



Mandating Multiple Measures and Encouraging Student Supports: Evaluating a New Approach to Developmental Education in California's Community Colleges

Federick Ngo

University of Nevada, Las Vegas

Tatiana Melguizo

University of Southern California

AB705 is a landmark higher education policy that has changed approaches to developmental/remedial education in the California Community College system. We study one district that implemented reforms by placing most students in transfer-level math/English courses and encouraging enrollment in support courses based on multiple measures of academic preparation (e.g., GPA). We use regression discontinuity designs to examine the impact of these new placement procedures, finding benefits to English support course recommendations for low GPA students, but no evidence of benefits or penalties for math. We use inverse probability weighted regression adjustment to explore the relationship between support course enrollment and subsequent outcomes. While enrollment in concurrent support courses appeared beneficial, enrollment in developmental courses was associated with poorer outcomes.

VERSION: October 2022

Suggested citation: Ngo, Federick, and Tatiana Melguizo. (2022). Mandating Multiple Measures and Encouraging Student Supports: Evaluating a New Approach to Developmental Education in California's Community Colleges. (EdWorkingPaper: 22-662). Retrieved from Annenberg Institute at Brown University: <https://doi.org/10.26300/neqq-gd84>

**Mandating Multiple Measures and Encouraging Student Supports:
Evaluating a New Approach to Developmental Education in California's Community
Colleges**

Federick Ngo

University of Nevada, Las Vegas

Tatiana Melguizo

University of Southern California

Contact: federick.ngo@unlv.edu

WORKING PAPER

Acknowledgments: This research was supported by a grant from the Spencer Foundation (#10018461). All opinions are the authors' and do not reflect those of the granting agency. We are thankful for feedback and support from Maury Pearl, Deborah Harrington, Jessica Cristo, Mily Kudo, Cheryl Ching, Elise Swanson, Soumya Mishra, and Elif Yücel.

Abstract

AB705 is a landmark higher education policy that has changed approaches to developmental/remedial education in the California Community College system. We study one district that implemented reforms by placing most students in transfer-level math/English courses and encouraging enrollment in support courses based on multiple measures of academic preparation (e.g., GPA). We use regression discontinuity designs to examine the impact of these new placement procedures, finding benefits to English support course recommendations for low GPA students, but no evidence of benefits or penalties for math. We use inverse probability weighted regression adjustment to explore the relationship between support course enrollment and subsequent outcomes. While enrollment in concurrent support courses appeared beneficial, enrollment in developmental courses was associated with poorer outcomes.

Keywords: higher education policy; community colleges; developmental education; regression discontinuity

**Mandating Multiple Measures and Encouraging Student Supports:
Evaluating a New Approach to Developmental Education in California's Community
Colleges**

Introduction

Significant reforms have been enacted in recent years across the nation's community colleges to improve the outcomes of students placed in developmental/remedial education. These efforts seek to mitigate the harmful effects of developmental education and set students on more efficient and effective paths towards degree completion and transfer. In 2019, the California Community College system (CCC) fully implemented the legislation outlined in Assembly Bill 705 (AB705), which instructed the system's 116 community colleges to maximize student completion of transfer-level math and English courses in one year's time, a metric known as "throughput." Completion of transfer-level courses not only meets 2-year degree graduation requirements, but also fulfills requirements necessary to transfer to all public 4-year institutions in California. The policy requires the use of multiple measures (e.g., high school course grades; high school GPA) to direct as many students as possible into transfer-level math and English courses, and encourages colleges to offer an array of concurrent student supports, including corequisite courses and tutoring, to assist students in completing these degree and transfer requirements.

Descriptive evidence on student outcomes after AB705 shows that it has resulted in substantially more students enrolling in and completing math and English degree requirements than before the reform (Cuellar Mejia et al., 2021). This is hardly a surprise since the prerequisite model of developmental education, in which students take placement tests and are assigned to

remedial math and English coursework that they must complete in order to access upper-level courses, has been shown to significantly hamper student progress (Valentine et al., 2017). Under AB705, the vast majority of students are now allowed to enroll directly in the transfer-level courses in math and English that were oftentimes inaccessible before.

However, there is currently little evidence on how the mechanisms of the policy that have been developed – mandatory multiple measures placement and encouraging enrollment in student supports – impact student success outcomes. Another outstanding question is how the continued practice of offering developmental education prerequisites affects students in the new policy context. AB705 allows colleges across the state to continue developmental education practices if it is determined that students “are highly unlikely to succeed in a higher-level course without it” (CCCCO, n.d.). Indeed, just 7 of the 116 colleges do not offer developmental education at all, with the rest continuing to enroll a non-negligible share of students into courses below transfer-level (Hern & Snell, 2021). Since the evidence shows that developmental education is largely ineffective (Valentine et al., 2017), and that it has disproportionately impacted racially minoritized students (Melguizo & Ngo, 2020), some have criticized and questioned those colleges that have continued to offer developmental courses (Hern & Snell, 2021). It is therefore important to examine whether transfer-level and developmental education placement in the context of AB705’s multiple measures mandate and increased student supports is now beneficial – or whether it continues to be harmful – for California’s community college students.

Our study answers these important questions of policy and practice by examining AB705 outcomes in a large urban community college district (LUCCD) that in 2019 began to make changes to practice in accordance with the mandates of AB705. Leveraging sharp cutoffs based

on high school GPA (for English) and multiple cutoffs based on high school GPA and math course-taking (for math), we use administrative data and a suite of regression discontinuity designs to estimate the impact of AB705's policy treatment in the LUCCD: direct placement in transfer-level courses with recommendations for student supports for those falling below set cutoffs. These support recommendations varied across colleges in the district, as they do across the entire California Community College system, but can be described as one of two types: concurrent supports that consist largely of corequisite courses, enhanced courses, and tutoring; and developmental education courses that are not transferable. We focus on students entering LUCCD in the first semesters of the AB705 implementation context. The data include student demographic characteristics, high school GPA information, math and English placement information, and all student enrollment records through Spring 2020. We use the data to generate outcomes connected to the main goal of AB705: throughput, enrollment in and completion of transfer-level math/English within one academic year.

Results from our RD estimates show a benefit to this new approach in developmental education, which is direct placement in transfer-level courses and recommendations for support based on high school GPA cutoffs. Students at the margin of the lowest English cutoff were more likely to complete transfer-level English, and enroll in and complete units than their higher-GPA peers. Students at the margin of the math cutoffs were just as likely to complete transfer-level math and earn college credits as their higher-GPA peers.

Since colleges recommended, but did not necessarily require, additional math and English supports for students who entered with lower GPAs, we also use inverse probability weighted regression adjustment (IPWRA) to explore the relationship between enrollment in these recommendations and student outcomes. The results indicate that concurrent supports (e.g.,

corequisites; tutoring) in English, and to a lesser extent in math, were associated with increased throughput and units attempted and completed. Enrollment in concurrent math supports had a positive but non-significant relationship with throughput, but enrollment in developmental math was negatively associated with math throughput.

The study is significant because other research shows providing robust concurrent student supports, such as corequisite courses, can help students complete gatekeeper math and English courses in a timely manner (Boatman, 2012; Boatman et al., 2021; Logue et al., 2016; Logue et al., 2019; Meiselman & Schudde, 2019; Miller et al., 2021; Ran & Lin, 2022). The present study adds to this growing body of literature but also provides evidence in a context where high school GPA, not placement tests, are used to direct students to these additional supports. Our investigation using RD design offers one way of evaluating these programmatic decisions and is therefore useful to both policymakers and practitioners. The results of the study also offer insight into whether the use of multiple measures for placement, here high school GPA and prior course-taking, in conjunction with student supports, has mitigated the developmental education penalty, and whether it is maximizing student success and meeting the aims of AB705. The findings demonstrate that the set of placement, instructional, and curricular reforms enacted by math and English departments in response to AB705 appear to be effective in supporting students entering with lower GPAs.

Literature Review

Developmental education (DE), is one of the community college's four curricular functions (Cohen & Brawer, 2008). This is no small responsibility since by the *early 2000's* nationally about 60 percent of community college students took a developmental math or English course during their academic careers (Chen, 2016). Although some DE programs successfully

prepare students for the work ahead of them, studies generally show that these programs create a barrier to college progression. A meta-analysis study that reviewed rigorous quantitative studies around the nation concluded that students placed in developmental courses are less likely to make it to college-level courses and complete college requirements, and take longer to earn their credentials (Valentine et al., 2017). The situation is especially dire for racially minoritized students, who are more likely to enter DE—even when they are as qualified as their white peers (Melguizo & Ngo, 2020)—and are less likely to persist and complete it (Bailey et al., 2010).

Trends in Developmental Education Reform

The research documenting the pernicious effects of DE partially set the ground in the *mid 2000*'s for states around the nation to implement policy changes that attempted to “fix remediation” (Education Commission of the States, 2021; Jones, 2014). Florida, North Carolina, Texas, along with other states, passed state-level policies or introduced initiatives to modify assessment and placement (A&P), which is seen as a reason for high remediation rates. For example, Florida’s Senate Bill 1720, which was passed in 2013, granted students the choice to bypass placement testing and enroll directly in college-level courses, regardless of prior academic performance (Park et al., 2018).

Placement using multiple measures. One prong of these efforts consists of reforms to the A&P process, which has typically relied on placement exams to direct students towards DE courses. Research has examined the accuracy of various placement exams, documenting the severity of placement errors (Leeds & Mokher, 2020; Scott-Clayton et al., 2014), and has demonstrated the potential improvements to using multiple measures of student readiness, such as high school GPA, in lieu of or in addition to placement testing results (Bahr et al., 2019; Ngo & Kwon, 2015; Ngo et al., 2018; Scott-Clayton et al., 2014). Random assignment evaluations of

multiple measures policies in Minnesota and Wisconsin found that students who were placed in college-level courses were 11 and 16 percentage points more likely to complete math and English college-level courses (Cullinan & Biedzio, 2021).

