9%	0.2 ppt	
Term 6		42.1%	1.5%	40.9%	1.9%	-1.2 ppt	
Term 7		43.8%	1.5%	42.5%	1.9%	-1.3 ppt	
Term 8		44.4%	1.5%	43.4%	1.9%	-1.0 ppt	
Term 9		45.0%	1.5%	43.9%	2.0%	-1.1 ppt	

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.65
Impact on Completion of College-Level English by Subgroup (Among Students in the English Subsample)

Term	Observations	Business-as-Usual Group		Program Group		Estimated Effects	
		Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Gender							
Male	5,744						
Term 1		26.6%	0.8%	32.4%	1.1%	5.8 ppt	***
Term 2		37.3%	0.9%	39.6%	1.2%	2.3 ppt	*
Term 3		42.3%	0.9%	43.7%	1.2%	1.4 ppt	
Term 4		44.0%	0.9%	45.4%	1.2%	1.4 ppt	
Term 5		45.7%	0.9%	46.4%	1.2%	0.7 ppt	
Term 6		46.3%	0.9%	47.1%	1.2%	0.8 ppt	
Term 7		46.8%	0.9%	47.6%	1.2%	0.8 ppt	
Term 8		47.0%	0.9%	47.8%	1.2%	0.8 ppt	
Term 9		47.1%	0.9%	48.0%	1.2%	0.9 ppt	
Female	4,864						
Term 1		29.9%	0.9%	37.6%	1.3%	7.7 ppt	***
Term 2		43.2%	1.0%	47.8%	1.3%	4.6 ppt	***
Term 3		48.0%	1.0%	52.8%	1.3%	4.8 ppt	***
Term 4		50.1%	1.0%	54.7%	1.3%	4.6 ppt	***
Term 5		52.0%	1.0%	56.2%	1.3%	4.2 ppt	***
Term 6		52.7%	1.0%	57.0%	1.3%	4.3 ppt	***
Term 7		53.9%	1.0%	57.6%	1.3%	3.7 ppt	***
Term 8		54.4%	1.0%	57.9%	1.3%	3.5 ppt	***
Term 9		54.8%	1.0%	58.2%	1.3%	3.4 ppt	***
Pell Recipient							
No							
Term 1	4,509	37.6%	1.0%	44.0%	1.4%	6.4 ppt	***
Term 2		49.6%	1.0%	53.1%	1.4%	3.5 ppt	**

(continued)

Appendix Table A.65 (continued)

Term	Observations	Business-as-Usual Group		Program Group		Estimated Effects	
		Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 3		55.5%	1.0%	58.0%	1.4%	2.5 ppt	*
Term 4		57.7%	1.0%	59.8%	1.4%	2.1 ppt	
Term 5		59.9%	1.0%	61.3%	1.4%	1.4 ppt	
Term 6		60.6%	1.0%	62.2%	1.4%	1.6 ppt	
Term 7		61.5%	1.0%	63.1%	1.4%	1.6 ppt	
Term 8		61.8%	1.0%	63.5%	1.4%	1.7 ppt	
Term 9		61.9%	1.0%	63.6%	1.4%	1.7 ppt	
Yes	4,749						
Term 1		26.9%	0.9%	35.5%	1.3%	8.6 ppt	***
Term 2		42.0%	1.0%	46.0%	1.4%	4.0 ppt	***
Term 3		47.3%	1.0%	51.5%	1.4%	4.2 ppt	***
Term 4		49.5%	1.0%	53.7%	1.4%	4.2 ppt	***
Term 5		51.4%	1.0%	55.1%	1.4%	3.7 ppt	***
Term 6		52.1%	1.0%	55.7%	1.4%	3.6 ppt	**
Term 7		53.2%	1.0%	56.1%	1.4%	2.9 ppt	**
Term 8		53.8%	1.0%	56.6%	1.4%	2.8 ppt	**
Term 9		54.1%	1.0%	56.8%	1.4%	2.7 ppt	*
Race/ethnicity							
White	4,315						
Term 1		36.8%	1.0%	41.3%	1.4%	4.5 ppt	***
Term 2		50.5%	1.1%	51.5%	1.4%	1.0 ppt	
Term 3		55.2%	1.0%	55.4%	1.4%	0.2 ppt	
Term 4		57.3%	1.0%	56.9%	1.4%	-0.4 ppt	
Term 5		58.9%	1.0%	58.0%	1.4%	-0.9 ppt	
Term 6		59.5%	1.0%	59.0%	1.4%	-0.5 ppt	

