Why Do I Have to Repeat Algebra in College?

The Equity Cost of College Readiness Standards Misalignment

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Abstract

This study explores what linked high school and community college transcript data can reveal about college readiness, college transitions, and inequity as high school graduates enroll in a local community college. We do so by leveraging access to a unique longitudinal dataset that tracks high school graduates from a large urban school district (LUSD) in California into and through a local community college district (LCCD). Focusing on math, we first use the dataset to offer an alignment-based framework and properly identify what we call *inter-sector math misalignment* (ISMM). First, we define ISMM as the proportion of students who, according to their high school transcripts and high school standards, were deemed "college ready" in math but were placed in developmental math when they transitioned to community college. Second, we explore whether the problem is more pronounced in campuses serving larger proportions of racially minoritized students, as a way to measure the *equity costs of inter-sector math misalignment*. Third, we use the linked dataset to explore whether high school measures may be useful for assessment and placement (A&P).

The results confirmed that significant proportions of students meeting the standards found themselves placed in developmental math education upon community college enrollment. Second, we demonstrated that ISMM was most severe in colleges serving larger proportions of minoritized students within the district. Third, we provided evidence that efficient multiple measures consist of either combining the results of a commercially-developed test with high school measures or using a diagnostic test.

For many students graduating high school, the next step is enrolling in a local community college. The National Center for Education Statistics reports that among high schoolers planning to enroll in college, over one-third enrolled directly in an associate's degree program in a two-year college after high school (Dalton, Ingels, & Fritch, 2016). Among public two-year college students, the median distance from home to campus was just 8 miles (Hillman & Weichman, 2016). The accessibility and affordability of community colleges make them a particularly attractive choice for students of color, low-income students, and first-generation college students (Carnevale, Smith, & Strohl, 2010).

Yet formal data linkages between community colleges and their feeder high schools are not commonplace (Dynarski & Berends, 2015), meaning that students typically begin community college with a blank slate of academic achievement. This is a hallmark of the open-access mission of the community college, and simultaneously a reason for the prevalent use of placement tests to assess college readiness. Consequently, many high school graduates—roughly 60 percent—have found themselves placed in remedial/developmental math or English courses upon community college enrollment (Chen, 2016). Despite the fact that these courses are intended to catalyze postsecondary attainment, a meta-analysis of developmental education evaluation studies came to an unfortunate conclusion: overall, developmental education has had negative effects on college-level course completion, credits earned, and degree attainment (Valentine, Konstantopoulos, & Goldrick-Rab, 2017).

Taken together with related research on the errors that placement tests incur, namely that as many as one-third and one-quarter of students may be placed in remedial English and math, respectively, in error (Scott-Clayton, Crosta, & Belfield, 2014), it is important to consider the costs of *not* using students' high school records in the high-school-to-community-college pathway. We therefore explore in this study what linked high school and community college transcript data can reveal about college readiness, college transitions, and inequity as high school graduates enroll in a local community college.

We do so by leveraging access to a unique longitudinal dataset that tracks high school graduates from a large urban school district (LUSD) in California into and through a local community college district (LCCD). Focusing on math, which has a more linear sequence of courses than English, we first use the dataset to offer an alignment-based framework and properly identify what we call *inter-sector math misalignment* (ISMM). We define ISMM as the proportion of students who, according to their high school transcripts and high school standards, were deemed "college ready" in math but were placed in developmental math when they transitioned to community college. We focus on an array of indicators of college readiness that could be easily gleaned from high school transcripts, including highest and last math courses taken, grades in math courses, state test score results, and a specific college-readiness indicator developed by the California State University (CSU) system. We create four categories of the degree of ISMM for each indicator – minor, moderate, substantial, and severe – to provide an intuitive and straightforward way of categorizing the magnitude of the problem.