Student supports. Another prong of DE reform focuses on expanding and encouraging or requiring student participation in alternative approaches to DE, including the use of concurrent support courses (Kosiewicz et al., 2016). Recent quasi-experimental evaluations of DE reforms in Tennessee, Texas, and New York suggest that placing students directly in college-level courses with concurrent supports – a corequisite model – has been effective in terms of college-level course completion and helped reduced racial course completion gaps (Boatman, 2012; Boatman, 2021; Boatman et al., 2021; Logue et al., 2019; Meiselman & Schudde, 2019; Miller et al., 2021; Ran & Lin, 2022). Notably, each of these contexts was co-requisite support based on placement test score cutoffs, not high school GPA cutoffs (i.e., a multiple measures approach). Together, these evidence bases have been used to make a strong case for employing multiple measures in assessment and placement and the creation of a set of co-requisite courses or concurrent academic supports (e.g., tutoring) in community colleges across the nation.

AB705 in the California Community Colleges

After more than a decade of trying to tackle the DE problem indirectly through basic skills related initiatives, task forces, and success initiatives, California finally passed Assembly Bill 705 (AB705) one of the most ambitious higher education reforms affecting community colleges to date. In Fall 2019, the California Community College (CCC) system implemented AB705 systemwide, expecting each of the CCC's 116 institutions to drastically reduce student placement in developmental education and instead place the majority of students directly into transfer-level courses. Through these changes in placement, along with curricular and student

support reforms, each CCC is expected to maximize the probability that entering students complete transfer-level English and math courses in one year's time.

A focus on multiple measures placement. Like most other community colleges across the nation, prior to early 2000s most California community colleges were relying on commercially developed exams such as ACCUPLACER and COMPASS to place students. However, California was one of the few states in the nation that required colleges to use multiple measures in addition to placement tests (Melguizo et al., 2014). This was partially in compliance from a legal challenge that required colleges to include additional measures such as high school GPA, and proxies for student motivation in addition to the score in the placement test. The fact that colleges had full autonomy over A&P meant that multiple measures were not followed consistently, colleges within the same district used different measures associated with different points, and the rules varied so much, that in some cases multiple measure points were used to subtract points from the placement exam, which resulted in students being placed in a lower-level developmental course (Melguizo et al., 2014).

The journey of the state of California to define and fully implement multiple measures has been long. In 2012, Long Beach City College (LBCC) incorporated high school performance measures to its placement algorithm and this resulted in an increase in college-level placement from 14% to 59% in English, and from 9% to 31% in math. LBCC compared the completion rates of college-level courses under the two different versions, and found slightly lower but overall, very similar completion rates, (62% versus 64% in English, and 51% versus 55% in math) (LBCC, 2014). The success of this initial pilot led to the Multiple Measures Assessment Project (MMAP) a state-level study that used transcript data to evaluate the potential benefits of using multiple measures (Willett et al., 2015). Willett and collaborators expanded this work at

the state-level by using high school and college data from Cal-Pass Plus for students who entered the California community college system between Fall 2007 and Summer 2014 to explore what measures of high school achievement are the best predictors of course outcomes in college. They used decision trees that include simple if-then logical models that are more intuitive for the use of community college faculty and institutional researchers. They concluded that high school GPA is the most consistently used predictor of performance across levels of math and English. They found that the minimum HSGPA to access college level math is 3.0, assuming that pre-calculus was not completed in high school, and the minimum HSGPA in English is 2.6 (Bahr et al., 2019). The results of this study along the nationwide and local work documenting the detrimental effects of a long-sequence of developmental colleges and the discount of the knowledge gained in high school, led the California Community College Chancellor's office to recommend the default HSGPA cutoffs for placement.

AB705 outcomes and student supports. Early findings of a state-level evaluation of AB705 implementation suggest that access to, and success in, transfer-level math and English courses has increased substantially among first-time English and math students of all racial/ethnic groups, but equity gaps remain, especially in math (Cuellar Mejia et al., 2021). Despite this early success in terms of access and completion of transfer-level courses within one-year, multiple advocacy groups are questioning the effectiveness of the policy. The California Acceleration Project, (CAP) analyzed the validation reports that 114 of the community colleges sent to the Chancellor's office for approval of their A&P policies and practices. They concluded that none of the colleges could reliably justify the placement of students in developmental courses, and that most of the colleges were ignoring multiple measures and inappropriately using guided self-placement to steer college into remedial courses (CAP, 2021). This is not entirely

unexpected, however, since even while AB705 provided a set of recommended thresholds for course placement based on students' high school GPA (CCC, 2018), the bill left room for colleges to create their own placement rules and allows colleges to define co-requisite supports, and customize and innovate the forms of concurrent support for students in transfer-level courses.

Pressure has been mounting for the state to provide more direct guidance to colleges in the use of multiple measures, so colleges stop placing students in DE. In 2022, legislators deliberated Assembly Bill 1705, which proposes for the state to "...require that a community college district or a community college not recommend or require student to enroll in pretransfer level English or mathematics coursework, except under specified circumstances." Essentially, the state is making it very hard for colleges to offer DE and instead moving towards universal placement in transfer-level courses. Colleges are expected to continue to develop the co-requisite courses or concurrent academic supports necessary to maximize the probability that the students will pass math and English transfer-level courses within one year. The present study offers insight into this evolving implementation of AB705 in California's community colleges, focusing specifically on the impact of the strategy of mandating multiple measures placement while encouraging students to enroll in concurrent support courses and in some cases allowing students to enroll in developmental education courses.

Data

We conducted the study using administrative data from a large urban community college district (LUCCD). We focused on students who entered LACCD in 2019 (winter, spring, summer, or fall terms), when this alternative approach to developmental education placement began to be implemented. These students completed the educational background questionnaire

that was used to gather information for educational planning purposes (CCC Apply), including making placement recommendations for math and English. The administrative data include demographic information for each student, course enrollment records through Spring 2020, and responses to a set of background questions. Among these are questions asking students to report their high school GPA (nearest tenth), grades in English and math courses, and highest levels of math completed. These high school course-taking and GPA data began to be collected more systematically due to the requirements of AB705. We dropped those with GPA less than 1 from the analysis (e.g., 131 had a “0” inputted). The final analytical sample is 31,092 first-time students, and their characteristics are summarized in Table 1. We also present mean student characteristics for a set of narrower GPA bins, since our analysis relies on regression discontinuity design and comparison of bands of students above and below each GPA cutoff.

[Insert Table 1]

Female students make up 53% of the sample, and they are more represented in the upper end of the GPA distribution. About two-thirds (65%) of the sample is Hispanic, followed by white (11%) and Black (9%) students. Over half (52%) of the sample received a Pell grant award and/or the Board of Governor’s fee waiver. This declines with GPA. Overall, 7 percent of students enrolled in an English support course recommendation, 7 percent enrolled in a concurrent math support course recommendation, and 12 percent enrolled in a developmental math course. A higher share of students in the lower GPA bands enrolled in these courses.

The primary outcome of interest is throughput – completion of transfer-level math or English within one year (i.e., winter, spring, summer, and fall terms). This is the primary performance metric outlined in AB705 policy. Of this analytical sample, 22% achieved English throughput and math 10% achieved math throughput. Since some of the support courses

developed to help students meet the aims of AB705 are additional credits and therefore an additional cost to students, we also report and examine the impact of the AB705 placement policies on total units attempted in one year and total units completed in one year. These outcomes also offer important insight into how the course-taking recommendations being offered under AB705 may be affecting student progress and completion beyond completing transfer-level math and English.

Methods

English Cutoffs: Sharp RD

English cutoffs were consistent across the LUCCD colleges, with high school GPA thresholds set at 2.6 and 1.9. It is important to note that falling below each of these cutoffs did not result in blocked enrollment in higher-level courses, as it did in the previous prerequisite model of developmental education. The primary “treatment” of falling below the cutoffs was receiving different messages about English support course recommendations. All students could enroll in English 101, the transfer-level English course, but those falling below the 2.6 cutoff were encouraged to discuss options with a counselor and enroll in co-requisite courses or pre-requisite courses (e.g., below transfer level). Those falling below the 1.9 cutoff were more strongly recommended to do so (see Appendix for examples of English placement recommendations).

Since these specific GPA cutoffs were part of a substantial effort by researchers and the CCCCCO to identify appropriate thresholds (Bahr et al., 2019), we first estimate sharp regression discontinuity designs that provide an intent-to-treat (ITT) estimate of placement in each of the English levels. This approach also offers a means of validating the cutoffs that were set by the MMAP project (Bahr et al., 2019). We used the `rdrobust` package in Stata 15.0, which does

data-driven local-polynomial-based RD estimation with robust confidence intervals (Calonico et al., 2014). This strategy overcomes one main limitation of standard RD approaches, that is, researchers bandwidth specifications can be arbitrary and result in bias. The method is robust to larger bandwidths and to bandwidth choice, and calculates an optimal bandwidth. The package also allows us to report and compare results from three inference procedures: (i) conventional RD estimates with conventional variance estimator; (ii) bias-corrected RD estimates with conventional variance estimator; (iii) bias-corrected RD estimates with robust variance estimator (Calonico et al., 2017). As an additional check, we estimate the RD with and without covariates (college, semester, gender, race/ethnicity, and financial aid receipt as evidenced by Pell grant of BOG fee waiver receipt).

Math Cutoffs: Frontier RD

LACCD uses two criteria for math course placement – high school GPA and highest math course completed in high school. Students are recommended to take either statistics and liberal arts mathematics (SLAM) or business and STEM courses (BSTEM) based on thresholds for these two criteria (math placement recommendations are also available in the Appendix).

