DEGREES OF FREEDOM:

Probing Math Placement Policies at California Colleges and Universities

(Report 3 of a 3-part series)

Pamela Burdman

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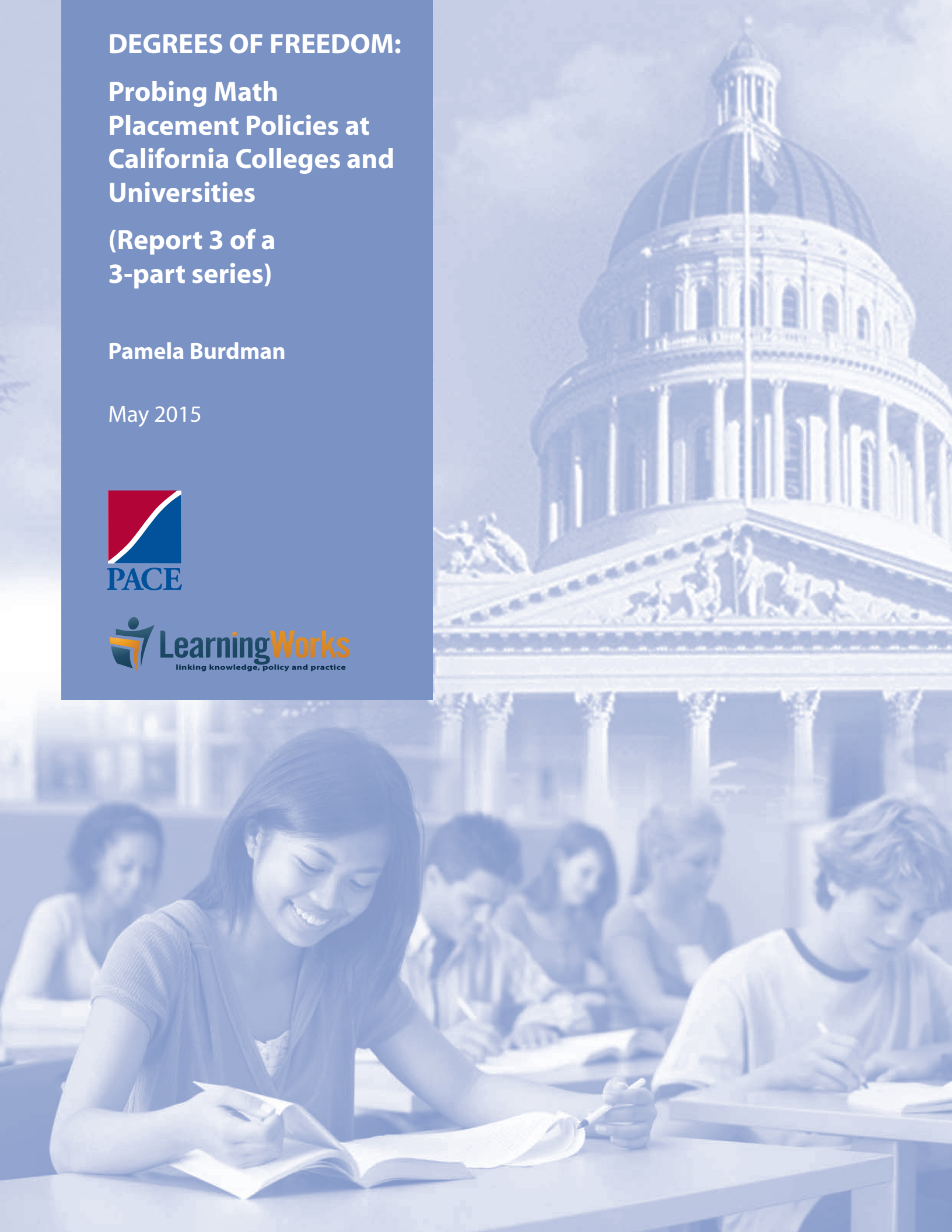

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EXECUTIVE SUMMARY

There is growing concern that the remedial math courses taken by most community college students unnecessarily divert some students from earning a degree. Anecdotes of students who thought they had completed their math requirements in high school only to have remedial courses delay their progress through college are common. In addition, research has shown that African American and Latino students are disproportionately affected, frequently facing three or four remedial math classes. Redesigning the placement policies that assign students to these sequences could be as important as redesigning the curricula into which students are placed.