Second, we explore whether the problem is more pronounced in campuses serving larger proportions of racially minoritized students, as a way to measure the *equity costs of inter-sector math misalignment*. In other words, we examine how misalignment in college readiness standards between feeder high schools and receiving community colleges creates inequity. The purpose of this analysis is to shift the focus away from the individual districts and towards their inter-sector alignment as a way to identify and reduce potential equity gaps. This shift to an

inter-sector view is in line with the vision of the Every Student Succeeds Act (ESSA), which for the first time in history is requiring that K12 schools prepare all students for college and careers.[1]

Third, we use the linked dataset to explore whether high school measures may be useful for assessment and placement (A&P). Specifically, we determine which tests (e.g., ACCUPLACER or the MDTP diagnostic) and high school measures (e.g., highest math course, standardized test results) have the potential to reduce placement error and improve the likelihood of success in college math courses. This analysis offers some guidance for the dramatic policy shifts taking place across the nation away from placement testing and towards the use of alternative placement criteria. Case in point, in 2017 California passed Assembly Bill 705 (AB705), a state-level mandate that requires each community college to maximize the probability that students will enroll in and complete college-level math and English within one year (AB705, 2017). Accordingly, the law advocates for colleges to prioritize high school information over placement tests in the placement process, with the goal of improving placement accuracy and making sure that only students who need developmental courses are placed in them. However, California has a heavily decentralized education governance structure (Brewer & Smith, 2008), and so significant local variation in implementation is to be expected. Our examination of ISMM across high-school-to-community-college pathways can help to characterize the extent to which this variation may be an issue. Further, California does not currently have an inter-sector statewide data system[2] and as a result many colleges are using students' self-reported information that, according to the literature, might not be reliable and valid (Rosen, Porter, & Rogers, 2017). With our complete transcript data and placement testing results, we can examine variation in ISMM across feeder pathways and also determine which non-self-reported high school measures can be used in addition to or in lieu of placement tests.

These analyses can help to answer the question of why so many students who appear to be college-ready repeat courses like algebra when they enroll in a community college, and what can be done to alleviate this. Specifically, we offer a framework to estimate the extent and degree of ISMM, along with its equity implications. This framework can be used to explore misalignment issues for different populations of students (e.g., free/reduced lunch, minoritized students), different educational transitions (e.g., middle school to high school), and multiple subjects (e.g., English). It can also be applied to estimate the costs of short- (e.g., passing the next course) and long-term (e.g., attaining a degree or certificate) postsecondary outcomes. More broadly, the study sheds light on the previously neglected issue of high school and community college alignment, which we see as necessary for identifying and confronting the prevalent equity gaps inherent in college remediation. In the following sections we elaborate on the design of the framework, and we present the data, results, conclusions, and policy implications.

Defining College Readiness

The problem of standards misalignment between high schools and community colleges is ultimately a problem of differing conceptions of college readiness. Indeed, there is not a single widely accepted definition of college readiness given that states and local education organizations have the autonomy to define their own college readiness standards, and different

[1] See https://www.ed.gov/ESSA

[2] Currently, California has separate datasets housing information regarding the educational outcomes of students in the different sectors (e.g., California Community Colleges Management Information System Data Mart, California Department of Education). Lack of a common student identifier complicates collecting inter-sector data. Cal-PASS Plus has attempted to collect inter-sector transcript data but the dataset is limited given that not all schools and colleges participate (see: https://www.calpassplus.org).

instruments are used to assess college readiness (Porter & Polikoff, 2012). Definitions also span a wide spectrum, with some being more narrowly focused on academic skill thresholds and others more broadly inclusive of non-academic skills and behaviors, such as college knowledge (Conley, 2007; Tierney & Duncheon, 2015; Roderick, Nagaoka, & Coca, 2009). Additionally, even commonly-used and readily-accepted readiness indicators such as SAT/ACT scores and high school GPA are sensitive to students' racial/ethnic backgrounds and to selectivity of postsecondary institution attended (Klasik & Strayhorn, 2018).

For the purposes of this study, we identified key college readiness indicators used in California and available within students' high school transcripts. These are: high school GPA, completion of algebra 2 or a higher level of math, and grades in math courses; California Standards Test (CST) results in math; and results from the Early Assessment Project (EAP), a measure developed to assess readiness for the four-year CSU system. The EAP is a voluntary supplement to the CST math and English tests that was designed with the explicit goal of helping students avoid remediation in college. Students graduating from California high schools and achieving certain thresholds for each of the aforementioned indicators should be "college ready" and not referred to remedial math coursework in college.

A Framework for Estimating ISMM

We operate under the assumption that if high schools and community colleges had an overall aligned set of college readiness standards, community colleges would trust the information in high school transcripts and would place students in the next course of the math sequence. Accordingly, ISMM is defined as instances in which students who are college ready are placed in a developmental math course below algebra 2.