We therefore use a frontier RD design, holding the math course threshold fixed and modeling the discontinuity along GPA using standard single running variable RD methods (Reardon & Robinson, 2012). Although the single estimate that is obtained in the frontier RD approach is more easily interpretable than other multiple rating-score RD designs, there is a reduction in power and generalizability since not all observations are used in the RD (Reardon & Robinson, 2012). The frontier estimates apply only to the specific frontier, in this case, students who completed certain math classes in high school. For the math analysis, we also exclude three colleges who had variations in their math placement procedure

RD Validity

The validity of RD estimates hinges on whether the variation/discontinuity in outcomes can be directly attributed to the assignment variable. One potential issue we observed is a non-smooth density of the GPA running variable, sometimes near the GPA cutoffs. There are more students who indicated GPAs of 1.0, 1.5, 2.0, 2.5, 3.0., 3.5, and 4.0 than there were who indicated the GPA values in between. This suggests there may be manipulation of the running variable, which could potentially be the result of students or counselors inputting certain GPAs to game the placement. One concern, for example, is counselors assigning a 2.5 to students who do not know their GPA, which is just below the upper English cutoff. Since the primary identification assumption in the RD design is that the only thing that varies discontinuously at the cutoff is the treatment assignment, it is possible that any jump in the outcome is related to the running variable and not to the treatment status.

[Insert Figure 1]

This may not be a substantial issue if no other observable variables are discontinuous at the cutoff. We assess this threat to validity using two procedures. First, we set each of the demographic control variables (e.g., race/ethnicity, gender, and financial aid receipt) as the outcome of the RD equation to examine if there are differences in observables at the margin of the cutoff.

We also provide a robustness check using a method outlined by Gerard et al. (2020) for manipulation-robust RD design. The approach calculates an upper and lower bound of the RD treatment affect based on the estimated extent of manipulation at the cutoff, and was applied by Ran and Lin (2022) in their study of corequisite models in Tennessee, where they also observed

discontinuities in the running variable. These results are provided as a robustness check following the presentation of the main RD findings.

Student Support Recommendations: IPWRA

Students are allowed to enroll directly in transfer-level courses but are encouraged to take varying supports depending on their GPA. Appendix Tables A1 and A2 show the set of recommended supports in both English and math. These were gleaned from the placement messages students received, paired with information from institutional websites. Nearly all of the suggested supports for English were concurrent support courses. However, math supports were a mix of concurrent and development (e.g., prerequisite) courses.

Since the cutoffs are used to make recommendations, and not assignments, for student support courses, it is possible that the sharp RD results are biased due to students' choices to enroll in the coursework and supports of their own choosing. We therefore explored the potential of using GPA as an instrument for student support course enrollment and a fuzzy RD strategy that estimates the average treatment effect for compliers. However, we did not observe any significant discontinuities in support course enrollment at the cutoffs. Therefore, GPA proved to be a weak instrument and a fuzzy RD approach would not result in valid estimates.

We therefore used inverse probability weighted regression adjustment (IPWRA) to model and estimate the relationship between enrollment in the recommended support courses and student outcomes. IPWRA improves upon a standard regression approach because the two-step procedure corrects for potential bias in treatment effect estimation that results from selection into the treatment. Inverse probability weighting has been used to estimate treatment effects of higher education policies and programs, including first-year seminars (Culver & Bowman, 2020), math pathways (Authors), and vertical transfer (Witteveen & Attewell, 2020), among others.

Equation 1 shows the first stage of IPWRA, in which we use a logit model to estimate the likelihood of treatment (enrollment in a recommended English or math support course).

$$\ln \left(\frac{P(\text{Support}_i)}{1-P(\text{Support}_i)} \right) = \beta_0 + \beta_1 \text{GPA}_i + \beta_2 \text{Female}_i + \beta_3 \text{FinAid}_i + \gamma \text{Race}'_i + \lambda \text{Level}'_i + \delta \text{Campus}'_j + \theta \text{Term}'_k + \varepsilon_i \quad (1)$$

Covariates include high school GPA (continuous), gender, a dichotomous indicator of financial aid receipt in the first term of enrollment, race/ethnicity (dummies for each of 8 categories), and initial math/English placement level (dummies for each level). We also include campus dummies and term dummies, since the set of supports offered vary by campus and term. We cluster standard errors at the college level.

We calculate treatment probability weights and assign the inverse probability of being treated for treated individuals and the inverse probability of not being treated for control individuals. These are used in the linear outcome (Y_{ict}) regression shown in equation 2.

$$Y_i = \beta_0 + \beta_1 \text{GPA}_i + \beta_2 \text{Female}_i + \beta_3 \text{FinAid}_i + \gamma \text{Race}'_i + \lambda \text{Level}'_i + \delta \text{Campus}'_j + \theta \text{Term}'_k + \varepsilon_i \quad (2)$$

With the inclusion of covariates in both the treatment (1) and outcome (2) models, IPWRA is a doubly robust estimator and remains consistent if either model is correctly specified (Woolridge, 2010). The resulting treatment effect estimate in the Average Treatment Effect on the Treated (ATT). We do not interpret this ATT as a causal effect, however, since the IPWRA design relies heavily on the assumption that selection into treatment or the outcomes model is correctly specified. We therefore describe all of the IPWRA results as the estimated association between support course enrollment and subsequent student outcomes.

Limitations

This set of complementary analyses provides evidence on LUCCD's usage of multiple measures placement and the development and offering of a set of student supports in accordance with AB705 expectations. However, it is important to note that the student outcome data extends through the Spring 2020 semester, the beginning of the global COVID-19 pandemic. With the switch to remote classes and campus closures, it is possible that some of the completion outcomes we are examining (e.g., throughput; units completed) might be affected by changes related to the pandemic. Units attempted should not be affected since these enrollment decisions would have been made prior to March 2020 when institutions in the district began to shift to remote operations. Although the results are generalizable only to one district in the broader California Community College system, they findings do provide importance evidence on the practices that have ensued statewide following AB705 legislation and implementation.

Findings

English Placement

We first present ITT estimates of the impact of English placement assignment at the margin of the upper and lower GPA cutoffs (see Figure 2). We examined completion of transfer-level English in 1 year (i.e., throughput), total credits attempted in one year, and total credits completed in one year. There do not appear to be any visual discontinuities at the 2.6 cutoff. The visuals suggest some discontinuities at the 1.9 cutoff, with students just below the cutoff with higher rates of throughput and more credits attempted and completed than those immediately to the right of the cutoff.

[Insert Figure 2]

These visual discontinuities are corroborated by the RD estimates presented in Table 2, which show the conventional, bias-corrected, and robust RD estimates for each of the three

outcomes of interest (Calonico et al., 2014). The upper panel shows the results at the margin of the 2.6 cutoff, and the lower panel shows the 1.9 cutoff. We provide estimates with and without covariates. There are no consistent significant effects at the 2.6 cutoff., but there is a consistent negative effect of placing above the cutoff relative to placing below the cutoff at the lower cutoff. Looking at the bias-corrected and robust estimates, students just above the cutoff were 14.6 percentage points less likely to complete transfer-level English within one year. This effect drops to 11.7 percentage points but is still significant when we include covariates in the model. Student above the lower cutoff also attempted about 5 fewer units and completed 2 fewer units than students just below the cutoff.

[Insert Table 2]

Math Placement

We show the discontinuity visualizations for the relationship between math placement and math throughput in Figure 3. There do not appear to be any discontinuities at the GPA frontier for calculus+ students, at the 3.0 cutoff for the <calculus students, or at the 2.3 cutoff, and this is corroborated by the robust RD estimates shown in Table 3. This suggests no significant differences in outcomes at the margin of the math frontier cutoffs.

[Insert Table 3]

[Insert Figure 3]

Validity

Covariates. To examine threats to validity of the RD estimates, we set each of the covariates as the outcome in the same RD model. None of the these were discontinuous at any of the cutoffs. We provide a visualization of the covariate RDs in Figure 4. There are no discontinuities in any of these covariates.

[Insert Figure 4]

Manipulation-robust RD. As described above, the GPA running variable was not smooth and there was bunching at certain GPA values. Since manipulation of the running variable can potentially threaten the internal validity of RD estimates, we conducted additional analyses using the method developed by Gerard et al. (2020), which assesses the extent of manipulation and, when there is manipulation, calculates an upper and lower bound of the RD estimate. These manipulation-robust RD estimates are presented in Table 4. There was no evidence of manipulation at the English cutoffs. There was evidence of manipulation at the two 3.0 cutoffs in math, and therefore the upper and lower bounds are provided. Both of these indicate no significant difference in outcomes at the 3.0 math cutoffs. There was also no evidence of manipulation at the 2.3 math cutoff. Overall, these manipulation-robust estimates align with the sharp RD estimates presented above.

[Insert Table 4]

Enrollment in Support Recommendations

Since the primary treatment at the GPA cutoffs is a recommendation to enroll in a math or English support course (see Appendix for list of support courses), we also sought to explore how these support courses may influence student outcomes. Figure 5 shows that English support course enrollment increases with lower GPAs, but is fairly low overall. Less than 5 percent of students with high school GPA over 3.0 enrolled in an English support course. Just about 15 percent of students with incoming high school GPA below 2.0 enrolled in an English support course.

Figure 6 shows the take-up of the recommendation to enroll in a math support course, including concurrent support courses or developmental courses. More students enrolled in

developmental courses than concurrent support courses, and this gap was larger for students with lower incoming GPAs. Important to note in both figures is that there is no evidence of discontinuities in support enrollment at the math or English cutoffs. Therefore, a fuzzy RD design could not be used to estimate causal impacts of enrollment in math or English supports.