(continued)

Appendix Table A.65 (continued)

Term	Observations	Business-as-Usual Group		Program Group		Estimated Effects	
		Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 7		60.0%	1.0%	59.6%	1.4%	-0.4 ppt	
Term 8		60.3%	1.0%	59.9%	1.4%	-0.4 ppt	
Term 9		60.6%	1.0%	60.1%	1.4%	-0.5 ppt	
Black	2,203						
Term 1		18.5%	1.2%	27.6%	1.7%	9.1 ppt	***
Term 2		29.7%	1.4%	36.5%	1.9%	6.8 ppt	***
Term 3		35.3%	1.5%	41.9%	2.0%	6.6 ppt	***
Term 4		37.0%	1.5%	43.5%	2.0%	6.5 ppt	***
Term 5		39.0%	1.5%	44.6%	2.0%	5.6 ppt	***
Term 6		39.8%	1.5%	45.3%	2.0%	5.5 ppt	***
Term 7		41.1%	1.5%	45.5%	2.0%	4.4 ppt	**
Term 8		41.6%	1.5%	45.5%	2.0%	3.9 ppt	*
Term 9		41.7%	1.5%	46.0%	2.0%	4.3 ppt	**
Hispanic	2,241						
Term 1		27.8%	1.4%	36.9%	1.9%	9.1 ppt	***
Term 2		40.4%	1.5%	44.6%	2.0%	4.2 ppt	**
Term 3		46.6%	1.5%	50.3%	2.0%	3.7 ppt	*
Term 4		48.8%	1.5%	53.0%	2.0%	4.2 ppt	**
Term 5		51.8%	1.5%	55.1%	2.0%	3.3 ppt	*
Term 6		52.6%	1.5%	55.6%	2.0%	3.0 ppt	
Term 7		53.7%	1.5%	56.6%	2.0%	2.9 ppt	
Term 8		54.0%	1.5%	57.2%	2.0%	3.2 ppt	
Term 9		54.1%	1.5%	7.3%	2.0%	3.2 ppt	

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.66
Impact on College-Level Credits Earned by Subgroup

Term	Observations	Business-as-Usual Group		Program Group		Estimated Effects	
		Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Gender							
Male	6,662						
Term 1		4.7	0.1	5.0	0.1	0.3	***
Term 2		9.0	0.2	9.2	0.2	0.2	
Term 3		13.1	0.3	13.2	0.3	0.0	
Term 4		16.7	0.3	16.5	0.4	-0.2	
Term 5		19.4	0.4	19.1	0.5	-0.2	
Term 6		21.5	0.4	21.1	0.5	-0.4	
Term 7		23.2	0.5	22.5	0.6	-0.6	
Term 8		24.6	0.5	23.8	0.7	-0.7	
Term 9		25.2	0.5	24.4	0.7	-0.8	
Female	6,134						
Term 1		5.1	0.1	5.6	0.1	0.5	***
Term 2		10.0	0.2	10.8	0.2	0.7	***
Term 3		14.8	0.3	15.8	0.3	1.0	***
Term 4		19.0	0.4	20.0	0.5	1.0	**
Term 5		22.2	0.4	23.4	0.5	1.2	**
Term 6		24.6	0.5	25.9	0.6	1.3	**
Term 7		26.7	0.5	28.3	0.7	1.6	**
Term 8		28.4	0.6	30.1	0.7	1.7	**
Term 9		29.2	0.6	30.9	0.8	1.7	**
Pell Recipient							
No	5,616						
Term 1		6.1	0.1	6.6	0.1	0.5	***
Term 2		11.7	0.2	12.3	0.3	0.6	**

(continued)

Appendix Table A.66 (continued)