With this in mind, we introduce three different ways to estimate ISMM. First, we consider completion of high school math courses. If a student passed algebra 2 with a C or better in high school, the student should be placed in the next course in the math sequence in college (e.g., trigonometry or pre-calculus). Based on our conversations with community college math faculty, who considered this a low bar and expressed concerns about high school grade inflation, we also restrict the sample to students who received either an A or a B in algebra 2 in high school. Second, we try to further address the grade inflation and trust issue by using information from state standardized tests. Specifically, we identify remedial placement among students who were deemed proficient or advanced by the 11th grade CST math test. Third, we examine college math placement by 11th grade EAP results. Analyzing ISMM according to the EAP indicator is particularly relevant since students who pass the EAP can bypass remediation if they attend a CSU (Howell, Kurlaender, & Grodsky, 2010). We also consider last math course taken, since this may be the most straightforward alignment indicator, and overall GPA, since this is one of the proposed measures to be used under AB705.

Categorizing the Degree of ISMM

We wanted to offer a simple and straightforward way for researchers and educational leaders to categorize the degree of ISMM. In order to do this, we divide the ISMM estimate into quartiles. The lowest quartile corresponds to instances in which colleges placed 25 percent or fewer of the students in a course below algebra 2. We consider this to be *minor ISMM*. The following quartile ranging between 25 and 50 percent is considered *moderate ISMM*. *Substantial ISMM* is defined when the proportion of college ready students placed below algebra 2 is between 50 and 75 percent, and *severe ISMM* corresponds to proportions of misalignment above 75 percent.

Estimating the Equity Costs of ISMM

As mentioned above California's heavily decentralized governance structure enables colleges to design their own A&P policies and practices. We argue that this provides occasions for colleges to design practices that might unintentionally hamper the students that they are intending the serve. As a first approximation of a measure of the equity costs associated with ISMM, we present comparisons of the degree of ISMM by race and by college campus based on math course alignment and the two measures that math faculty might consider more "objective" – the 11th grade CST and EAP scores. The between-campus comparisons are relevant and a good proxy for potential equity costs given evidence of neighborhood racial and socioeconomic segregation (Owens, Reardon, & Jencks, 2016). It is also pertinent as college decisions tend to be local, and most students enroll in a college a few miles from where they live (Hillman, 2016; Turley, 2009).

Identifying the Transcript-Based Multiple Measures that Reduce Placement Error

In addition to examining ISMM and its equity costs, the rich transcript data allow us to consider which transcript-based measures might be most useful for improving course placement. California has already been a leader nationally in the use of multiple measures as a way to strengthen the A&P process (Rodriguez, Cuellar-Mejia, & Johnson, 2016). In fact, studies have documented that including multiple measures in the A&P process was beneficial in terms of increasing access to higher-level courses while not decreasing the likelihood of success in those courses (Author 2015; Author, 2018). However, these studies relied on self-reported data collected through the A&P process and not on transcript data.

We therefore capitalize on the rich data available and identify the combinations of measures most effective for reducing the severe error rate (SER) in placement, as proposed by Scott-Clayton et al. (2014). We also take advantage of the autonomy that LCCD colleges have over their A&P policies and practices. The variation in placement tests used means we are able to estimate *which types of test* (e.g., the commercially-developed ACCUPLACER or the MDTP diagnostic) *and which types of multiple measures* (e.g., grade in highest math, CST, EAP, and others) minimizes SER and maximizes the likelihood of succeeding in the assigned course.

To calculate the SER we estimate probit models of passing and failing a given course on a set of student-level predictors. The obtained coefficients are used to estimate the predicted probabilities of passing the course for those *below* the cutoff. Severe placement errors are those students who are predicted to pass college-level math but not placed there, or those predicted to fail the course but were placed there. The fact that we use official data instead of student self-reported data is critical to address the rooted mistrust issue that exists between the two sectors, as well as the fact that there is empirical evidence suggesting that students may not accurately report this information (Rosen et al., 2017).

One improvement over Scott-Clayton et al. (2014) is that we are able to include standardized test scores (CST) in the estimation and compare across more college readiness indicators from high school transcripts that might be useful for improving college math placement. We contribute further to the policy discussions by illustrating how error rates change under difference placement schemes (e.g., placement test only; placement test + high school transcripts; diagnostic + high school transcripts). The reality is that very few districts would have access to high school transcripts so we offer effective ways for districts to minimize error using the available information.