[Insert Figures 5 & 6]

We therefore turned to IPWRA to examine the relationship between English or math support course enrollment and student outcomes. Table 5 shows the results from the treatment equation (logit model) and the factors associated with enrollment in an English support course or a math support course. We examined concurrent math supports and developmental math separately.

Students with higher high school GPAs were less likely to enroll in English support courses and developmental courses, but the relationship between high school GPA and concurrent math support enrollment was not significant. There were no differences by gender in support course enrollment. Receipt of financial aid was strongly related to support course enrollment. Transforming the logit coefficients, we see that students receiving financial aid have $e^{1.174} = 3.23$ times the odds of enrolling in an English support course than those who did not receive aid. They have 3.28 times the odds of enrolling in concurrent math support, and 2.40 times the odds of enrolling in developmental math.

Compared to white students, Black students had 1.68 times and Hispanic students had 1.99 times the odds of enrolling in English support. These groups, along with Filipino students, were also more likely to enroll in concurrent math supports than white students. Asian students were less likely to enroll in developmental math, but Pacific Islander students were more likely

to do so than white students. There were also differences by initial math and English placement level, as well as campus, but these are not shown to protect the anonymity of the system.

[Insert Table 5]

Support Outcomes. Table 6 presents IPWRA treatment effect coefficients (linear model) associated with enrollment in English or math support courses. The mean outcome for the control group is also shown. Students who enrolled in English supports were 20.9 percentage points more likely to achieve throughput in English. They also attempted about 6 more units on average in one year, and completed about 3 more units. This is most likely owing to the fact that supports courses typically required enrollment in additional units.

There was a positive relationship (2.8 percentage points) between concurrent math support enrollment and math throughput, but this was not significant. Concurrent math support enrollment was associated with enrollment in about 8.5 more total units, and completion of 5.5 more units.

In contrast, enrollment in developmental math appears to be negatively associated with subsequent math throughput. Students who enrolled in developmental math were 6 percentage points less likely to achieve math throughput than their peers who did not enroll in a developmental math course. They also attempted nearly 6 more units and completed 3.3 more credits than their peers, again owing to the fact that developmental courses require enrollment in more units.

[Insert Table 6]

Discussion

This study uses RD design to evaluate the impact of AB705's mandate for the California Community Colleges to use math and English placement cutoffs based primarily on high school

GPA to direct students to appropriate coursework. Overall, the findings from one large urban community college district show no major evidence of negative impacts in completion outcomes for students falling below the GPA cutoffs. In fact, for English the opposite seems to be the case – students entering with the lowest GPAs who fell just below English cutoffs appear to be doing better than those above the cutoffs. The math results are slightly more challenging to interpret given the use of both high school GPA and highest high school math course as placement criteria. However, the frontier RD estimates from the largest subsamples of math students also appear to show no pattern of significant differences in outcomes at any cutoff.

One takeaway from the study is that this model of direct placement in transfer-level courses using multiple measures, along with encouragement for students to enroll in support courses, does not appear to result in the same large negative penalties that prior work on the pre-requisite model of remediation has documented (Martorell & McFarlin, 2011; Melguizo et al., 2016; Ngo & Melguizo, 2016; Valentine et al., 2017). This validates, in a sense, the work of MMAP in identifying the appropriate GPA cutoffs for use across the CCC system (Bahr et al., 2019; Willett et al., 2015). Other states and systems may be able to replicate this model of using high school GPA and coursework in lieu of placement testing to make placement decisions and support recommendations in order to ameliorate the negative effects of developmental education.

The study findings also provide evidence from the first year of implementation of AB705 showing that English support courses for students with lower incoming GPAs may be very effective in helping these students complete transfer-level courses in one year. Although the results for concurrent math support courses and throughput were not significant, they were positive, suggesting that concurrent math supports did not necessarily adversely affect students' outcomes. These conclusions are in accordance with other rigorous evaluations showing the

benefits of corequisite models, one type of support courses offered in the district (Boatman, 2012; Boatman, 2021; Boatman et al., 2021; Logue et al., 2016; Meiselman & Schudde, 2019; Miller et al., 2022; Ran & Lin, 2022). Importantly, this study shows that making these recommendations based on high school GPA can also be effective. Students who followed the recommendations and enrolled in English support courses and concurrent math supports on average had better outcomes than those who did not enroll in any support courses.

One important finding that stands out is the observed negative relationship between enrollment in developmental math and math throughput. Students who opted to or were recommended to enroll in developmental math courses instead of enrolling directly in transfer-level courses were 6 percentage points less likely on average to complete a transfer-level math course within one year. This is a significant penalty given the control group average of 10 percent throughput. Although these IPWRA estimates are not causal, they should warrant further investigation of whether the continued practice and offering of developmental courses is necessary and in what ways those courses can be improved to better support students.

Despite the observed benefits of concurrent support courses, our analysis also shows relatively low take-up of concurrent support courses in this context of student choice. A key descriptive finding from the analysis shows financial aid receipt was strongly predictive of support course enrollment, suggesting that the extra costs of these courses may have been a deterrent for some students. Future research should therefore also examine how to increase enrollment in these supports, along with student perspectives and experiences in these courses. Another important area of research is on how counselors work with students to identify and enroll in the appropriate supports. At the policy level, the CCC system can devote more resources to developing robust concurrent supports, including corequisite courses, which have

demonstrated promise but were not consistently offered across the district. Research has examined the characteristics of corequisite support courses that are predictive of student success (Rue et al., 2022), and explored curriculum, pedagogy, and learning in these courses (Atkins & Beggs, 2017; Avni & Finn, 2021). More research should examine how features of corequisites and other concurrent supports can support student outcomes.

Conclusion

The California Community College system has made a major shift in their approach to developmental education across their 116 campuses. This study illustrates that using multiple measures with a clear set of HSGPA cutoffs works, as there were no major differences in throughput and other relevant outcomes for students at the cutoffs. Students who enrolled in the set of recommended concurrent supports oftentimes fared better than their peers, evidence that encouraging these supports alongside direct placement in transfer-level courses can set students on a more efficient and effective path towards degree completion and transfer. These findings from California present evidence on what could be a robust assessment, placement, and support model for other community colleges across the nation.

References

- Atkins, C., & Beggs, C. T. (2017). Commuting the Math Sentence: Accelerating Developmental Mathematics Using the Co-Requisite Model. *NADE Digest*, 9(1), 20-24.
- Avni, S., & Finn, H. B. (2021). Meeting the Needs of English Language Learners in Co-Requisite Courses at Community College. *Community College Journal of Research and Practice*, 45(8), 560-574.
- Bahr, P. R., Fagioli, L. P., Hetts, J., Hayward, C., Willett, T., Lamoree, D., Newell, M. A., Sorey, K., & Baker, R. B. (2019). Improving placement accuracy in California's community colleges using multiple measures of high school achievement. *Community College Review*, 47(2), 178-211. doi:10.1177/0091552119840705
- Bailey, T., Jeong, D. W., & Cho, S. W. (2010). Referral, enrollment, and completion in developmental education sequences in community colleges. *Economics of Education Review*, 29(2), 255-270.
- Barnett, E. A., & Reddy, V. (2017). *College placement strategies: Evolving considerations and practices*. New York, NY: Center for the Analysis of Postsecondary Research.
- Boatman, A. (2012). *Evaluating institutional efforts to streamline postsecondary remediation: The causal effects of the Tennessee developmental-course redesign initiative on early student academic success*. Harvard University.
- Boatman, A. (2021). Accelerating college remediation: Examining the effects of math course redesign on student academic success. *The Journal of Higher Education*, 92(6), 927-960.
- Boatman, A., Claro, S., Fresard, M., & Kramer, J. W. (2021). Do Corequisite Math Courses Improve Academic Outcomes in Technical Colleges?: Evidence from Chile. *Research in Higher Education*, 1-28.
- California Community Colleges Chancellor's Office (n.d.). What is AB 705? Retrieved from <https://assessment.cccco.edu/ab-705-implementation>
- Calonico, S., Cattaneo, M. D., Farrell, M. H., & Titiunik, R. (2017). rdrobust: Software for regression-discontinuity designs. *The Stata Journal*, 17(2), 372-404.
- Calonico, S., Cattaneo, M. D., & Titiunik, R. (2014). Robust nonparametric confidence intervals for regression-discontinuity designs. *Econometrica*, 82(6), 2295-2326.
- Cuellar Mejia, M., Rodriguez, O., Johnson, H., & Perez, C. A. (2021). *Community college math in California's new era of student access*. Public Policy Institute of California. <https://www.ppic.org/publication/community-college-math-in-californias-new-era-of-student-access/>
- Cullinan, D., & Biedzio, D. (2021). Increasing Gatekeeper Completion: Three-Semester Findings from an Experimental Study of Multiple Measures Assessment and Placement. MDRC. https://www.mdrc.org/sites/default/files/MMA_Final_Report.pdf
- Education Commission of the States. (2015). *Moving from single to multiple measures for college course placement*. Retrieved from <http://www.ecs.org/moving-from-single-to-multiple-measures-for-college-course-placement>
- Hern, K. & Snell, M. (2021, October). Invalid Placement Practices Widespread in CA Community Colleges. California Acceleration Project. <https://accelerationproject.org/Publications/ctl/ArticleView/mid/654/articleId/136/Invalid-Placement-Practices-Widespread-in-CA-Community-Colleges>
- Kosiewicz, H., Ngo, F., & Fong, K. (2016). Alternative models to deliver developmental math: Issues of use and student access. *Community College Review*, 44(3), 205-231.

