PACE

POLICY BRIEF

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Mathematics from High School to Community College:

Using Existing Tools to Increase College-Readiness Now

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Policy Brief 14-1

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Introduction

High school graduation, a longtime yardstick of success for students and schools alike, has been eclipsed. In response to the economic demands and opportunities of the 21st century, the new goal for P-12 education is to graduate students who are college- and career-ready in order to meet state and national goals of increased college completion rates. Successfully meeting these goals will require aligning California's P-12 standards, curriculum, instruction, assessments, and structures to pave the way to college preparedness. The state is tackling a large part of this alignment by allocating $1.25 billion in 2013-14 to support implementation of the Common Core State Standards (CCSS). Both the CCSS and the associated Smarter Balanced Assessment Consortium (SBAC) assessments are intended to align with college-readiness (Kirst, 2013).

Fundamental as the CCSS and SBAC assessments are as reforms, they exist within a larger educational system and current school structures that also affect student preparedness. For example, implementation of the CCSS and SBAC assessments does not change high school graduation requirements. To be eligible to graduate, students must meet three requirements in mathematics: 1) pass the California High School Exit Exam (CAHSEE) in mathematics, which measures a student's competency at the middle school level; 2) take two years of mathematics in high school; and 3) pass Algebra 1. Low high school graduation requirements mislead students into believing they are ready for college when they

Executive Summary

The adoption and implementation of the Common Core State Standards and Smarter Balanced assessments in mathematics are intended to provide all students in California with the knowledge and skills required to transition from high school to college-level coursework. This implementation will take time. Concurrent with these efforts, policymakers and educators can begin to increase college-readiness now, especially for community college-bound students, by using two existing tools – the California High School Exit Exam in mathematics and the Academic Performance Index – to identify 10th-graders who need remediation and to reward high schools for encouraging all students to enroll in appropriate Grade 12 mathematics. This policy brief explains the benefits of these straightforward policy changes.

are not (Kirst & Bracco, 2004; Venezia & Kirst, 2005).

Nor will the CCSS and SBAC implementation explicitly address structural gaps between high school and college. For example, CCSS and SBAC assessments will not require high school seniors to take mathematics. Two-thirds of California's college-going students begin at a community college (Foundation for California Community Colleges, 2013), where they are assessed by a high-stakes mathematics placement examination (Burdman, 2012; Hughes & Scott-Clayton, 2011; Venezia, Bracco, & Nodine, 2010). This missed opportunity to use senior year to advance more students toward college-readiness in mathematics is an example of a structural misalignment between the P-12 and community college systems that is not addressed by the CCSS or by the SBAC assessments.

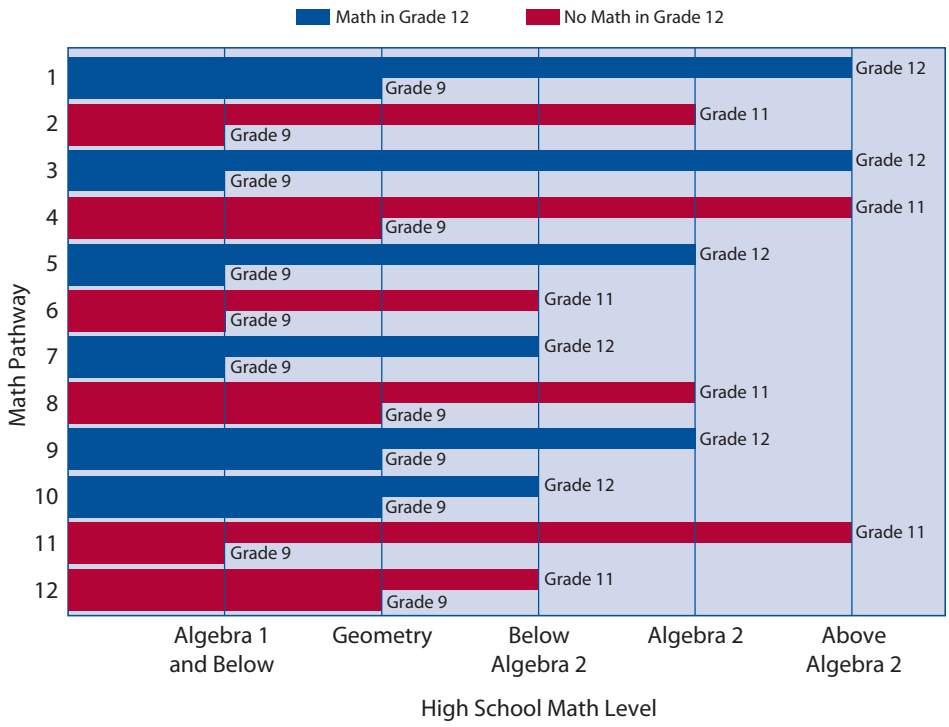
Concurrent with implementing CCSS and SBAC assessments, California is revising the Academic Performance Index (API), the state's system for evaluating school quality. Along with CCSS and SBAC, the API is a tool that can be used to increase college-readiness. This brief proposes additions to the API to encourage specific school and student behaviors that could increase college-readiness in mathematics. These API recommendations can be adopted now, and will remain relevant during and after implementation of the CCSS and SBAC assessments.

One Size Does Not Fit All

There are many mathematics pathways to high school graduation. Finkelstein, Fong, Tiffany-Morales, Shields, and Huang (2012) analyzed the mathematics and science course-taking patterns of more than 24,000 students from 24 different California school districts and documented 2000 course-taking patterns. Fewer than one-third of the students in their sample followed paths in the top 20 most common patterns.

Using similar methodology in a local context, I observed the middle and high school histories of 2,920 ethnically and economically diverse students from a single high school, and followed 953 of them to community college. (See Appendix A for demographic overview.) The research reported here (Jaffe, 2012) compares the high school mathematics histories of all 12th-grade students with the histories of the subset who went on to attend community college as freshmen. In the study sample, high school course-taking patterns were broadly grouped into 12 mathematics pathways, defined by three markers: *Where Students Start* (Grade 9 Math Course); *When Students Stop* (Math in Grade 12); and *Where Students Stop* (Highest-Level Math). I used Algebra 2 as the reference for highest-level mathematics because of findings that it is a "tipping point," in that every course beyond Algebra 2 doubles the odds of completing college (Adelman, 2006). Figure 1 presents the 12 high school mathematics pathways traveled by all students and the subset of community college-bound students in my research.