Term	Observations	Business-as-Usual Group		Program Group		Estimated Effects	
		Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 3		17.3	0.3	17.9	0.4	0.5	
Term 4		22.2	0.4	22.6	0.5	0.4	
Term 5		25.9	0.5	26.3	0.6	0.4	
Term 6		28.9	0.5	29.2	0.7	0.3	
Term 7		31.4	0.6	31.8	0.8	0.4	
Term 8		33.4	0.6	34.0	0.8	0.6	
Term 9		34.3	0.6	35.0	0.9	0.6	
Yes	5,695						
Term 1		4.9	0.1	5.4	0.1	0.5	***
Term 2		9.7	0.2	10.1	0.2	0.5	**
Term 3		14.1	0.3	14.7	0.4	0.5	
Term 4		17.9	0.4	18.4	0.5	0.5	
Term 5		20.8	0.4	21.5	0.6	0.7	
Term 6		23.0	0.5	23.6	0.6	0.6	
Term 7		24.7	0.5	25.3	0.7	0.5	
Term 8		26.1	0.5	26.5	0.7	0.4	
Term 9		26.8	0.6	27.1	0.7	0.3	
Race/Ethnicity							
White	5,529						
Term 1		6.2	0.1	6.5	0.1	0.3	**
Term 2		12.1	0.2	12.3	0.3	0.2	
Term 3		17.7	0.3	17.7	0.4	0.0	
Term 4		22.6	0.4	22.3	0.5	-0.3	
Term 5		26.2	0.5	25.8	0.6	-0.5	
Term 6		28.9	0.5	28.4	0.7	-0.5	

(continued)

Appendix Table A.66 (continued)

Term	Observations	Business-as-Usual Group		Program Group		Estimated Effects	
		Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 7		31.2	0.6	30.6	0.8	-0.6	
Term 8		33.0	0.6	32.5	0.8	-0.6	
Term 9		33.9	0.6	33.3	0.9	-0.6	
Black	2,547						
Term 1		3.6	0.1	4.0	0.2	0.5	***
Term 2		6.9	0.2	7.6	0.3	0.7	**
Term 3		10.1	0.4	11.0	0.5	0.9	*
Term 4		12.8	0.5	13.9	0.6	1.1	*
Term 5		15.0	0.5	16.3	0.7	1.3	*
Term 6		16.7	0.6	18.1	0.8	1.4	*
Term 7		18.0	0.7	19.5	0.9	1.5	*
Term 8		19.0	0.7	20.6	1.0	1.5	
Term 9		19.5	0.7	21.0	1.0	1.5	
Hispanic	2,585						
Term 1		4.5	0.1	5.2	0.2	0.7	***
Term 2		8.6	0.3	9.5	0.3	0.8	**
Term 3		12.9	0.4	13.9	0.5	1.0	*
Term 4		16.5	0.5	17.4	0.7	0.9	
Term 5		19.5	0.6	20.5	0.8	1.0	
Term 6		21.9	0.7	22.6	0.9	0.8	
Term 7		23.8	0.7	24.4	1.0	0.6	
Term 8		25.3	0.8	25.9	1.1	0.5	
Term 9		25.9	0.8	26.6	1.1	0.7	