- Leeds, D. M., & Mokher, C. G. (2020). Improving indicators of college readiness: Methods for optimally placing students into multiple levels of postsecondary coursework. *Educational Evaluation and Policy Analysis*, 42(1), 87-109.
- Logue, A. W., Douglas, D., & Watanabe-Rose, M. (2019). Corequisite mathematics remediation: Results over time and in different contexts. *Educational Evaluation and Policy Analysis*, 41(3), 294-315.
- Logue, A. W., Watanabe-Rose, M., & Douglas, D. (2016). Should students assessed as needing remedial mathematics take college-level quantitative courses instead? A randomized controlled trial. *Educational Evaluation and Policy Analysis*, 38(3), 578-598.
- Long Beach Community College (2014). Promise pathways. Long Beach, CA: Long Beach City College. Retrieved from: lbcc.edu/promisepathways
- Meiselman, A. Y., & Schudde, L. (2019). The impact of corequisite math on community college student outcomes: Evidence from Texas. *Education Finance and Policy*, 1-45.
- Melguizo, T., Bos, J. M., Ngo, F., Mills, N., & Prather, G. (2016). Using a regression discontinuity design to estimate the impact of placement decisions in developmental math. *Research in Higher Education*, 57(2), 123-151.
- Melguizo, T., Kosiewicz, H., Prather, G., & Bos, J. (2014). How are community college students assessed and placed in developmental math? Grounding our understanding in reality. *The Journal of Higher Education*, 85(5), 691-722.
- Melguizo, T., & Ngo, F. (2020). Mis/alignment between high school and community college standards. *Educational Researcher*, 49(2), 130-133.
- Miller, T., Daugherty, L., Martorell, P., & Gerber, R. (2022). Assessing the effect of corequisite English instruction using a randomized controlled trial. *Journal of Research on Educational Effectiveness*, 15(1), 78-102.
- Ngo, F., Chi, W. E., & Park, E. S. Y. (2018). Mathematics course placement using holistic measures: Possibilities for community college students. *Teachers College Record*, 120(2), 1-42.
- Ngo, F., & Kwon, W. W. (2015). Using multiple measures to make math placement decisions: Implications for access and success in community colleges. *Research in Higher Education*, 56(5), 442-470.
- Ngo, F., & Melguizo, T. (2016). How can placement policy improve math remediation outcomes? Evidence from experimentation in community colleges. *Educational Evaluation and Policy Analysis*, 38(1), 171-196.
- Ran, X., & Lin, Y. (2022). The effects of corequisite remediation: Evidence from a statewide reform in Tennessee. *Educational Evaluation & Policy Analysis*. <https://journals.sagepub.com/doi/abs/10.3102/01623737211070836>
- Reardon, S. F., & Robinson, J. P. (2012). Regression discontinuity designs with multiple rating-score variables. *Journal of research on Educational Effectiveness*, 5(1), 83-104.
- Scott-Clayton, J., Crosta, P. M., & Belfield, C. R. (2014). Improving the targeting of treatment: Evidence from college remediation. *Educational Evaluation and Policy Analysis*, 36(3), 371-393.
- Whinnery, E., & Odekar, V. (2021). 50-state comparison: Developmental education policies. Education Commission of the States. <https://www.ecs.org/50-state-comparison-developmental-education-policies/>
- Willett, T., Hayward, C., Nguyen, A., Newell, M., Bahr, P., Hetts, J., Lamoree, D., Sorey, K., & Duran, D. (2015). *Multiple Measures Assessment Project (MMAP) Spring*

2015 Technical Report. Sacramento, California: Research and Planning Group for California Community Colleges

Figures & Tables

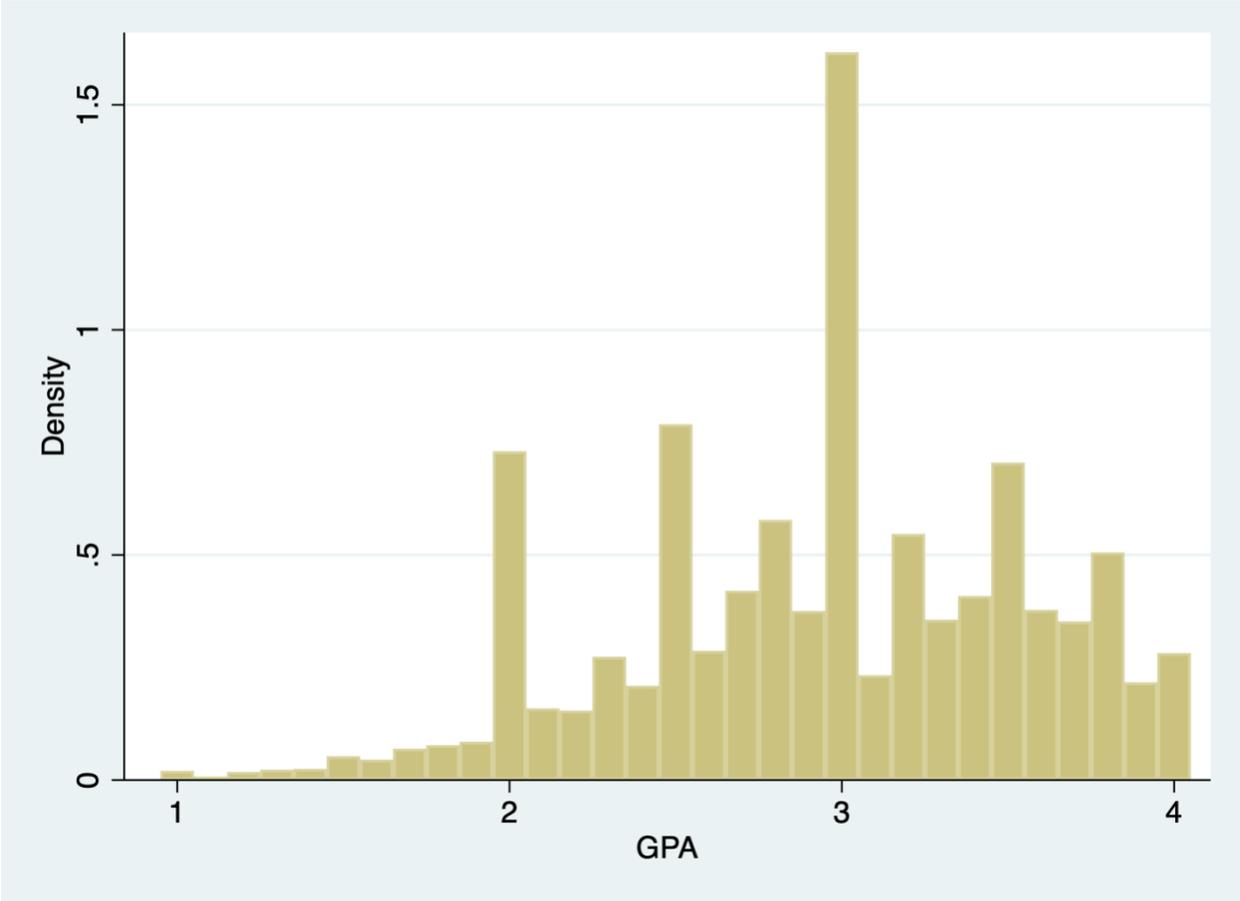


Figure 1. Distribution of high school GPA running variable

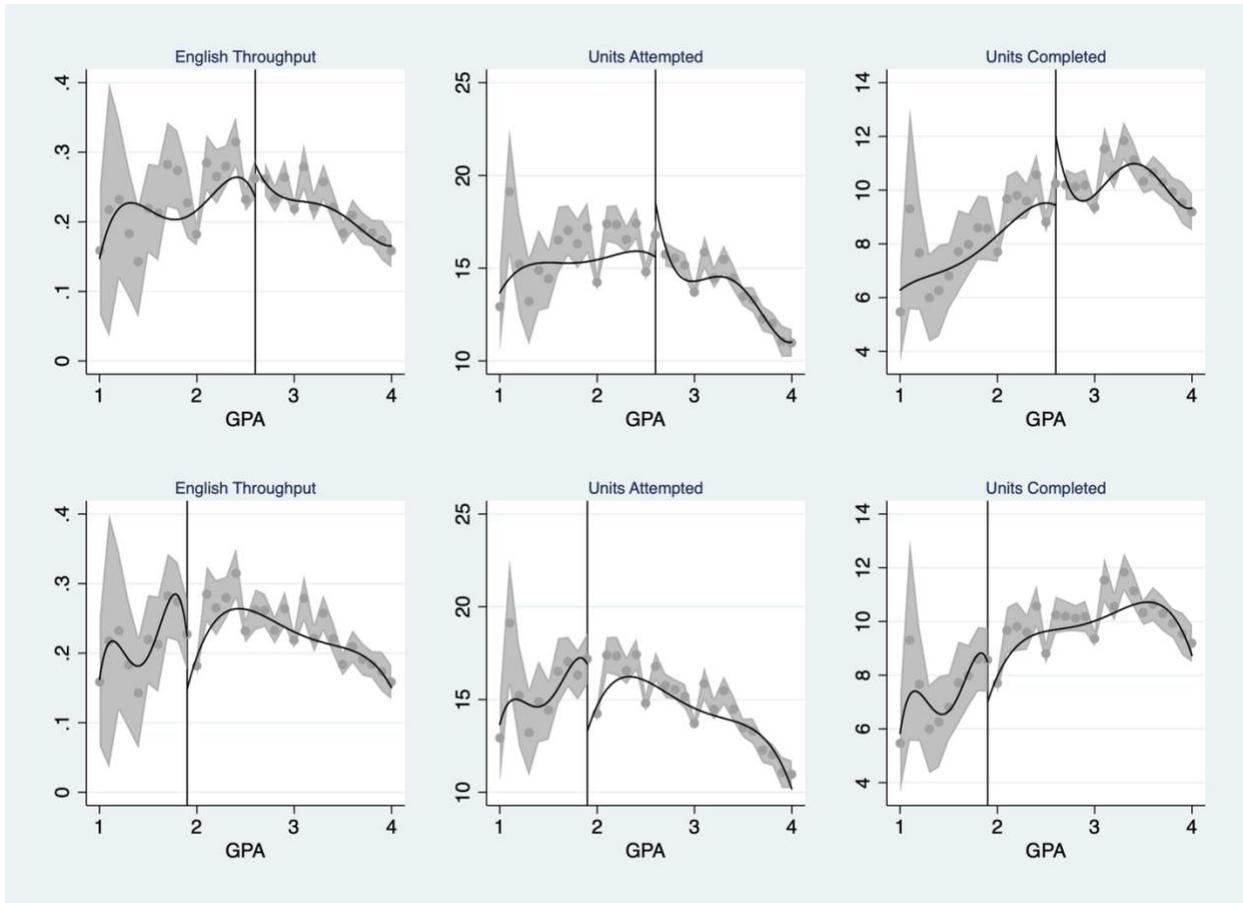


Figure 2. Outcome visualizations for English placement at 2.6 GPA (upper panel) and 1.9 GPA (lower panel) cutoffs