Data and Sample

The linked data come from a research partnership between LUSD and LCCD. It is composed of nine cohorts of students who graduated from LUSD between 2005-2014 and

enrolled in LCCD within three years. The dataset includes the demographic information, standardized testing results, and complete high school and community college transcripts of 85,213 students. As illustrated in Table 1, the full sample is composed of a racially diverse group of students with variation in college readiness. Importantly, we observe each student's community college math placement testing results and subsequent course placements in the math sequence (i.e., arithmetic, pre-algebra, algebra 1, algebra 2, and transfer-level math).

[Table 1]

Focal Sample: College Math Ready

The focal sample is composed of 33,246 LUSD graduates who enrolled in LCCD and had complete information on all key measures of interest. We restricted the sample to students who had GPA information and an 11th grade CST math result, took math in high school that was at the algebra 2 level or higher, and received a college math placement. Limiting the sample to algebra 2 students provides a way to focus on college math readiness, since admission to the California four-year colleges requires at least three years of math. Sample sizes for analyses of CST and EAP results are smaller since not all students took the CST, and EAP was voluntary.

Among these students who took algebra 2 or a higher-level math course in high school, 28% took trigonometry or pre-calculus, and 7% took calculus. In terms of the CST for math in 11th grade, it is noteworthy that despite the fact that all the students passed algebra 2 or higher, only 8% of the students received a proficient or advanced score in the 11th grade CST (See Table 1). The fact that such a low percentage of students who took algebra 2 received a score of proficient or above in the math CST exam provides some empirical grounding to partially justify the mistrust that community college math faculty expressed related to the knowledge and skills gained in the required math courses in high school.

The last proxy for college readiness standards relies on the recommendation that the students received on the voluntary EAP. The results show that 28% of the students in the sample who chose to answer these additional questions actually passed the test.

Finally, it is striking to see that even though the focal sample is restricted to individuals who took and passed algebra 2 or higher in college, more than 60 percent of the students were placed in a developmental math course *below* algebra 2 (see Table 1). Just 27% were placed in algebra 2, and only 10% in a transfer-level course. The fact that 90% of the students were asked to either repeat algebra 2 or repeat up to five high school level math courses at the community college is extremely problematic not only for moral but also for economic reasons. This also calls into attention the urgent need to create mechanisms for inter-sector math alignment and collaboration among leaders and instructors as a way to address the pervasive inequalities that result from the current system.

Results

Estimates of ISMM

In order to provide the first estimates of ISMM, we compare in Table 2 the proportion of students that according to multiple potential college math readiness indicators were placed in a course below algebra 2 (e.g., cumulative high school GPA, grade in 12th grade math, highest high school math course passed with a B or higher, last high school math course, 11th grade CST math score, and passed the EAP). It is worth noting that this measure is a lower-bound estimate of ISMM, since we consider it as alignment when students repeat a course that they already passed in high school (i.e., placement in algebra 2 in college is not considered "misalignment" for focal sample students who passed algebra 2 or higher in high school).

Looking at the math placement of focal students by high school GPA, we see that 22% of students with the highest cumulative GPA (>3.7) were placed in a course below algebra 2, as were 50% of students in the B range (2.7-3.7). This finding illustrates that students who managed to maintain the highest GPA and completed math requirements were not shielded from being asked to repeat algebra in college.

We also estimated ISMM based on level of highest math course taken in high school, math taken in 12th grade, and last math taken to provide insight into whether continuity of math course-taking could be a useful placement criterion. We found that 36% of students who took algebra 2 or higher in 12th grade (last math) and passed it with an A were placed below algebra 2. This trend is prevalent even for the students who took college-level courses in high school. For instance, 36% of the students who passed trigonometry or pre-calculus with a B or higher were placed in developmental math, as well as 40% of those who took statistics and 15% of those who took calculus.

Finally, focusing on what most educators would consider the most objective, reliable, and valid measure, the 11th grade CST scores (Larsen McClarty, Way, Porter, Beimers, & Miles, 2017), we found large degrees of ISMM. The results show that 15% of the students who scored at a proficient level and 7% who scored advanced were placed in developmental math. Further, 25% of the students who completed the supplemental section of the CST and were deemed college-ready for the CSU system were placed in developmental math at a community college. Had these students chosen to attend a CSU instead of a community college, they would have been exempt from developmental education courses altogether.