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

***$p < .01$, **$p < .05$, *$p < .10$.

Appendix Table A.67
Impact on Credential Attainment or Transfer by Subgroup

Term	Observations	Business-as-Usual Group		Program Group		Estimated Effects	
		Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Gender							
Male	6,662						
Term 1		0.0%	0.0%	0.0%	0.0%	0.0 ppt	
Term 2		0.4%	0.1%	0.5%	0.2%	0.1 ppt	
Term 3		1.6%	0.2%	1.9%	0.3%	0.3 ppt	
Term 4		6.5%	0.4%	5.7%	0.6%	-0.8 ppt	
Term 5		11.9%	0.6%	11.5%	0.8%	-0.4 ppt	
Term 6		16.0%	0.6%	15.7%	0.9%	-0.3 ppt	
Term 7		18.6%	0.7%	18.0%	0.9%	-0.6 ppt	
Term 8		20.3%	0.7%	19.6%	0.9%	-0.7 ppt	
Term 9		21.2%	0.7%	20.4%	0.9%	-0.8 ppt	
Female	6,134						
Term 1		0.1%	0.1%	0.1%	0.1%	0.0 ppt	
Term 2		0.8%	0.2%	0.5%	0.2%	-0.3 ppt	*
Term 3		2.6%	0.3%	2.4%	0.4%	-0.2 ppt	
Term 4		8.8%	0.5%	8.6%	0.7%	-0.2 ppt	
Term 5		15.3%	0.7%	15.0%	0.9%	-0.3 ppt	
Term 6		19.9%	0.7%	19.8%	1.0%	-0.1 ppt	
Term 7		23.0%	0.8%	23.3%	1.0%	0.3 ppt	
Term 8		25.3%	0.8%	25.5%	1.1%	0.2 ppt	
Term 9		26.4%	0.8%	26.7%	1.1%	0.3 ppt	
Pell Recipient							
No	5,616						
Term 1		0.1%	0.1%	0.1%	0.1%	0.0 ppt	
Term 2		0.9%	0.2%	0.9%	0.3%	0.0 ppt	
Term 3		3.2%	0.3%	3.6%	0.5%	0.4 ppt	
Term 4		11.1%	0.6%	10.8%	0.8%	-0.3 ppt	
Term 5		18.5%	0.7%	18.8%	1.0%	0.3 ppt	
Term 6		23.6%	0.8%	23.6%	1.1%	0.0 ppt	
Term 7		26.8%	0.8%	27.1%	1.1%	0.3 ppt	
Term 8		28.9%	0.9%	29.0%	1.2%	0.1 ppt	
Term 9		30.0%	0.9%	30.2%	1.2%	0.2 ppt	
Yes	5,695						
Term 1		0.0%	0.0%	0.0%	0.0%	0.0 ppt	
Term 2		0.4%	0.1%	0.1%	0.1%	-0.3 ppt	*
Term 3		1.4%	0.2%	1.2%	0.3%	-0.2 ppt	
Term 4		5.9%	0.4%	5.1%	0.6%	-0.8 ppt	
Term 5		11.8%	0.6%	10.8%	0.8%	-1.0 ppt	
Term 6		16.6%	0.7%	16.1%	1.0%	-0.5 ppt	

(continued)

Appendix Table A.67 (continued)

Term	Observations	Business-as-Usual Group		Program Group		Estimated Effects	
		Mean	Standard Error	Mean	Standard Error	Mean Difference	Significance
Term 7		20.0%	0.8%	19.2%	1.0%	-0.8 ppt	
Term 8		22.3%	0.8%	21.4%	1.1%	-0.9 ppt	
Term 9		23.3%	0.8%	22.5%	1.1%	-0.8 ppt	
Race/ethnicity							
White	5,529						
Term 1		0.1%	0.1%	0.1%	0.1%	0.0 ppt	
Term 2		0.7%	0.2%	0.8%	0.2%	0.1 ppt	
Term 3		3.0%	0.3%	3.2%	0.5%	0.2 ppt	
Term 4		11.2%	0.6%	10.2%	0.8%	-1.0 ppt	
Term 5		19.4%	0.8%	17.9%	1.0%	-1.5 ppt	
Term 6		24.5%	0.8%	23.8%	1.1%	-0.7 ppt	
Term 7		27.7%	0.8%	27.0%	1.2%	-0.7 ppt	
Term 8		30.0%	0.9%	29.2%	1.2%	-0.8 ppt	
Term 9		31.0%	0.9%	30.0%	1.2%	-1.0 ppt	
Black	2,547						
Term 1		0.0%	0.0%	0.1%	0.1%	0.1 ppt	
Term 2		0.7%	0.2%	0.4%	0.3%	-0.3 ppt	
Term 3		1.4%	0.3%	1.3%	0.5%	-0.1 ppt	
Term 4		3.6%	0.5%	3.6%	0.7%	0.0 ppt	
Term 5		7.3%	0.7%	7.5%	1.0%	0.2% ppt	
Term 6		11.1%	0.9%	11.7%	1.2%	0.6% ppt	
Term 7		13.9%	1.0%	13.7%	1.4%	-0.2% ppt	
Term 8		14.8%	1.0%	15.0%	1.4%	0.2% ppt	
Term 9		15.3%	1.0%	16.2%	1.4%	0.9% ppt	
Hispanic	2,585						
Term 1		0.0%	0.0%	0.0%	0.0%	0.0 ppt	
Term 2		0.2%	0.1%	0.2%	0.2%	0.0 ppt	
Term 3		1.2%	0.3%	1.0%	0.4%	-0.2 ppt	
Term 4		5.7%	0.7%	5.1%	0.9%	-0.6 ppt	
Term 5		10.1%	0.9%	10.1%	1.2%	0.0 ppt	
Term 6		14.2%	1.0%	13.6%	1.3%	-0.6 ppt	
Term 7		17.5%	1.1%	17.0%	1.4%	-0.5 ppt	
Term 8		20.1%	1.1%	19.3%	1.5%	-0.8 ppt	
Term 9		21.5%	1.2%	20.5%	1.6%	-1.0 ppt	