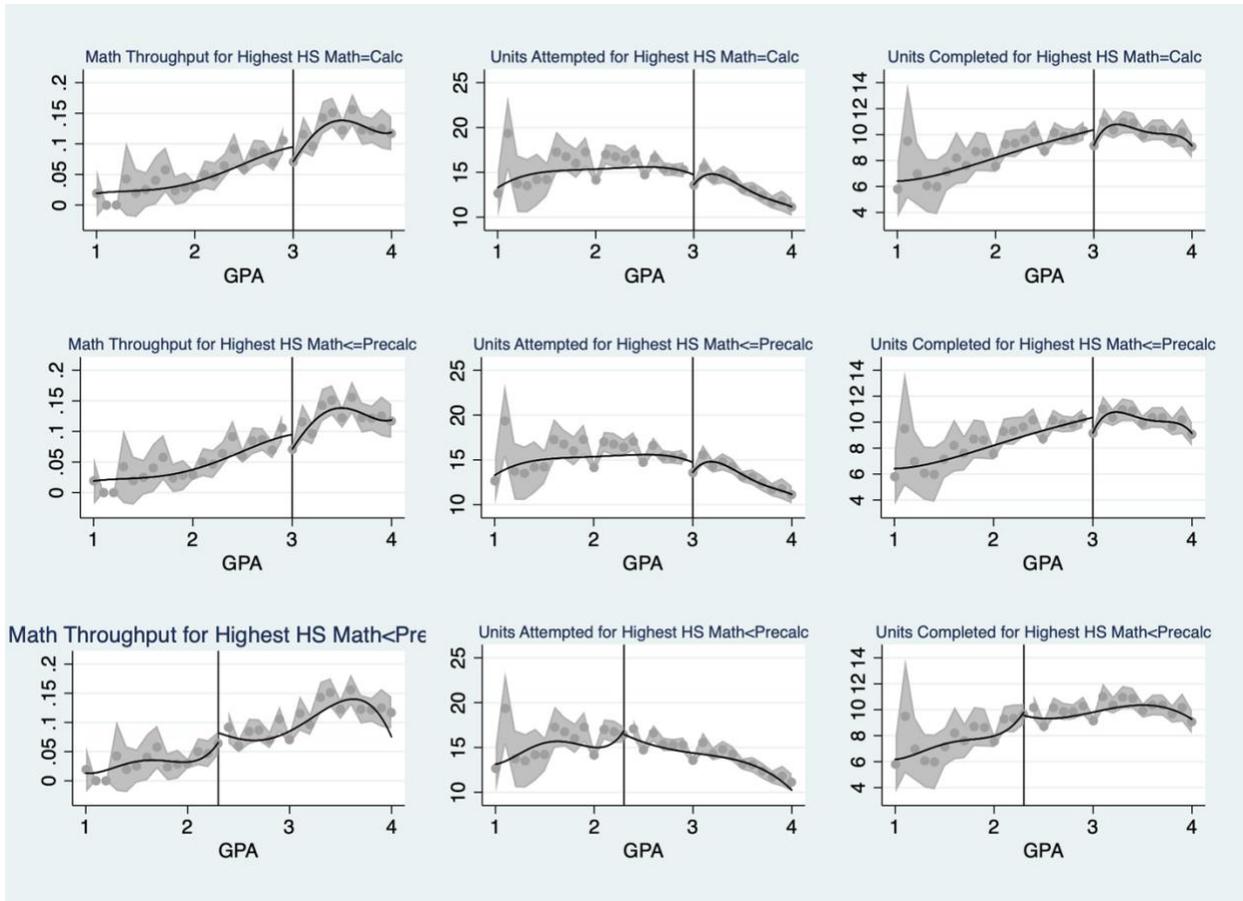


Figure 3. Outcome visualizations for math placement at 3.0 GPA + calculus (upper panel), 3.0 GPA + precalculus (middle panel), and 2.3 GPA (lower panel) cutoffs