[Table 2]

The Degree of ISMM

The estimates reported above provided a clear indication that ISMM is a prevalent issue between these two urban districts. In order to estimate the magnitude of the problem, we first calculated the percentage of students who according to the indicators reported above were placed in developmental math. We use four categories to identify whether the misalignment can be considered *minor* (<25%), *moderate* (25-50%), *substantial* (50-75%) and *severe* (>75%).

The results in the right-hand columns of Table 2 illustrate that based on the following three high school transcript measures: cumulative high school GPA, grade in 12th grade math, and highest math passed with B or higher, the extent of the problem can be considered *moderate*. However, if the measure used is the last high school math course, ISMM becomes a *substantial* issue. Nearly three-quarters of the students who took an algebra 2 course in high school with a B or better were placed in a developmental math course. If the focus is on the 11th grade CST math test, the misalignment issue can be described as *minor*, given that "only" 15 and 7 percent of the students who scored proficient or advanced were placed in developmental math. Finally, ISMM is categorized as *moderate* when using the results from the EAP test.

Taken together, these results confirm that the A&P policies and practices that were used during this time were problematic given that they mostly relied on commercially-developed tests like ACCUPLACER, and in few instances gave additional multiple points for student's self-reported high school transcript data (Author 2014; Author 2015). At the same time, this finding suggests the need for using the actual high school transcript information given that students, in particular minoritized and female students, tend to under-report and self-place in a course below the one they successfully passed (Author, 2016; Rosen et al., 2017). This confirms the need to use multiple measures but not necessarily the self-reported college readiness measures currently

being used. The findings suggest that in order for the mandate of AB 705 to be effective, districts need cross-sector collaboration to share transcripts and agree on college-readiness measures.

The Equity Cost of ISMM

In the previous sections we provided not only *a measure,* but also examined *the degree* of the ISMM problem. We now proceed to provide an estimate of the equity cost of ISMM by exploring whether the magnitude of the problem is greater in colleges that serve more racially minoritized students.

We calculated and compared the degree of ISMM across racial groups and across the nine district colleges for highest high school math (B or better) and the two test-based measures (i.e., CST and EAP) since these latter two measures are standardized across the district. Table 3 shows that Black students and Latino students consistently experienced the highest rates of ISMM. For example, 77% of Black students and 64% of Latino students experienced math course ISMM, and 28% of those passing the EAP in each group were placed in developmental math, compared to 15% of white and Asian students. Again, these students may have avoided remediation had they matriculated directly to a CSU.

[Table 3]

Given the reality of racial segregation and growing income segregation (Owens, Reardon, & Jencks, 2016), and the fact that college choices are geographically situated (Hillman, 2016; Turley, 2009), we suspect that these inequities are related to community college feeder pathways. Examining ISMM by campus, shown in Table 4, it is apparent that some colleges consistently had *severe* or *substantial* ISMM. Whereas the majority of the colleges had *minor* ISMM with respect to CST scores and EAP results, College C, had 82% of its proficient and advanced math students placed in algebra 1 or below in college. Further, 98% of those who passed the EAP requirements were placed in developmental math. Notably, the four colleges that had *severe* ISMM in math courses each had large Black and Latino student populations.

The findings provide strong evidence of the fact that ISMM is more prevalent in colleges that serve larger Black and Latino student populations. The lack of alignment ended up serving either directly or indirectly as a mechanism to discard the knowledge and skills accumulated in high school and served to track students into the developmental math sequence in college. This result provides additional evidence to further support the need to create the conditions for urban districts to collaborate and design an authentic high school transcript based multiple measure A&P system. In the last part of the paper, we offer a more prospective view with a set of actionable measures to support districts as they move towards collaborating and creating authentic and equitable systems of A&P in math.

[Table 4]

Identifying the Multiple Measures that Reduce Placement Error

Using these high school measures of college math readiness to improve A&P may only be politically feasible and practically relevant if they are predictive of success in college. We therefore capitalize on the linked transcript data to explore which combination of multiple measures can be used to improve A&P and address the problem of current inter-sector math misalignment. Specifically, we describe how using different combinations of tests (e.g., commercially-developed or diagnostic) and high school transcript measures can minimize the severe error rate (SER) in placement and maximize the likelihood of succeeding in a math course, following the work of Scott-Clayton et al. (2014). We focus on the cutoff between elementary and intermediate algebra (Algebra 1/Algebra 2) given the above ISMM analyses.