NOTES: Heteroskedastic robust standard errors in columns 2 and 4. Impact estimates control for full set of covariates as well as college and testing cohort fixed effects.

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

Appendix B. Creation of the Multiple Measures System

To create their MMA placement systems, each college (1) used historical data to develop an algorithm for math and English placement, (2) chose cut scores, and (3) installed the new placement system.

Using Historical Data to Develop Algorithms

Historical high school and placement test data were needed to create predictive algorithms at each college. Five colleges in the study had been using ACCUPLACER tests for several years. A sixth college had been using ACCUPLACER tests for English but had transitioned from a homegrown math assessment to the ACCUPLACER set of math tests more recently; this college was therefore testing the use of the alternative placement system only for English placement in this study. The seventh college in our sample had been using COMPASS tests, standardized placement tests which were discontinued by the provider (ACT) shortly after this study began. This college was also testing the use of the alternative system only for English placement. At this college, the predictive algorithm tested in the alternative placement system did not make use of any placement test scores; rather, it was based only on high school GPA and other high school data. The status quo placement system in this case used only scores from ACCUPLACER, the test that the college selected to replace COMPASS.

CAPR researchers worked with personnel at each college as well as SUNY's central institutional research unit to obtain historical data on students who first enrolled during the 2011–12, 2012–13, and 2013–14 academic years. Data on multiple measures, such as high school performance and placement test scores, as well as data on outcomes in college-level courses, were used to create algorithms for predicting student performance in college-level math and English among students in the study sample. In some instances, data on these measures were available in a digital format in college systems. Other colleges maintained records of high school transcripts as digital images; in these cases, the needed data had to be entered into computer systems by hand.

In order to estimate the relationships between the measures—or predictors—in the dataset and performance in an initial college-level course, the historical data used for analyses were restricted to students who took placement tests and enrolled in a college-level course without first having taken a developmental course. This set of students constituted our estimation sample.

For each of the colleges, we began by creating a model for estimating the relationship between high school GPA and success (defined as earning a grade of C or higher) in an initial college-level course in a given subject, math or English (see Equation 1 below). We then estimated the relationship between placement test scores and success in these initial college-level courses (Equation 2). A third model included both high school GPA and placement test scores for the appropriate subject (Equation 3). A fourth model added additional information when available (Equation 4). Added variables included the number of years that had passed since high school completion, whether the student's diploma was a standard high school diploma or a GED, SAT scores, ACT scores, and, when available, scores on the New York State Regents Examinations, as well as interaction terms and nonlinear terms for certain variables. Identical procedures were followed for both math and English.