FIGURE 1. High School Mathematics Pathways



Students in each of these 12 pathways completed the Algebra 1 high school graduation requirement. When it came to preparing students for post-secondary education, however, all mathematics pathways were not equal. In both the Finkelstein et al. (2012) study and in mine, the largest group of students followed a similar accelerated course-taking pattern for all four years of high school, beginning with Geometry in Grade 9 and graduating with coursework beyond Algebra 2 (Figure 1, Path 1). This pathway is the preferred "one size" that is most likely to prepare students for college-level math courses. Finkelstein et al. (2012) found that the greatest participation in a single course-taking pattern was for students who took Geometry in Grade 9, enrolled in mathematics for all four years of high school, and finished with Calculus, two courses beyond Algebra 2. But only 3.3 percent of students exhibited this pattern. Similarly, in my sample, more than one-third of all students took an accelerated pathway that began with Geometry, included four years of high school mathematics, and progressed beyond Algebra 2. (See Figures 1 and 2, Path 1.) Nevertheless, most students, and more than 80 percent of the community college-bound students, did not take this pathway. This "size" did not fit them.

In my study, the high school mathematics path most frequently traveled by the community college-bound students was notably less rigorous. Almost 20 percent started in Algebra 1 or below, stopped before senior year, and finished with no high school mathematics beyond Algebra 2. (See Figures 1 and 2, Path 2.) Smaller percentages of students followed the other pathways. (See Figure 2.) I then explored how students who followed these different high school mathematics pathways fared when they entered community college as freshmen and were assessed for college-readiness.

What Predicts College-Readiness in Mathematics?

To identify factors that increase college-readiness in mathematics for community college freshmen, I tested demographic and academic high school variables in a multinomial logistic regression, using ACT COMPASS[1] assessment levels as the outcome variable.[2] Table 1 presents the five levels of assessed placement in community college mathematics. (See Appendix B for cut scores.)

FIGURE 2. Comparison of Participation in Different High School Math Pathways

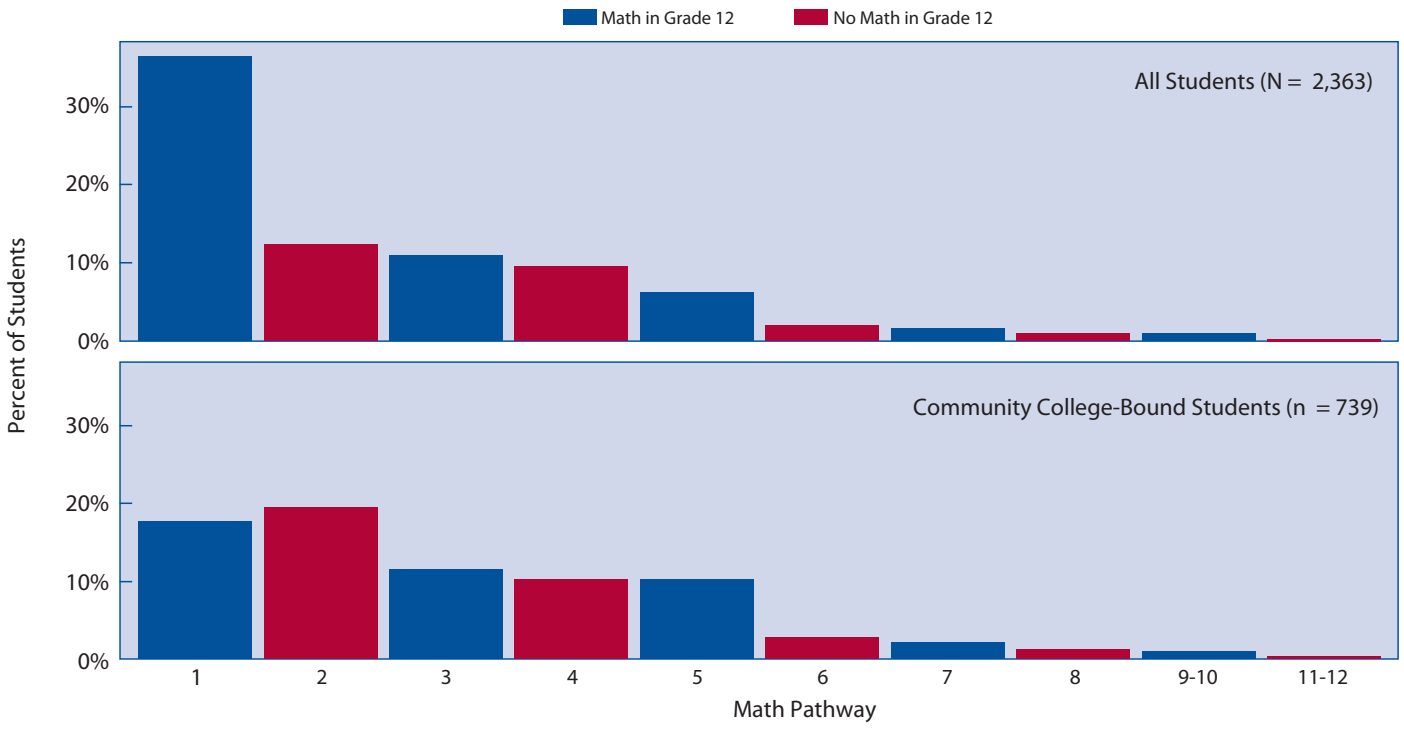


TABLE 1. Five Levels of Placement in Community College Mathematics Based on the ACT COMPASS Examination