We present in Table 5 SER estimates and predicted passing rates (C or higher) for the following placement criteria available in the high school transcript data: placement test alone; high school GPA; 11th grade CST in math; highest high school math course; highest math course passed with a B or higher; last math course passed; results on the math portion of the California High School Exit Exam (CAHSEE); all high school indicators; all high school indicators plus the score on the ACCUPLACER; using a high school index; and using a high school index with the placement test score.

[Table 5]

Looking at the SER calculations for the colleges that used the ACCUPLACER, we find that one-fifth of students at the Alg1/Alg2 cutoff were placed in error. Like Scott-Clayton et al. (2014) study, we found that using high school GPA instead of placement test results would result in roughly similar error rates. Using the highest math taken in high school (passed with B or better) would significantly reduce the SER. Combinations of measures may be the most beneficial; we found the most promising relies on using an index of high school measures plus the results of the placement tests. This combination resulted in a reduction of SER at the Alg1/Alg2 cutoff, as well as for other courses in the developmental math sequence.[3]

In contrast, just 11% of students in the college using the MDTP diagnostic were placed in error. Interestingly, the use of the high school index did not reduce the SER in the diagnostic testing context, suggesting that the use of high school transcript indicators might not improve placement accuracy much relative to diagnostic data. This is an important finding that suggests that math faculty in multiple sectors could collaborate to create and validate a diagnostic test should they not have access to high school transcripts.

Discussion & Conclusion

A shift away from college placement testing and towards multiple measures is underway, with more than 50 percent of community colleges now reporting using multiple indicators in addition to or in place of placement test scores (Rutschow & Hayes, 2018). However, data linkages between high schools and community colleges are rare, and which measures to use and to which lengths they should be used remain unclear.

In this paper we provided a simple heuristic to guide these efforts and to frame equity considerations related to standards misalignment within high-school-to-community-college feeder pathways. First, we found that inter-sector math misalignment was evident with respect to high school grades, math course-taking, and standardized test results, with significant proportions of students meeting these standards finding themselves placed in developmental math education upon enrolling in local community colleges. Even high-achieving students who may have been considered college-ready by their high schools were expected to start college in developmental math courses following placement testing.

Second, we demonstrated that ISMM was most severe in colleges serving larger proportions of minoritized students within the district. Since ISMM varied dramatically across high school and community college feeder patterns, this analysis illuminates one unique aspect of the geography of college opportunity: *opportunity is shaped by inter-sector agreements and understandings of college readiness*. Improving the data infrastructure between the K12 and higher education sectors might be a necessary but not sufficient condition to lessen this inequality of postsecondary opportunity (Kirst & Venezia, 2004; Venezia & Jaeger, 2013).

Third, through the complementary SER analyses, we provided evidence that efficient multiple measures consist of either combining the results of a commercially-developed test with

[3] Results available upon request.

high school measures or using a diagnostic test such as the MDTP. Taken together, the findings suggest a shift towards transcript-based high school indicators may improve placement while at the same time reduce equity gaps that stem from college-readiness standards misalignment. Although California is moving towards this with the implementation of AB705, the geography of college opportunity across the nation is currently threatened by the lack of trust and data sharing agreements between high schools and community colleges. There is a need for bold measures to create the conditions for faculty and district leaders from across sectors to engage in a truthful collaboration that could eradicate the equity costs associated with the current high levels of inter-sector misalignment.

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Table 1. Description of sample in high-school-to-community college linked dataset