(1) $\Pr(C \text{ or better}) = \alpha + (\text{HS GPA})\beta 1 + \varepsilon$

(2) $\Pr(C \text{ or better}) = \alpha + (\text{ACCUPLACER})\beta 1 + \varepsilon$

(3) $\Pr(C \text{ or better}) = \alpha + (\text{HS GPA})\beta 1 + (\text{ACCUPLACER})\beta 2 + \varepsilon$

(4) $\Pr(C \text{ or better}) = \alpha + (\text{HS GPA})\beta 1 + (\text{ACCUPLACER})\beta 2 + X\beta 3 + \varepsilon$

Because the focus of this analysis is the overall predictive power of each model, we used the Akaike Information Criterion (AIC) to compare the models. The AIC is a measure of model fit that combines a model's log-likelihood with the number of parameters included in the model (Akaike, 1998; Burnham & Anderson, 2002; Mazerolle, 2004). When comparing models, a lower AIC statistic indicates a better fitting model (Mazerolle, 2004). The best fitting model was the one selected for use at each college in the study. Tables B.1 and B.2 below list the full set of variables used in each college's algorithm for math and English.

Appendix Table B.1
Math Algorithm Components by College

	High School GPA	Years Since High School Graduation	HS Diploma/ GED Status	Regents Math Score	SAT Math Score	ACCUPLACER Arithmetic Score	ACCUPLACER Algebra Score	ACCUPLACER College-Level Math
College 1	X	X	X			X	X	X
College 2	X	X	X	X	X	X	X	X
College 3	X	X	X			X	X	
College 4								
College 5	X	X				X	X	X
College 6								
College 7	X	X	X				X	

Appendix Table B.2
English Algorithm Components by College

	High School GPA	High School Rank	Years Since High School Graduation	HS Diploma/ GED Status	ACCUPLACER Reading Score	ACCUPLACER Sentence Skills Score	WritePlacer or Other Writing Score[a]
College 1	X		X	X	X	X	
College 2	X		X	X	X	X	X
College 3	X		X	X	X		X
College 4	X	X	X	X	X	X	X
College 5	X		X		X	X	X
College 6	X		X	X			
College 7	X		X	X	X		

[a]To test writing skills, some colleges administered WritePlacer, an ACCUPLACER sub-test, while others administered a test created by the college.

Choosing Cut Points for Projected Placement and Pass Rates

After algorithms were established at each college, we used the coefficients from the regressions to simulate placement and success rates as a basis for faculty decisions about where to establish cut points that distinguish students ready for college-level courses from those needing remediation. Consider the following simplified example using Equation 3 from above.