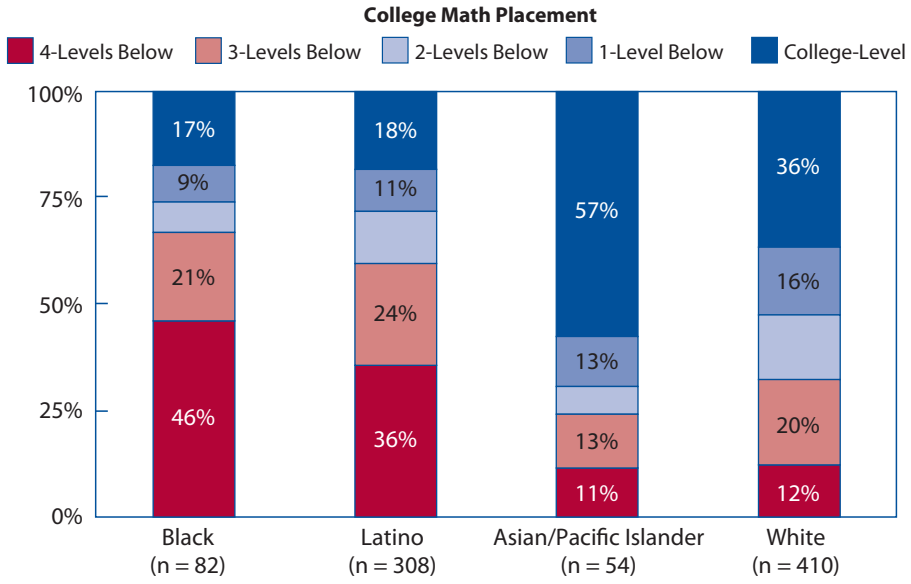
Assessment:	Placement
College-Level:	College-Level
1-Level Below:	Intermediate Algebra
2-Levels Below:	Algebra 1
3-Levels Below:	Pre-Algebra
4-Levels Below:	Basic Arithmetic

The analysis included tests of 11 independent variables for their effect on preparing students for college-level mathematics. My three high school mathematics pathway markers -- Grade 9 Math Course, not taking mathematics in Grade 12, and Highest-Level Mathematics -- were tested, along with math course GPA in Grades 9, 10, and 11, and 10th-grade CAHSEE Math scores. Gender, ethnicity, parent education, and lower socio-economic status[3] were also included as variables in the multinomial logistic regression. Table 2 presents the variables that were significant predictors of placement in below college-level mathematics. (See Appendix C for full summary table.)

TABLE 2. Significant Predictors of Placement in Levels Below College-Level Mathematics

Variables Tested	Levels below-college-level mathematics			
	-1	-2	-3	-4
Gender				
Race/Ethnicity				
Parent Education				
Low SES				
Grade 9 Math	✓	✓	✓	✓
Grade 12 - No Math		✓	✓	✓
Highest-Level Math				
Grade 9 Math GPA				✓
Grade 10 Math GPA				✓
Grade 11 Math GPA		✓	✓	
CAHSEE Math	✓	✓	✓	✓

FIGURE 3. Community College Mathematics Placement Assessment by Ethnicity



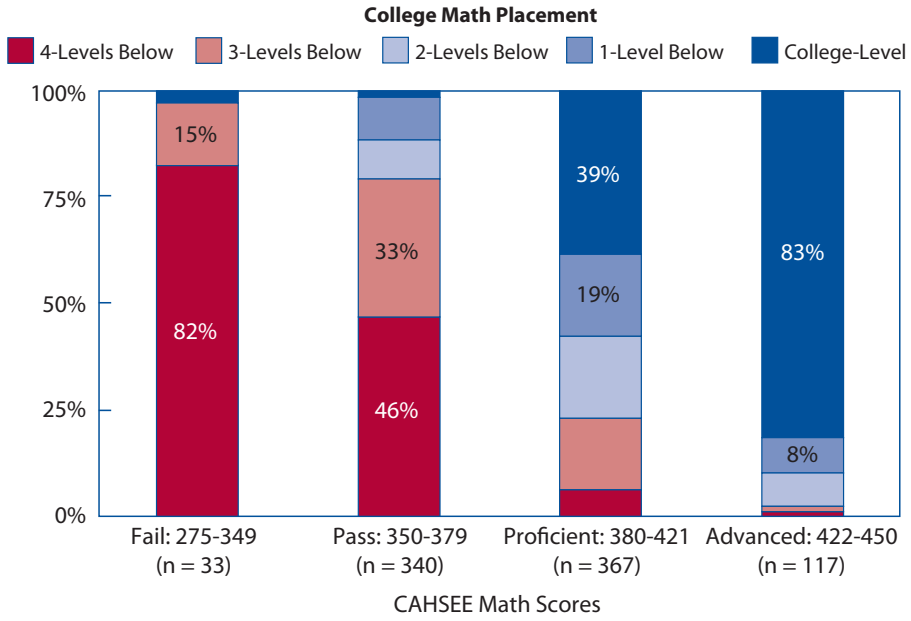
This brief concentrates on two of the most useful findings. First, CAHSEE Math performance was a significant predictor of placement at all four levels below college-level mathematics. Second, not taking mathematics in Grade 12 was a significant predictor for students placing 2-, 3-, and 4-levels below college-level mathematics. These findings point to steps educators and policymakers can take immediately that would increase the number of California students who are ready for college-level mathematics.

Findings and Recommendations for Educators and Policymakers

In my sample of community college freshmen, 29 percent assessed as college-ready.[4] Of the more than two-thirds who were underprepared, 45 percent placed 3- or 4- levels below college-level mathematics. Four out of five black and Latino students were underprepared, with most severely unprepared. Sixty-seven percent of black students placed 3- or 4-levels below college-level mathematics, as did 60 percent of Latino students. (See Figure 3.)

This research suggests that state policies and school practices already in place can be modified to benefit students of color and community college-bound students who might otherwise be underprepared for college. Because one size does not fit all and different students have different needs, a bundle of incentives is likely to work best.

FIGURE 4. Community College Assessed Math Placement Level by CAHSEE Math



Finding 1: The CAHSEE Math scale scores were significant predictors of placement at all levels of below-college-level mathematics.[5] To better understand the implications of this finding, CAHSEE Math performance levels[6] were cross-tabulated with community college placement results. For high school students, a passing score on the CAHSEE Math (in the 350-379 range)[7] is a powerful leading indicator of being unprepared for college. Fewer than 3 percent of students who passed the CAHSEE but scored below Proficient placed into college-level mathematics. Almost four out of five (78.5 percent) of these students were assessed by the community college as needing remedial coursework in pre-algebra or basic arithmetic. Figure 4 illustrates that mastery of the basic mathematics that CAHSEE measures has a profound impact on whether or not students are assessed as ready for college-level work when they enter community college.