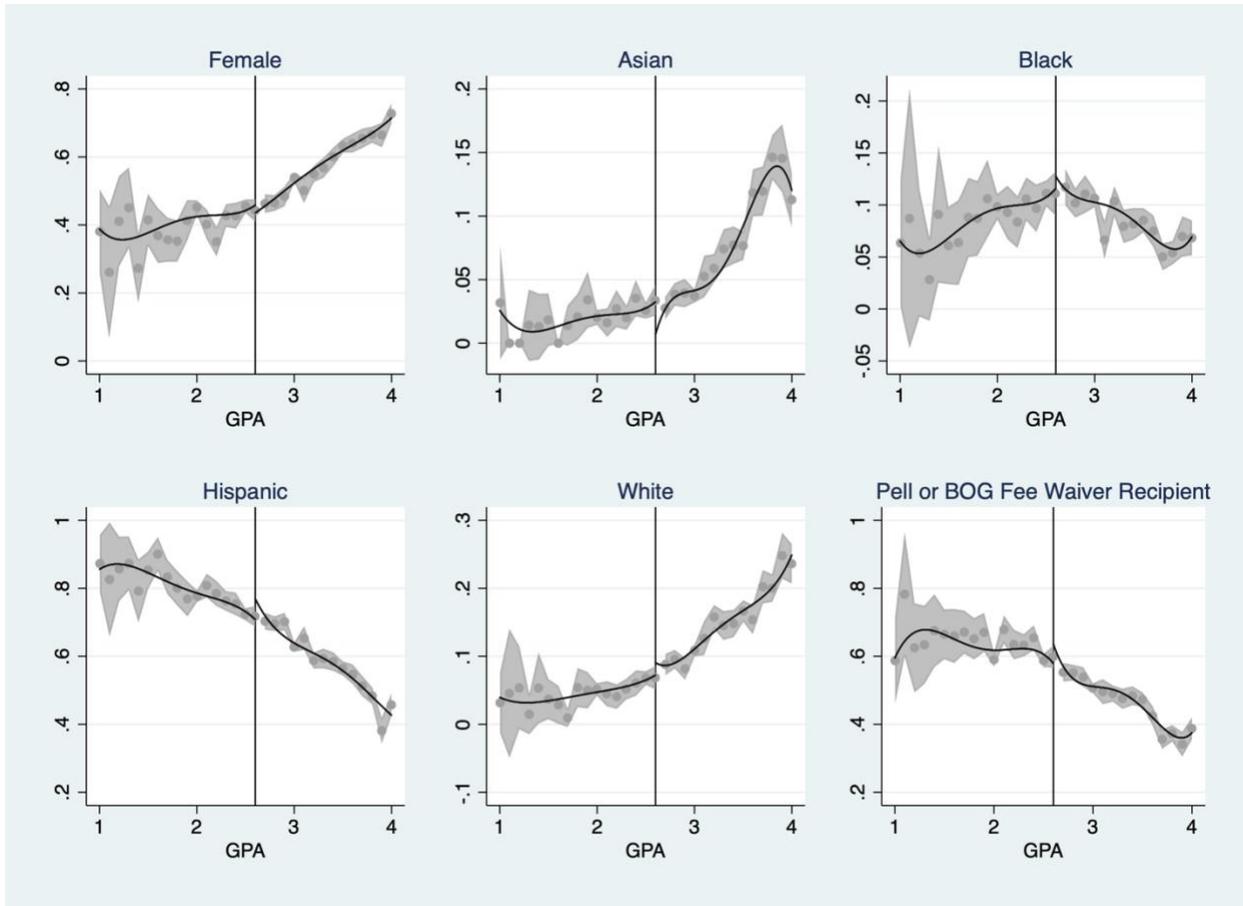


Figure 4. Covariate continuity at the 2.6 GPA cutoff

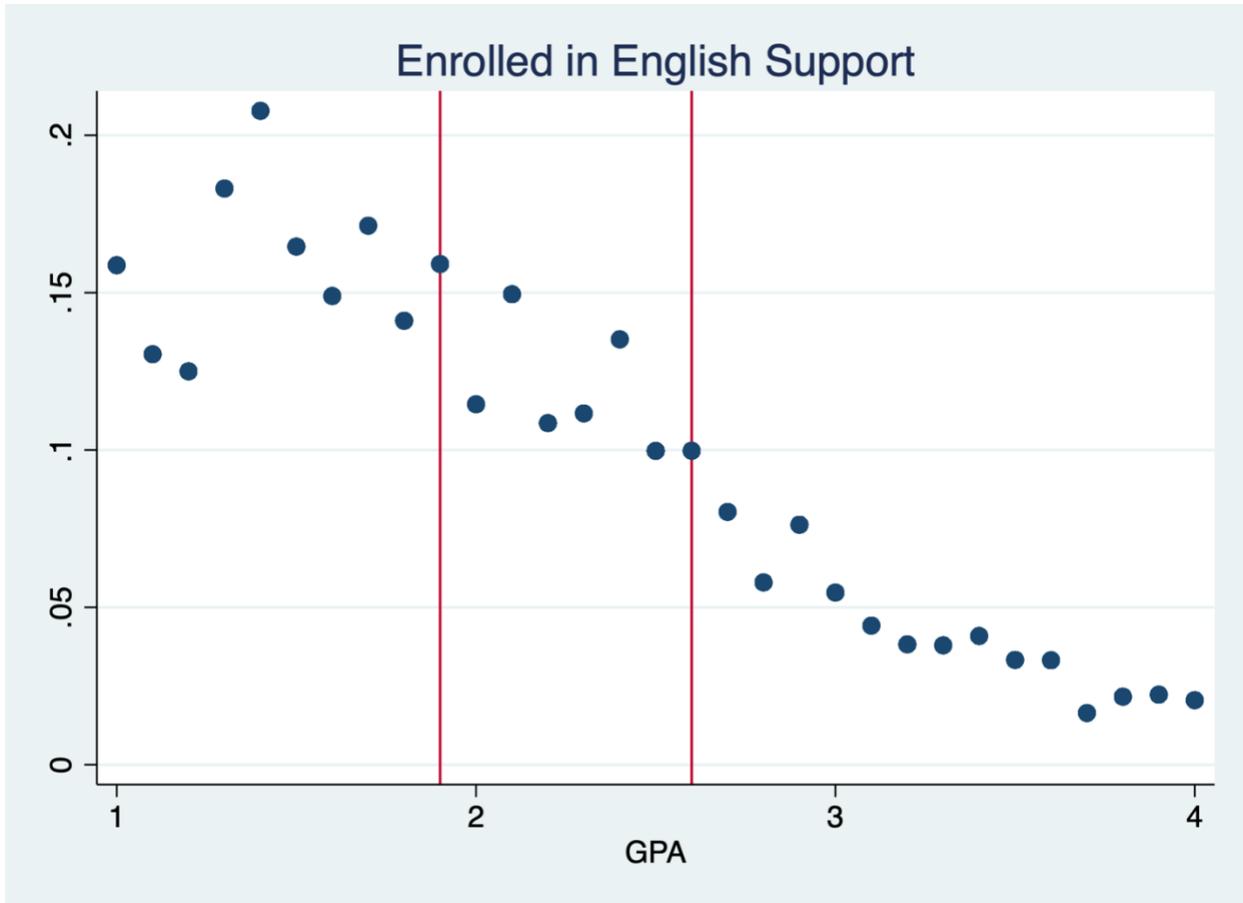


Figure 5. Enrollment in English support courses (e.g., corequisites) following placement recommendation

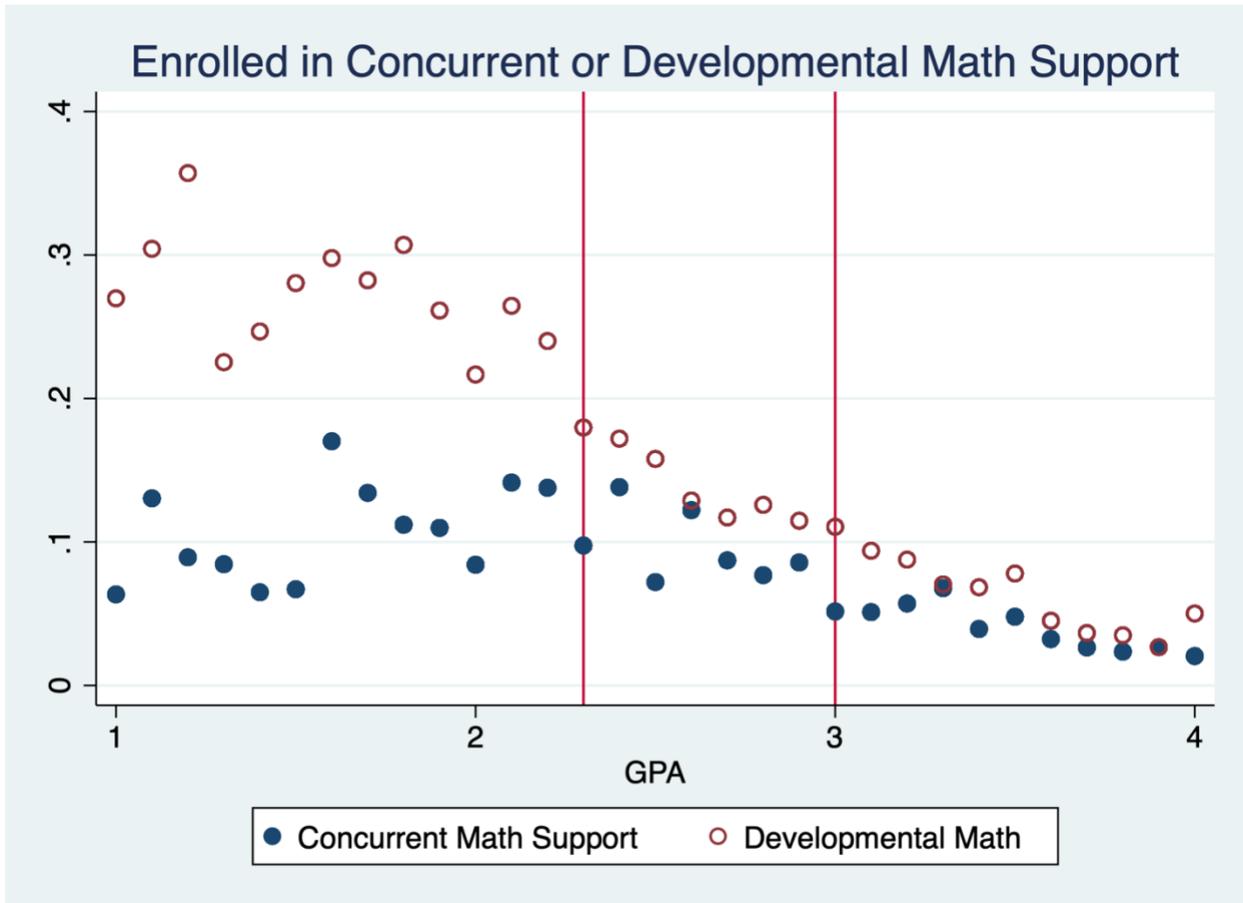


Figure 6. Enrollment in math supports following placement recommendation

Table 1. Characteristics and outcomes of full and RD samples by GPA Bins

	All (1.0-4.0)	1.7-1.8	1.9-2.0	2.1-2.2	2.3-2.4	2.4-2.5	2.6-2.7	2.8-2.9	3.0-3.1
Characteristics									
Female	0.53	0.38	0.44	0.40	0.43	0.45	0.46	0.48	0.53
American Indian	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Asian	0.06	0.02	0.02	0.02	0.04	0.03	0.03	0.04	0.04
Black	0.09	0.09	0.10	0.10	0.10	0.11	0.11	0.11	0.10
Filipino	0.02	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02
Hispanic	0.65	0.80	0.78	0.77	0.75	0.73	0.70	0.70	0.63
Multiracial	0.03	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.03
Pacific Islander	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
White	0.11	0.04	0.05	0.05	0.06	0.07	0.09	0.08	0.10
Other/Unknown	0.04	0.02	0.02	0.02	0.01	0.03	0.02	0.02	0.07
Financial Aid	0.52	0.66	0.61	0.63	0.65	0.60	0.55	0.54	0.51
Support Course Enrollment									
English Support	0.07	0.16	0.12	0.11	0.14	0.11	0.07	0.08	0.05
Concurrent Math									
Support	0.07	0.12	0.09	0.11	0.14	0.09	0.08	0.09	0.05
Developmental Math	0.12	0.28	0.23	0.20	0.17	0.15	0.12	0.11	0.11
Outcomes									
English Throughput	0.22	0.26	0.20	0.27	0.31	0.25	0.25	0.26	0.23
Math Throughput	0.10	0.05	0.04	0.06	0.09	0.07	0.08	0.11	0.09
Units Attempted	14.42	16.85	14.80	16.84	17.42	15.67	15.63	15.17	13.99
Units Completed	9.76	8.40	8.05	9.67	10.57	9.42	10.15	10.18	9.63
N	31,092	721	2,765	1,330	651	4,000	3,102	1,167	5,750

Note: Sample includes all first-time-in-college students in LUCCD in 2019 and who had high school GPA information. Financial aid is a dichotomous indicator of receiving either the Pell grant or Board of Governor's fee waiver during the first term of enrollment. Support courses are described in the Appendix. English/math throughput is defined as the successful completion of a transfer-level English/math course in one year from initial enrollment.

Table 2. Sharp RD results at each English cutoff

Covariates	English Throughput		Units Attempted		Units Completed	
	x	x	x	x	x	x
2.6 GPA Cutoff						
Bandwidth	0.294	0.282	0.266	0.276	0.278	0.286
Conventional	0.043 (0.029)	0.05 (0.028)	-0.32 (0.808)	0.157 (0.712)	0.421 (0.710)	0.754 (0.657)
Bias-corrected	0.048 (0.029)	0.056* (0.028)	-0.543 (0.808)	0.093 (0.712)	0.3 (0.710)	0.759 (0.657)
Robust	0.048 (0.037)	0.056 (0.036)	-0.543 (1.003)	0.093 (0.887)	0.3 (0.893)	0.759 (0.828)
N	31092	31092	31092	31092	31092	31092
1.9 GPA Cutoff						
Bandwidth	0.388	0.412	0.249	0.285	0.328	0.359
Conventional	-0.115*** (0.028)	-0.088*** (0.026)	-5.987*** (0.945)	-4.268*** (0.823)	-2.445*** (0.685)	-1.641** (0.616)
Bias-corrected	-0.146*** (0.028)	-0.117*** (0.026)	-7.599*** (0.945)	-5.265*** (0.823)	-3.225*** (0.685)	-2.203*** (0.616)
Robust	-0.146*** (0.034)	-0.117*** (0.031)	-7.599*** (1.167)	-5.265*** (0.984)	-3.225*** (0.876)	-2.203** (0.794)
N	31092	31092	31092	31092	31092	31092

Notes: RD results are estimated using `rdrobust` in Stata 15.0 (Calonico et al., 2014), and the results from three inference procedures (Calonico et al., 2017) are shown. The treatment is receiving the placement code above each cutoff. Covariates include race, gender, financial aid receipt, placement level, campus, and term. English/math throughput is defined as the successful completion of a transfer-level English/math course in one year from initial enrollment. Units attempted and completed are bounded to a one-year time period.