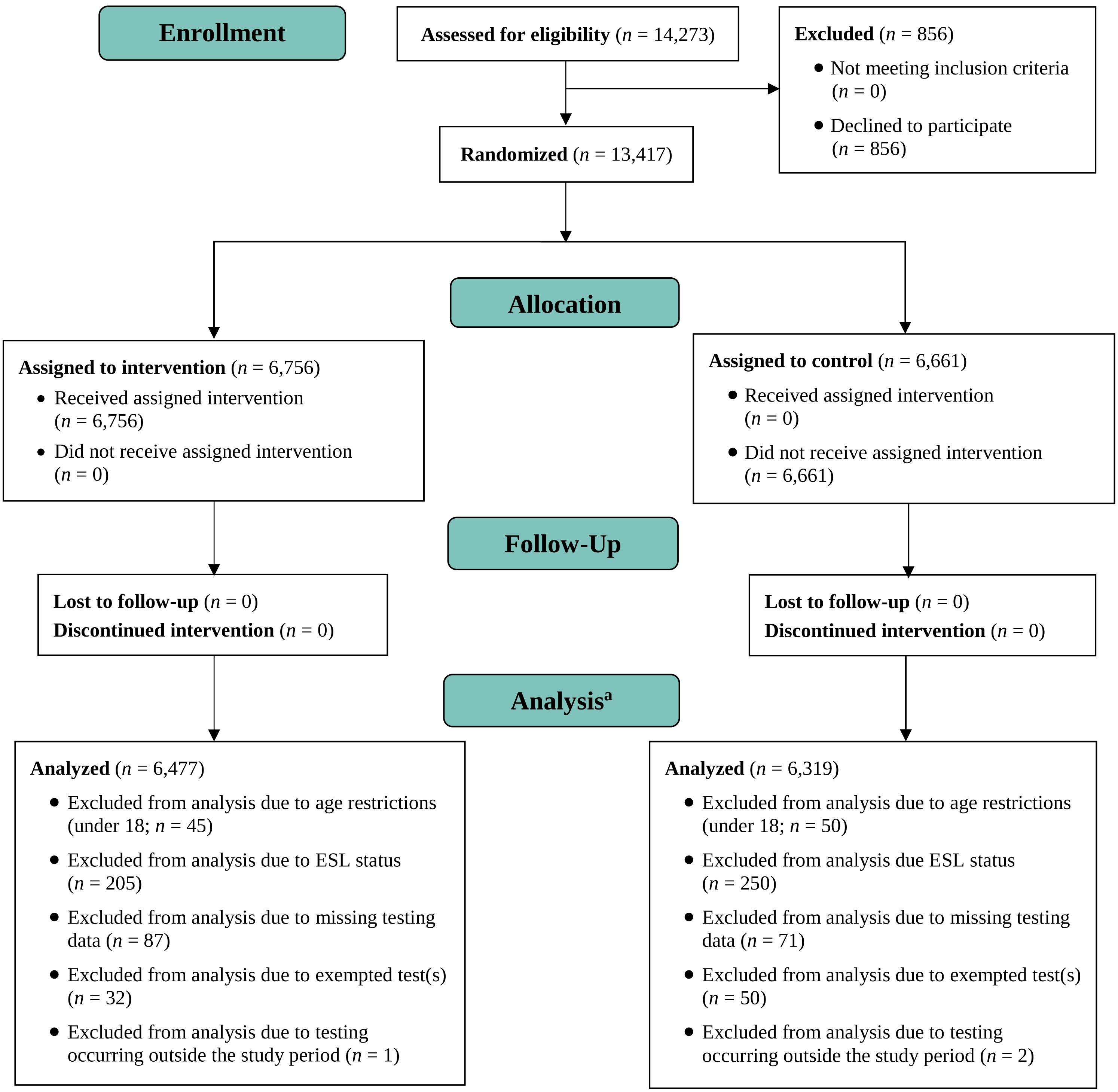
$$Placement_{\mathrm{i}} = \begin{cases} \text{College level if } \hat{Y}_{\mathrm{i}} \geq 0.6 \\ \text{Developmental if } \hat{Y}_{\mathrm{i}} < 0.6 \end{cases}$$

Let $\hat{Y}$ represent the predicted probability of success in a college-level course. We use regression coefficients and a student's own placement test scores and high school GPA to predict the probability of earning a C or better in college-level math ($\hat{Y}$) for any new student *i*. A set of decision rules can then be determined based on these predicted probabilities. For each college, we generated spreadsheets projecting the share of students who would place into a college-level course at any given cut point on $\hat{Y}$, as well as the share of those students we would anticipate earning a C or better in that course. These spreadsheets were given to colleges so that faculty in the relevant departments could set cut points for students taking math or English courses. The cut point differs from the projected pass rate and represents the lowest probability of passing for any given student; the cut point implies that every student must have that probability of passing or higher. Many faculty opted to create placement rules that either (1) kept pass rates in college-level courses similar to historical pass rates or (2) kept college-level placement rates similar to historical placement rates. Under the first approach, the algorithm tended to predict increases in the number of students placed into college-level coursework.

Installing the Alternative Placement System

Colleges in the study had two options for installing the placement system. At colleges running the system through ACCUPLACER, researchers programmed custom rules into the ACCUPLACER software for students selected to be part of the program group. The rules specified the ACCUPLACER placement determination for every combination of multiple measure values used in the algorithm, which were accessed from a pre-registration file created and uploaded with data for each incoming student. Other colleges conducted their placement through MDRC's custom-built server and therefore did not need to create a pre-registration file. Instead, student information was sent to MDRC servers in one of two ways. Either all information was uploaded together and a placement decision was returned for each student, or students' supplemental information was uploaded in batches and test scores were uploaded individually by counselors after students completed their testing. The values of the uploaded multiple measures and test scores were then multiplied by their respective algorithm weights and summed to generate the predicted probability of success and the corresponding placement, which was returned to the college.

Appendix C. Consort Flow Diagram



[a] Numbers shown as excluded for particular criteria are not mutually exclusive.

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