The success of the CAHSEE Math[8] assessment in predicting unpreparedness for college-level coursework means that California already has in place a statewide high school assessment that could be used to identify students who have not mastered foundational mathematics before they apply to college. Effective interventions could then help high school students identified as deficient by the CAHSEE gain skills and increase their preparedness. For example, high school remediation that enables students to place 1- or 2-levels below college-level mathematics, rather than 3- or 4-levels below, would improve these students' prospects of success and decrease the time they need to complete college. On the higher end of the CAHSEE continuum, strengthening the mathematics skills of students who score Proficient would also increase college-readiness. More than twice as many students (83 percent) with CAHSEE Math scores of Advanced placed into college-level mathematics as students (39 percent) who scored Proficient. (See Figure 4.)

Recommendation 1: Leverage the CAHSEE Math to improve foundational math skills in high school.

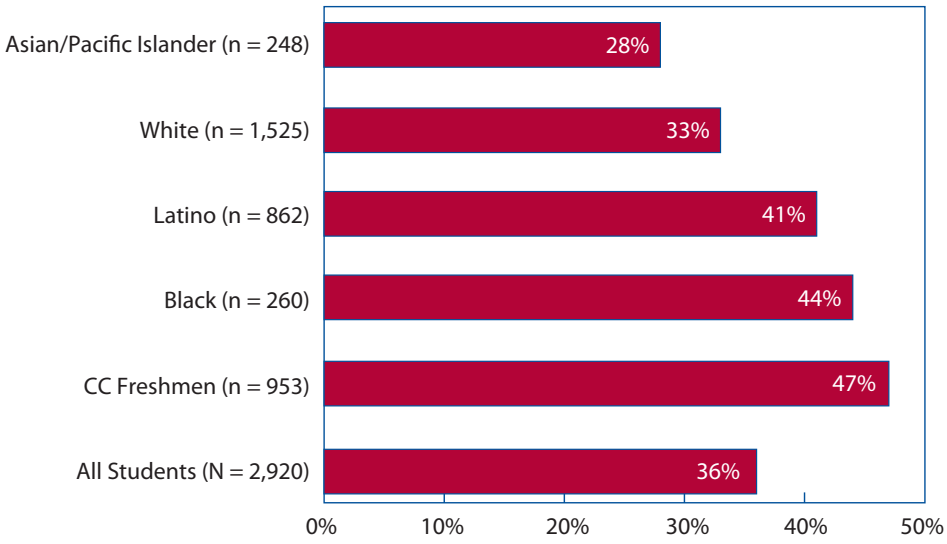
The danger in raising the standards for high school graduation is that too many students will be left behind. It is therefore prudent to smooth the transition to college-ready standards by promoting college-aligned objectives while still maintaining a pragmatic floor. My results show that the CAHSEE Pass score is unacceptably low for college-readiness. Students must score at Proficient or Advanced levels on the CAHSEE Math to place into college-level mathematics in community college. Currently, however, the API takes into consideration only the percentage of students who pass the test. Revising the API to reward high schools for increasing performance on the CAHSEE from Pass to Proficient (or, better yet, to Advanced) would communicate to high schools that they have some responsibility for ensuring students have these skills before they graduate. This policy lever could shift practice, triggering and accelerating the remediation process for students while they are still in high school.

Finding 2: Not taking mathematics in Grade 12 was a significant predictor for students placing 2-, 3-, or 4-levels below college-level mathematics. This

effect is large. All other factors being equal, students who took no mathematics in Grade 12 were 58 percent more likely to place 2-levels below than into college-level mathematics. (See Appendix C for analysis.) Fifty-five percent of students who placed 2-, 3-, or 4-levels below college-level took no mathematics in Grade 12. More than one-third of all students, and more than 40 percent of black and Latino students took no mathematics in Grade 12.[9] (See Figure 5.)