*p<.05 **p<.01 ***p<.001

Table 3. Sharp frontier RD results at each math cutoff

Covariates	Math Throughput		Units Attempted		Units Completed	
	x	x	x	x	x	x
3.0 GPA + Calculus						
Bandwidth	0.381	0.4	0.382	0.389	0.36	0.363
Conventional	-0.024 (0.098)	0.023 (0.097)	3.093 (3.224)	4.399 (2.801)	3.846 (2.581)	4.164 (2.414)
Bias-corrected	-0.141 (0.098)	-0.064 (0.097)	3.968 (3.224)	6.472* (2.801)	5.635* (2.581)	6.946** (2.414)
Robust	-0.141 (0.173)	-0.064 (0.172)	3.968 (6.042)	6.472 (5.079)	5.635 (4.898)	6.946 (4.425)
N	6198	6198	6198	6198	6198	6198
3.0 GPA + Precalculus						
Bandwidth	0.187	0.185	0.225	0.224	0.219	0.213
Conventional	-0.038** (0.012)	-0.036** (0.012)	-1.964* (0.972)	-1.642 (0.850)	-1.936* (0.849)	-1.801* (0.776)
Bias-corrected	-0.013 (0.012)	-0.011 (0.012)	-2.131* (0.972)	-1.914* (0.850)	-2.507** (0.849)	-2.492** (0.776)
Robust	-0.013 (0.011)	-0.011 (0.011)	-2.131 (1.745)	-1.914 (1.532)	-2.507 (1.522)	-2.492 (1.402)
N	8619	8619	8619	8619	8619	8619
2.3 Cutoff						
Bandwidth	0.976	0.924	0.805	0.857	0.915	0.935
Conventional	0.048 (0.028)	0.039 (0.028)	3.660** (1.280)	2.380* (1.129)	2.220* (1.118)	1.39 (1.045)
Bias-corrected	0.045 (0.028)	0.038 (0.028)	3.658** (1.280)	2.135 (1.129)	1.871 (1.118)	1.089 (1.045)
Robust	0.045 (0.030)	0.038 (0.030)	3.658** (1.337)	2.135 (1.180)	1.871 (1.161)	1.089 (1.089)
N	5284	5284	5284	5284	5284	5284

Notes: RD results are estimated using `rdrobust` in Stata 15.0 (Calonico et al., 2014), and the results from three inference procedures (Calonico et al., 2017) are shown. The treatment is receiving the placement code above each cutoff. Covariates include race, gender, financial aid receipt, placement level, campus, and term. For math, the subsamples are defined by both high school GPA and high school math course-taking criteria. English/math throughput is defined as the successful completion of a transfer-level English/math course in one year from initial enrollment. Units attempted and completed are bounded to a one-year time period.

*p<.05 **p<.01 ***p<.001

Table 4. Manipulation-robust RD estimates

	SRD Naïve	Lower	Upper
English 2.6	0.028	0.028	0.028
English 1.9	-0.148	-0.148	-0.148
Math 3.0 + Calculus	0.046	-0.109	0.891
Math 3.0 + Precalculus	0.006	-0.060	0.940
Math 2.3	-0.049	-0.049	-0.049

Notes: The manipulation-robust RD approach (Gerard et al., 2020) conducts a bound exercise that calculates an upper and lower bound of the RD treatment affect based on the estimated extent of manipulation at the cutoff. Estimates with no differences in the upper and lower bound indicate no evidence of manipulation.

Table 5. Predictors of enrollment in recommended English and math support courses, logit model

	Enrollment in English Support	Enrollment in Concurrent Math Support	Enrollment in Developmental Math
HS GPA	-0.758*** (0.100)	-0.204 (0.111)	-0.474*** (0.078)
Female	-0.005 (0.087)	0.043 (0.069)	0.089 (0.080)
Financial Aid	1.174*** (0.083)	1.187*** (0.036)	0.874*** (0.087)
American Indian	-0.914 (1.094)	0.738 (0.383)	-0.589 (0.517)
Asian	0.014 (0.121)	-0.046 (0.089)	-0.300* (0.148)
Black	0.500*** (0.094)	0.292* (0.129)	0.115 (0.181)
Filipino	0.295 (0.176)	0.628*** (0.146)	0.039 (0.233)
Hispanic	0.686*** (0.068)	0.586*** (0.080)	0.246 (0.155)
Multiracial	0.114 (0.233)	0.018 (0.189)	0.201* (0.091)
Pacific Islander	-0.115 (0.500)	0.43 (0.255)	-0.417 (0.304)
Other/Unknown	0.228 (0.208)	0.24 (0.155)	-0.446** (0.172)
Constant	-1.277*** (0.380)	-3.408*** (0.378)	-2.518*** (0.245)
N	31092	31092	31092

Notes: The reported coefficients are the log odds of enrollment in one of the types of support courses. Additional covariates include placement level, campus, and term (not shown). Standard errors are clustered by campus. The results are estimated using `teffects ipwra` in Stata 15.0.

*p<.05 **p<.01 ***p<.001

Table 6. Student outcomes after enrollment in support courses, linear model (inverse probability weighted regression adjustment)

	Enrolled in English Support			Enrolled in Concurrent Math Supports			Enrolled in Developmental Math		
	English Throughput	Units Attempted	Units Completed	Math Throughput	Units Attempted	Units Completed	Math Throughput	Units Attempted	Units Completed
Treatment Effect	0.209*** (0.037)	6.017*** (0.471)	3.317*** (0.405)	0.028 (0.035)	8.482*** (0.636)	5.508*** (0.621)	-0.060*** (0.010)	5.863*** (0.387)	3.278*** (0.349)
Control Group Mean	0.212*** (0.020)	14.131*** (0.377)	9.630*** (0.304)	0.094*** (0.012)	13.935*** (0.403)	9.451*** (0.332)	0.103*** (0.012)	13.800*** (0.345)	9.434*** (0.285)

Notes: The reported treatment effect is the effect of being in the treatment group (enrollment in one of the types of English or math support courses). The control group mean is the baseline outcome. These coefficients were estimated using a linear model and `teffects ipwra` in Stata 15.0. Covariates include race, gender, financial aid receipt, placement level, campus, and term (latter three not shown). Standard errors are clustered by campus. English/math throughput is defined as the successful completion of a transfer-level English/math course in one year from initial enrollment. Units attempted and completed are bounded to a one-year time period.

*p<.05 **p<.01 ***p<.001

APPENDIX

Appendix Table A1. English Placement Policies

Criteria	English Placement Code	Example Message
2.6 ≤ HSGPA	E1	You have placed into <u>ENGLISH 101</u> , a course that meets graduation and transfer requirements. Please see a counselor if you have any questions about your placement.
1.9 ≤ HSGPA < 2.6	E2	You have placed into <u>ENGLISH 101</u> , a course that meets graduation and transfer requirements. <i>You are strongly advised to enroll in ENGLISH 072 and English 101 concurrently for additional support.</i>
0.0 < HSGPA < 1.9	E3	You have placed into <u>ENGLISH 101</u> , a course that meets graduation and transfer requirements. <i>You are strongly advised to enroll in ENGLISH 072 and English 101 concurrently for additional support.</i>
HSGPA = 0.0 or is null	EN	There is insufficient information about your high school grade point average to complete the automated English placement process. Please see a counselor to find out how to complete your placement.

Appendix Table A2. Math Placement Policies

DEFAULT	Statistics and Liberal Arts Math (SLAM)			
	MN: HSGPA=0.0 or is null	1: (3.0≤HSGPA)	2: (2.3≤HSGPA<3.0)	3: (0.0≤HSGPA<2.3)
Business, Science, Technology, Engineering, and Mathematics (BSTEM)	1: (3.4≤HSGPA) or (2.6≤HSGPA<3.4 & HS High Math≥Calc)	M1: (3.4≤HSGPA) or (3.0≤HSGPA<3.4 & HS High Math≥Calc)	M2: (2.6≤HSGPA<3.0 & HS High Math≥Calc)	n/a
	2: (2.6≤HSGPA<3.4 & (HS High Math≤Pre-calc or is null)) or (0.0<HSGPA<2.6 & HS High Math≥Pre-calc)	M5: (3.0≤HSGPA<3.4 & (HS High Math≤Pre-calc or is null))	M6: (2.6≤HSGPA<3.0 & (HS High Math≤Pre-calc or is null)) or (2.3≤HSGPA<2.6 & HS High Math≥Pre-calc)	M7: (0.0<HSGPA<2.3 & HS High Math≥Pre-calc)
	3: (0.0≤HSGPA<2.6 & (HS High Math<Pre-calc or is null))	n/a	M9: (2.3≤HSGPA<2.6 & HS High Math<Pre-calc or is null)	M10: (0.0≤HSGPA<2.3 & (HS High Math<Pre-calc or is null))

Note: Each placement code (e.g., M5) allows the student to choose either a SLAM or BSTEM course.