	Total Sample		Focal Sample	
	Mean	**SD**	**Mean**	**SD**
Female	0.52	0.50	0.53	0.50
Asian	0.04	0.20	0.05	0.23
Black	0.11	0.31	0.09	0.28
Hispanic	0.70	0.46	0.71	0.45
White	0.12	0.32	0.11	0.32
Other	0.03	0.17	0.04	0.19
Free/Reduced Lunch	0.88	0.32	0.90	0.30
Cumulative HS GPA				
D to D- (0.7-1.7)	0.07	0.25	0.02	0.14
C to C-(1.7-2.7)	0.60	0.49	0.52	0.50
B to B- (2.7-3.7)	0.32	0.47	0.44	0.50
A to A- (>3.7)	0.01	0.11	0.02	0.14
Highest HS Math				
Basic Math/Pre-Algebra	0.00	0.00		
Algebra 1	0.08	0.27		
Geometry	0.28	0.45		
Algebra 2	0.42	0.49	0.60	0.49
Pre-calculus/Trigonometry	0.16	0.37	0.28	0.45
Statistics	0.02	0.15	0.04	0.20
Calculus	0.04	0.19	0.07	0.26
11th Grade Math CST				
Far Below Basic	0.33	0.47	0.33	0.47
Below Basic	0.42	0.49	0.40	0.49
Basic	0.18	0.38	0.19	0.39
Proficient	0.06	0.24	0.07	0.26
Advanced	0.01	0.10	0.01	0.11
Passed EAP Math	0.26	0.44	0.28	0.45
College Math Placement				
Basic Math	0.01	0.11	0.01	0.07
Arithmetic	0.22	0.41	0.15	0.35
Pre-Algebra	0.26	0.44	0.21	0.41
Algebra 1	0.26	0.44	0.26	0.44
Algebra 2	0.19	0.39	0.27	0.45
Transfer Level	0.06	0.24	0.10	0.30
N	85123		33246	

Notes: The focal sample only includes students who have a cumulative GPA and an 11th grade CST result, whose highest math was algebra 2 or higher, and who received a college math placement. The reason for this restriction is to more closely examine how these students who presumably should be placed in Algebra 2 or higher in college were actually placed.

Table 2. College math placement by college-readiness indicator (%)

	College Math Placement						Inter-Sector Math Misalignment	
	Basic Math	Arithmetic	Pre-Algebra	Algebra 1	Algebra 2	Transfer-Level	% Placed in Dev. Math	ISMM: Minor (<25%) Moderate (25-50%) Substantial (50-75%) Severe (>75%)
Cumulative HS GPA								
2.7-3.7	0	9	17	24	33	17	50	Substantial
> 3.7	0	3	9	11	32	46	22	Minor
Total	0	9	16	23	33	18	49	Moderate
Grade in 12th Grade Math								
A or B	0	10	15	19	31	25	44	Moderate
A	0	6	13	17	30	33	37	Moderate
Highest HS Math (>B)								
Algebra 2	0	11	19	25	35	10	55	Substantial
Trig/Pre-Calculus	0	5	13	17	36	28	36	Moderate
Statistics	0	7	14	18	36	24	40	Moderate
Calculus	0	1	5	9	26	59	15	Minor
Total	0	9	16	22	35	19	46	Moderate
Last HS Math Course								
Algebra 2	1	18	24	30	24	3	73	Severe
Trig/Pre-Calculus	0	8	17	23	35	17	48	Moderate
Statistics	0	8	14	20	36	22	42	Moderate
Calculus	0	2	8	10	31	48	21	Minor
Total	1	14	20	26	28	11	60	Substantial
11th Grade CST Math								
Proficient		1	6	7	37	48	15	Minor
Advanced		1	3	3	22	71	7	Minor
Passed EAP Math								
Ready for CSU	0	2	11	11	41	34	25	Moderate

Note: Sample only includes students who have a cumulative GPA and an 11th grade CST result, whose highest math was algebra 2 or higher, and who received a college math placement.

Table 3. College math placement by college-readiness indicators, disaggregated by race (%)

	College Math Placement						Inter-Sector Math Misalignment	
	Basic Math	Arithmetic	Pre-Algebra	Elem. Algebra	Algebra 2	Transfer-Level	% Placed in Dev. Math	ISMM: Minor (<25%) Moderate (25-50%) Substantial (50-75%) Severe (>75%)
Highest HS Math (>B)								
Asian	0	4	8	14	34	40	26	Moderate
Black	2	28	24	23	19	4	77	Severe
Hispanic	0	14	23	26	28	9	64	Substantial
White	0	5	6	18	37	34	29	Moderate
Other	0	11	14	15	38	22	40	Moderate
Total	0	14	20	24	29	14	57	Substantial
11th Grade CST Math: Proficient or Advanced								
Asian		0	2	4	24	70	6	Minor
Black		4	11	7	40	38	22	Minor
Hispanic		2	9	9	40	40	19	Minor
White		0	2	5	29	64	7	Minor
Other		1	8	3	33	56	11	Minor
Total		1	6	7	35	51	14	Minor
Passed EAP Math								
Asian		1	8	6	32	53	15	Minor
Black		4	18	6	48	24	28	Moderate
Hispanic		3	12	14	44	27	28	Moderate
White		1	5	9	37	49	15	Minor
Other		2	23	5	33	37	29	Moderate
Total		2	11	11	41	34	25	Moderate

Note: Sample only includes students who have a cumulative GPA and an 11th grade CST result, whose highest math was algebra 2 or higher, and who received a college math placement.