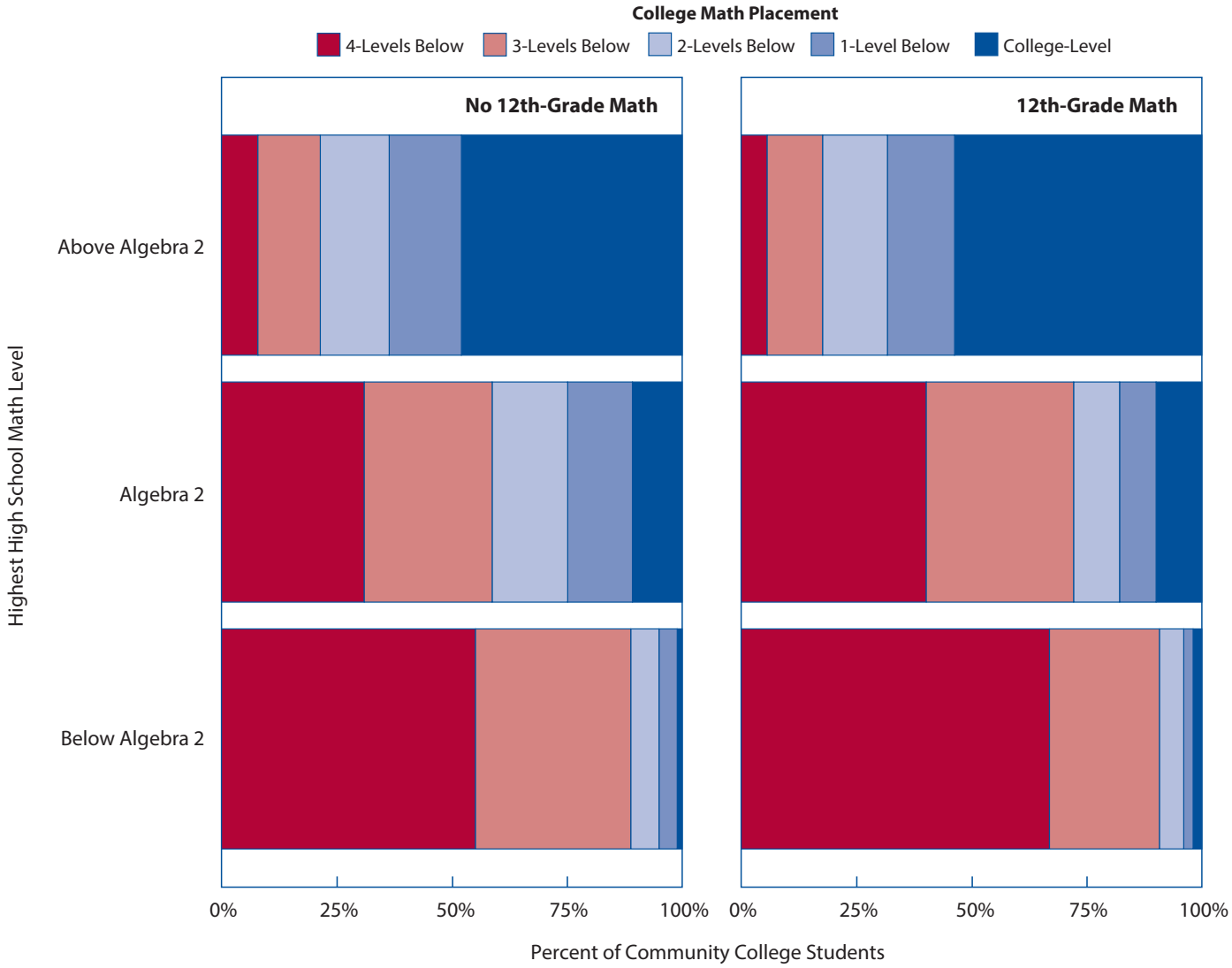
Almost half of community college-bound students took no mathematics in their senior year of high school. (See Figure 5.) This behavior -- what students *do* -- is consistent with research documenting what students *say*: they were unaware of the community college placement process and standards, and therefore did not use their high school years to prepare (Hughes & Scott-Clayton, 2011; Kirst & Bracco, 2004; Venezia et al., 2010; Venezia & Kirst, 2005). This failure to prepare for community college has different consequences for different students.

FIGURE 5. Who took No Math in Grade 12 by Student Group



No math in Grade 12 impacts highest-level math. In my study, 15 percent of all students and 23 percent of the community college-bound subset took Algebra 2 in the 11th grade and then took no mathematics in their senior year. These students had academic momentum in Grade 11, and were in a high school that offered higher-level mathematics courses, but they opted out of taking a mathematics course in Grade 12. Although highest-level mathematics was not a significant predictor in the regression model,[10] Adelman (2006) has documented the importance of advancing beyond Algebra 2. Consistent with his findings, only 11 percent of students in my sample who took Algebra 2 as their highest-level high school mathematics course placed into college-level mathematics. Students who took above-Algebra 2 coursework in Grade 12 fared much better, with 54 percent assessing into college-level mathematics. (See Figure 6 on the next page.)

FIGURE 6. Highest-Level High School Math and Community College Placement



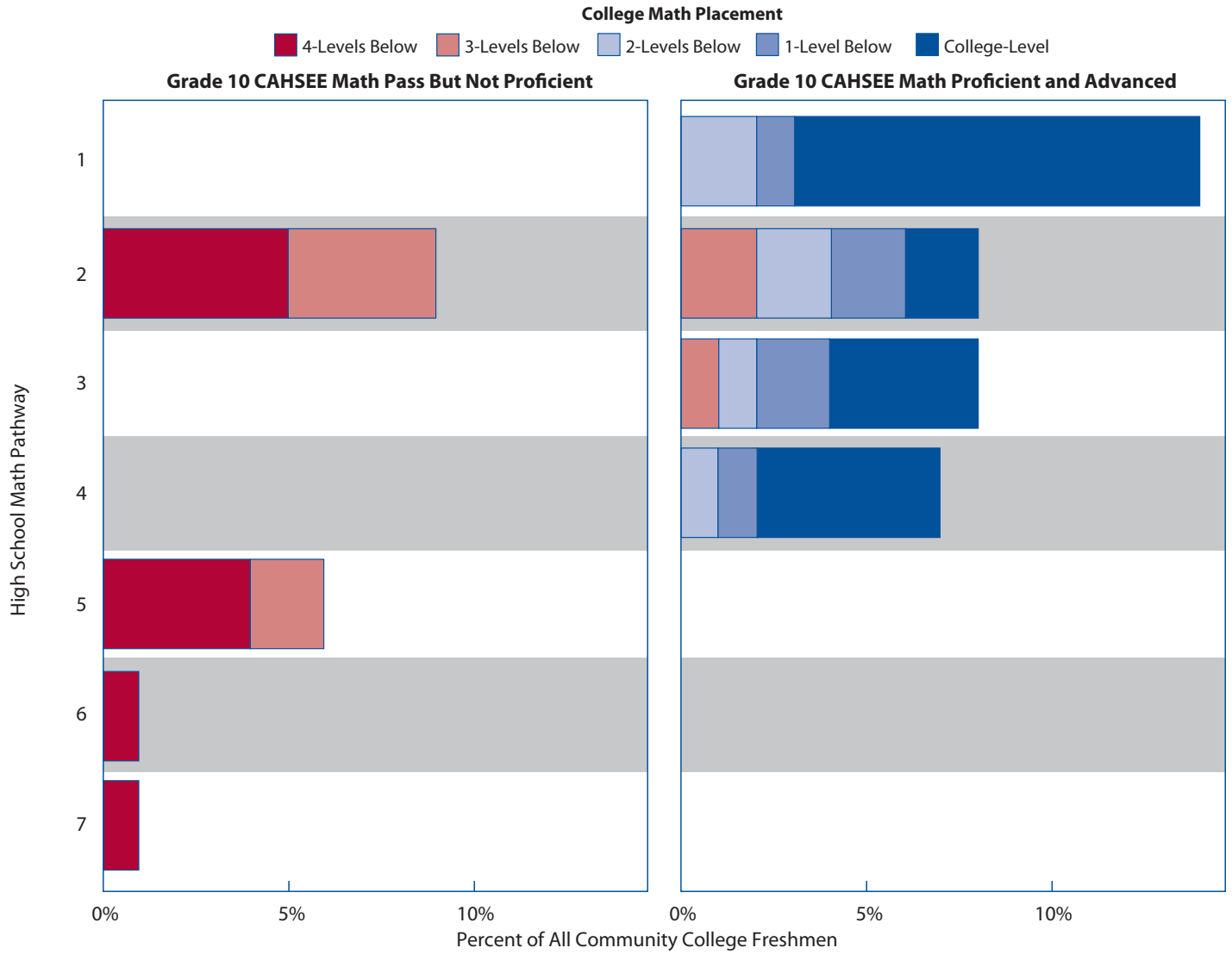
Different high school mathematics pathways and CAHSEE scores lead to different college placement outcomes. Figure 7 (next page), Paths 2, 4, and 6 map the 10 patterns most frequently followed from high school to community college for students who took no mathematics in Grade 12. Students who followed the same high school mathematics pathways had different placement results. For example, Path 2 (Algebra 1 or below in Grade 9, no mathematics in Grade 12, and no math beyond Algebra 2), was the most frequently traveled high school pathway for community college-bound students. Students who followed Path 2 assessed at all 5 placement levels, but they accounted for only 2 percent of community college freshmen who placed into college-level mathematics.