Table 4. College math placement by college-readiness indicator, disaggregated by campus (%)

Campus	Campus Profile		Highest HS Math (>B)						11th Grade CST Math: Proficient or Advanced						Passed EAP Math					
	N	Race	College Math Placement					ISMM	College Math Placement					ISMM	College Math Placement					ISMM
			Arith-metic	Pre-Alg.	Alg. 1	Alg. 2	Transfer-Level	% in Dev. Math/ ISMM	Arith-metic	Pre-Alg.	Alg. 1	Alg. 2	Transfer-Level	% in Dev. Math/ ISMM	Arith-metic	Pre-Alg.	Alg. 1	Alg. 2	Transfer-Level	% in Dev. Math/ ISMM
A	3,702	Asian 9% Black: 5% Latino: 72% White: 9%	17	18	29	31	6	63 Substantial	1	1	7	51	39	9 Minor	2	2	13	6\3	20	17 Minor
B	6,152	Asian 2% Black: 1% Latino: 97% White: 0%	15	34	25	23	4	73 Substantial	2	8	14	47	30	23 Minor	1	8	21	52	18	30 Moderate
C	2,411	Asian 4% Black: 11% Latino: 67% White: 7%	37	43	8	11	0	88 Severe	8	69	4	17	1	82 Severe	15	81	2	2	0	98 Severe
D	3,010	Asian 2% Black: 2% Latino: 92% White: 3%	2	33	25	27	12	61 Substantial	0	6	8	34	52	14 Minor	0	9	10	37	44	19 Minor
E	7,581	Asian 11% Black: 4% Latino: 56% White: 24%	1	7	21	36	34	29 Moderate	0	1	5	24	70	6 Minor	0	1	7	29	62	8 Minor
F	1,041	Asian 0% Black: 70% Latino: 30% White: 9%	34	26	20	19	1	79 Severe	0	7	7	79	7	14 Minor	0	23	5	68	5	27 Moderate
G	1,858	Asian 2% Black: 17% Latino: 80% White: 1%	31	20	28	11	1	80 Severe	2	15	20	43	20	37 Moderate	7	15	28	42	8	50 Substantial
H	5,169	Asian 5% Black: 4% Latino: 66% White: 22%	14	2	26	44	15	41 Moderate	1	1	6	54	38	8 Minor	1	1	12	68	18	14 Minor
I	1,487	Asian 1% Black: 41% Latino: 54% White: 2%	16	27	34	16	7	77 Severe	4	0	15	26	55	19 Minor	2	0	25	38	35	27 Moderate

Note: Sample only includes students who have a cumulative GPA and an 11th grade CST result, whose highest math was algebra 2 or higher, and who received a college math placement.

Table 5. Estimated severe error rate under various alternative placement schemes at Algebra 1/Algebra 2 cutoff

Placement Schemes	Colleges Using ACCUPLACER		Colleges Using MDTP Diagnostic	
	Severe Error Rate	Success Rate (>C)	Severe Error Rate	Success Rate (>C)
Placement Tests Alone	0.20	0.45	0.11	0.53
High School GPA	0.20	0.45	0.14	0.40
CST Math (11th grade)	0.21	0.43	0.18	0.33
Highest HS Math	0.20	0.44	0.13	0.44
Highest HS Math (>B)	0.16	0.53	0.11	0.46
Last Math	0.19	0.45	0.12	0.45
Math CAHSEE	0.20	0.43	0.15	0.40
All HS Measures	0.16	0.49	0.11	0.48
All HS + Placement Test	0.18	0.47	0.11	0.53
HS Index	0.14	0.52	0.11	0.46
HS Index + Test	0.15	0.51	0.10	0.50

Note: The severe error rote (SER) is estimated using probit models for each of the indicated placement schemes that predict the likelihood of success and failure in the upper course. The SER is the sum of under-placements (students who could pass higher-level course but were placed in the lower-level course, and over-placements (students placed in the upper-level course but placed there). The success rate is the percentage of students who could pass the course with a C or better, holding the remediation rate constant.