The diverse patterns of progress mapped in Figure 7, Paths 2, 4, and 6 suggest that four groups of students took no mathematics in Grade 12:

1. Students in Path 2 and Path 4 who *did not need 12th-grade mathematics* to place into college-level mathematics;

2. Students in Path 4 who were proficient on the CAHSEE Math and had advanced beyond Algebra 2 but placed 1- or 2-levels below college-

FIGURE 7. High School Pathway, CAHSEE Performance, and Community College Math Placement



Note: Shaded rows are pathways with no 12th-grade math

level mathematics. They may have had adequate competencies in foundational and high school mathematics but *needed to brush up*;

3. Students in Path 2 who were proficient on the CAHSEE Math but stopped at Algebra 2 in Grade 11. They appear to have been on-track to college-readiness in Grade 11 but placed 1-, 2-, and even 3-levels below. They *needed to acquire additional skills* in Grade 12 to be college-ready; and

4. Students in Path 2 and in Path 6 who passed but were not proficient on the CAHSEE Math and placed 3- and 4-levels below. These students had weak foundational skills, were not on track to college-readiness, and *needed remediation* to improve their preparedness for post-secondary education.

By not taking mathematics in Grade 12, the students in Groups 2, 3, and 4 did not just miss an opportunity. They diminished their chances for post-secondary success.

Recommendation 2: Include taking mathematics in Grade 12 as a high school API metric

Currently, most California high school students have to "opt in" to senior year mathematics. This paradigm should be flipped. Students should routinely be placed into senior year mathematics, with the opportunity to opt out if they insist. Adding points for taking mathematics in Grade 12 to the calculation for high school API scores would increase college-readiness by prompting schools to enroll more students in Grade 12 mathematics.

Recommendation 3: Include coursework beyond Algebra 2 as a high school API metric

Adelman (2006) demonstrates that every course beyond Algebra 2 doubles the odds of completing college. In my sample, only 11 percent of students who took Algebra 2 as their highest-level high school mathematics course placed into college-level mathematics. A revision to the API to reward schools that continue to advance capable students would encourage schools to move more students beyond Algebra 2.

This recommendation is related to but not redundant with promoting Grade 12 mathematics. It provides an additional message for counselors, students, and parents to counter the misleading message sent by low graduation requirements and even the Algebra 2 A-G requirement.[11] It also provides additional flexibility for schools to meet the diverse needs of students. Not all high school students who would benefit from Grade 12 mathematics will be ready for coursework beyond Algebra 2. However, students who are able to advance beyond Algebra 2 should be urged to do so.

Mathematics in Grade 12 is not a panacea

These recommendations should not be interpreted to mean that taking mathematics in Grade 12 can by itself bridge the readiness gap for all students. This is evident in Figure 7, Paths 1, 3, 5, and 7 which present the 10 most frequent patterns of progress from high school to community college for students who took mathematics in Grade 12.

Again, we see a diversity of pathways and of outcomes in each pathway. For example, although all of these students took mathematics in Grade 12, not all assessed as college-ready. For students in Paths 1 and 3, this may be due, in part, to whether the students were proficient or advanced in their foundational skills, and to which course above Algebra 2 they completed.[12] It may also reflect how well they learned the material above Algebra 2. The students who took Paths 5 and 7 had weak foundational skills, as indicated by their CAHSEE Pass scores. These students placed 3- and 4-levels below college-level mathematics, even though they took mathematics in Grade 12. Rather than being a cure-all for college unpreparedness, Figure 7 illustrates that the full potential of increasing enrollments in Grade 12 mathematics will depend on the improvement in curriculum and instruction promised by the CCSS.

Conclusion

California's education system is in transition. The successful implementation of the CCSS and the SBAC assessments will be challenging, will take time, and will not fully address the structural divide between high school and community college. Meanwhile, far too many students leave high school unprepared for college, and this is especially true for students who enroll in community college. The research presented here identified weak competencies in foundational mathematics, not taking mathematics in Grade 12, and not progressing beyond Algebra 2 as important junctures where high school students choose, are directed to, or find themselves on paths that diminish their chances of assessing as ready for college-level coursework. These key markers can be observed, measured, and improved in districts and high schools throughout California.

The policy incentives proposed here attempt to balance the benefits of clearly communicating and advancing college-readiness standards to high school students, particularly community college-bound high school students, without incurring the harmful and demoralizing effects of an approach that presumes that all students are ready to follow the same pathway.

With that balance in mind, this brief recommends the following revisions to the API:

1. Reward growth in the number of students performing at Proficient

and Advanced levels on the CAHSEE Math;

2. Reward growth in the number of students taking mathematics in Grade 12;

3. Reward growth in the number of students taking mathematics coursework beyond Algebra 2.

This bundle of recommendations addresses the role of unpreparedness in mathematics as a roadblock to college-readiness. Recommendation 1 suggests capitalizing on the existing CAHSEE Math to increase college-readiness, and Recommendations 2 and 3 advise better use of senior year. My research suggests that California's high school to community college transition would benefit from a thorough re-examination and possible re-structuring of Grade 12 to increase preparedness for community college-bound students.

If the purpose of the P-12 system today and tomorrow is to ensure that all students, including community college-bound students, are college- and career-ready then educators, researchers, and policymakers can learn from linking P-12 preparation with post-secondary experience and mining these data to improve student success. My research demonstrates the usefulness of this approach. Matching and analyzing the academic histories of students across systems can uncover what is and isn't working, and lead to responsive practical solutions. This will help more students to be ready for college-level work by the time they enroll in college.

APPENDIX A. Demographic Overview of Sample

Demographic Overview of All 12th-Graders and the Subset of Students Who Matriculated as Freshmen to the Community College (CC Freshmen)

	Study Sample		**California***
	All 12th-Graders N = 2,920 100%	CC Freshmen Subset n = 953 32.6% of All	First Time, Age 19 or Under Community College Students Fall 2012 N = 164,857
Gender			
Male	49.7%	52%	51%
Female	50.3%	48%	49%
Ethnicity			
Black	9%	9%	6%
Asian/Pacific Islander	8%	7%	9%
Latino	30%	35%	49%
White	52%	48%	25%
Parent Education			
High School or Lower	16%	23%	
Some College	18%	25%	
College Graduate	24%	25%	
Grad School	27%	19%	
Not Indicated	15%	8%	
Free/Reduced Fee Lunch	22%	29%	
Language Status			
English Only	70%	65%	
Fluent English Proficient (FEP)	9%	9%	
Reclassified FEP	15%	18%	
English Language Learner	7%	9%	
Special Education	6%	8%	
Met UC/CSU Requirements	73.5%	56%	
Mean total high school credits	245.79	236.48	

* Retrieved from http://datamart.cccco.edu/Students/Enrollment_Status.aspx

APPENDIX B. Community College's ACT COMPASS Cut Scores for Placement in Mathematics

Test Taken	Cut Score (04/06/04-06/05/07)	Cut Score (Starting 06/06/07)	Cut Score (Starting 05/01/08)	Placement Course	Placement Level	Note on Re-routing into Different Math Test
Pre-Algebra Type: 5 or 15	0-34 35-52 53-100	0-34 35-52 53-100	0-34 35-52 53-100	Basic Arithmetic Pre-Algebra Algebra 1	4-Levels Below 3-Levels Below 2-Levels Below	[1] No re-routing occurs in Pre-Algebra
Algebra Type: 6 or 16 All students start here	0-38 39-49 50-64 65-100 75-100[2]	0-38 39-49 50-100 65-100[2]	0-38 39-49 50-100 75-100[2]	Routed back[1] Intermediate Algebra College-level Routed up[2]	1-Level Below College-Level	[1] If Algebra test is completed with a score of 38 or less, student is routed back to take the Pre-Algebra test for placement [2] If Algebra test is completed with a score of 75 or higher, student is routed up to take the College Algebra test where a placement may be assigned if a score of 46 or above is obtained; otherwise student will be eligible for specified college-level math courses.
College Algebra Type: 7 or 17	00-36 37-45 46-100 60-100[1]	00-45 46-100 60-100[1]	00-45 46-100 60-100[1]	Routed up[1]	College-Level	[1] If College Algebra test is completed with a score of 60 or higher, student is routed up to take the Geometry test. If score in Geometry is 1-100, math placement will be based on highest score obtained in College Algebra. If a score of 66 or more is obtained on the Geometry test, student will be routed up to the Trigonometry test.
Geometry Type: 8 or 18	00-65[1] 66-100[2]	00-65[1] 66-100[2]	00-65[1] 66-100[2]	Routed back[1] Routed up[2]		[1] If Geometry test is completed with a score of 65 or less, math placement will be based on highest score obtained in College Algebra test. [2] If Geometry test is completed with a score of 66 or higher, student is routed up to take the Trigonometry test; otherwise placement will be based on College Algebra score.
Trigonometry Type: 9 or 19	00-44 45-65 66-100	00-44 45-65 66-100	01-65 66-100			No routing back

APPENDIX C. Summary Table of Multinomial Logistic Regression Model

Summary of Multinomial Logistic Regression Analysis Predicting Community College Placement in 1-, 2-, 3-, or 4-Levels Below College-Level Mathematics (n = 606)

	1-Level Below				2-Levels Below				3-Levels Below				4-Levels Below			
	B	Std. Error	Sig.	Delta-p	B	Std. Error	Sig.	Delta-p	B	Std. Error	Sig.	Delta-p	B	Std. Error	Sig.	Delta-p
Intercept	21.963	3.747	***		22.938	3.873	***		39.631	4.152	***		54.593	4.875	***	
Gender (Female)	.340	.329			-.525	.355			.528	.340			.289	.383		
Black	-.289	.569			-.933	.677			-.650	.606			.214	.645		
Latino	-.033	.139			-.126	.144			-.038	.142			.123	.163		
Asian/Pacific Islander	-.439	.354			-.584	.413			-.089	.349			-.082	.472		
Parent Education	-.030	.109			-.078	.112			-.029	.112			-.145	.131		
Low SES	-.491	.358			-.179	.360			-.013	.357			-.315	.401		
Grade 9 Math Course	-.076	.026	**	21.99%	-.071	.028	*	22.27%	-.089	.026	**	22.39%	-.127	.031	***	21.38%
Grade 9 Math GPA	-.172	.167			-.268	.172			-.252	.169			-.541	.187	**	14.42%
Grade 10 Math GPA	-.102	.160			-.048	.166			-.148	.160			-.387	.183	*	16.74%
Grade 11 Math GPA	-.283	.146			-.450	.151	**	14.96%	-.394	.147	**	16.69%	-.323	.169		
CAHSEE Math	-.048	.009	***	22.64%	-.052	.009	***	22.72%	-.082	.010	***	22.53%	-.118	.012	***	21.54%
Highest Math Course	.013	.036			.033	.040			-.052	.030			-.043	.034		
Grade 12 – No Math	.527	.347			1.049	.366	**	57.64%	.825	.344	*	45.66%	1.095	.391	**	49.20%

The reference category is college-level math.

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

Endnotes

1 ACT COMPASS is one of the most common standardized tests used by community colleges to place students into college-level or remedial coursework (Hughes & Scott-Clayton, 2011). Although researchers debate the validity of using a high-stakes standardized test as the primary determinant of placement in coursework for community college students, this remains the most common practice (Burdman, 2012; Hughes & Scott-Clayton, 2011), and is likely to continue (Hughes & Scott-Clayton, 2011; Venezia et al., 2010). In the logistic regression model discussed, I define community college-bound students as "college ready" if they place into college-level mathematics per their ACT COMPASS placement results. ACT COMPASS is an adaptive assessment; it begins with Algebra questions and, depending on their responses, students are routed down to pre-Algebra or basic arithmetic, or routed up to more advanced mathematics. Cut scores, determined by the community college, are presented in Appendix B.

2 The study's greatest limitation is its reliance on the ACT COMPASS assessment at a single community college to define college-readiness. ACT COMPASS is one of the two most commonly used placement assessments, and its validity and reliability have been validated (Hughes & Scott-Clayton, 2011). However, cut scores for placement are determined by each community college. In contrast, the CAHSEE Math assessment is given to all California 10th-graders and cut scores are set by the state. This lack of statewide standardization for community college placement assessment may compromise the generalizability of these findings, or their precision, since they are based on using ACT COMPASS placement as the outcome variable. The California Community Colleges Student Success Task Force recommended a common community college assessment for placement that will align with the CCSS and SBAC assessments. In August 2013, the Chancellor's Office issued a Solicitation for the management of the Common Assessment Program with funding to start with the 2013-14 fiscal year budget.

3 Students who were eligible for a free or reduced lunch in the K-12 National School Lunch Program or who received any financial aid during the first year of community college were coded as having lower socio-economic status.

4 This is almost twice the percentage of students who assessed as transfer-level, i.e., into college-level coursework in the state in Fall 2010. Statewide, 15 percent of students assessed into college-level mathematics; 21 percent assessed 1-level below; 24 percent assessed 2-levels below; 20 percent assessed 3-levels below; and 21 percent assessed 4- or more levels below. By comparison, almost twice as many students (29 percent) in my sample assessed into college-level mathematics, but fewer students assessed 1-level below (13 percent) and 2-levels below (13 percent). Forty-five percent assessed 3- or 4-levels below, compared to 41 percent of the statewide community college sample placing 3- or more levels below college-level (http://californiacommunitycolleges.cccco.edu/Portals/0/reportsTB/REPORT_BASICSKILLS_FINAL_110112.pdf, Table C-1).

5 This was unexpected since the CAHSEE Math primarily measures basic arithmetic and pre-Algebra, coursework that precedes high school instruction. In the preliminary analyses, the CAHSEE Math had the highest correlation to community college placement ($r = .669$, $p < .01$, $n = 857$) followed by the correlation between Grade 7 Math CST scores and community college placement ($r = .624$, $p < .01$, $n = 349$). Consistent with this finding, Terry & Rosin (2011) describe seventh-grade mathematics as the "pivot point" in California's mathematics pipeline.

6 Students receive scores ranging from 275-450 on the CAHSEE Math with 350 passing, 380 considered Proficient, and 422 considered Advanced.

7 In the full sample of 12th-graders, 42 percent of black students and 46 percent of Latino students scored in the 350-379 range on the CAHSEE Math, i.e., passing but not proficient. This compares to 11 percent of Asian/Pacific Islander students and 17 percent of white students who scored in this range.

8 The CAHSEE Math Pass score of 350 corresponds to a student answering 55 percent of the questions correctly (http://www.cde.ca.gov/ta/tg/hs/cefcahsee.asp). This low threshold was established to ensure that most students could pass it. As my study documents, a passing score is not predictive of college-readiness. Were the state to increase the CAHSEE Pass cut score to more accurately measure college-readiness standards, or replace the CAHSEE with a Smarter Balanced assessment, a major challenge remains: If the cut score for high school graduation is set too high, far too many students will be unable to earn a high school diploma.

9 Finkelstein et al. (2012) report that 30 percent of the students in their sample took no mathematics in Grade 12, with less advanced students less likely to take mathematics in their senior year.

10 Surprisingly, highest-level mathematics was not a significant predictor in this model for college-readiness. This may be because students missed Algebra problems on the assessment and were routed down to pre-Algebra and basic arithmetic, i.e., their placement assessment was determined by weak foundational mathematics skills without higher-level course-taking having been considered. Another possible explanation is that students with weak foundational mathematics skills never made it into higher-level high school mathematics coursework. In this sample, just 63 (7 percent) of the community college freshmen who scored Pass on the CAHSEE Math made it into an above-Algebra 2 course in high school. It may also be due, in part, to the interaction between not taking mathematics in Grade 12 (which was a significant predictor) and highest-level mathematics.

11 Algebra 2 meets the UC and CSU A-G eligibility requirement in mathematics; this eligibility floor is usually interpreted (or perhaps misinterpreted) as an indicator of college-readiness.

12 The percentages of students who placed into college-level mathematics varied by 12th-grade above-Algebra 2 course: 100 percent of 12th-graders who took AP B/C Calculus (n=10) placed into college-level mathematics; 94 percent of 12th-graders who took AP A/B Calculus (n=46) placed into college-level mathematics; 100 percent of 12th-graders who took Honors Precalc/Calc A (n=only 5) placed into college-level mathematics; 46 percent of 12th-graders who took Precalc/Trig (n=95) placed into college-level mathematics; 71 percent of 12th-graders who took AP Statistics (n=49) placed into college-level mathematics; and 28 percent of 12th-graders who took Statistics (n=100) placed into college-level mathematics.

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