This is the third report in *Degrees of Freedom*, a series being published by LearningWorks and Policy Analysis for California Education (PACE) to explore the role of math as a gatekeeper in higher education. It examines concerns that placement policies unfairly send the majority of community college students to remedial math, deterring them from completing college. It also considers how changes in these policies interact with university placement policies as well as with K-12 college readiness strategies.

Remedial Math Placement: A Community College Penalty?

The awareness that many students who perform well in high school math are assigned to community college remedial courses is contributing to discomfort with the current uses of placement exams. A frequent response to such discrepancies has been to fault high school instruction or curriculum. But recent research findings add to concerns about unfair placement practices: For example, community college students are more likely to require remedial math courses than university students with similar records. And about a quarter of students placed into community college remedial math courses could have succeeded in college-level courses. High school grades also appear to be better predictors of success in college math courses than the placement tests that are typically used.

An estimated 85 percent of California's community college students take remedial courses. While the state's university systems require students seeking to transfer to complete the equivalent of three years of high school math (i.e., through Algebra 2) as a prerequisite to any transferable math course, they have no purview over

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how community colleges measure that proficiency. Furthermore, due to their different enrollment priorities, California's three higher education systems – the California Community Colleges, California State University (CSU), and the University of California (UC) – approach math readiness very differently, ranging from the presumption of readiness at most UC campuses to community colleges' default assumption that most students are underprepared.

Math requirements' role as a filter raises the risk that students could be unfairly delayed in earning a degree or diverted from completing college altogether. But that role is changing: A new assessment and new placement practices at the community college level along with new K-12 Common Core-aligned tests that will exempt some students from placement testing will change the face of remedial placement in the state.

Placement Policies in California and Their Limitations

California community colleges have been part of a national move to re-think placement policies, given remedial math sequences' high attrition rates as well as implications for equity. Placement exams have several limitations:

- **Test content** doesn't always align well with high school curriculum or the college curricula into which tests place students. The tests typically emphasize algebra skills. But there is not a clear consensus about how much algebra college students need, and statistics and data analysis are increasingly considered core skills for college success. Differences among California's three higher education systems reflect these tensions. Furthermore, educators have begun to embrace cognitive strategies and learning skills as part of the definition of college readiness, in addition to the content knowledge that most tests assess.
- **Uses of test results** frequently conflict with testing industry norms saying that test scores should never be the sole factor in a high-stakes decision. The range of factors that can influence students' test performance is particularly salient for community college students. These include math anxiety and stereotype threat. Under-represented minorities have lower confidence in their math abilities than other students, according to research, and therefore may underperform on math tests.
- **Awareness and consistency** are also concerns. Students often don't realize that placement exams have high stakes, and poor K-16 curricular coordination leaves students ill-prepared. The lack of consistency across California colleges in tests and cut scores makes this problem harder to cure. As a result, researchers have found an inconsistent pattern of placement distributions across colleges. In a single college district, one college placed more than half of students four levels below college-level (typically an Arithmetic class), while another placed only 2 percent of its students at that level.

Though these limitations may sound abstract and technical, in reality they affect tens of thousands of California students. An analysis described in the report found that each year, some 47,000 entering community college students who recently passed a high school Algebra 2 class may be required to repeat that content in a remedial course based on their placement test results. How to mitigate such effects depends on how colleges diagnose the problem. At the moment, the question of how placement policies interact

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with students' self-perceived math ability and influence their test performance remains ripe for research and experimentation.

Changes in the Works

To address concerns about ineffective and inconsistent placement practices, community colleges and some universities around the nation are adopting three types of reforms:

- They are **changing tests**, based on the assumption that content or design is flawed, but can be improved. About a dozen community college systems have recently changed or replaced their assessments, and California is in the process of adopting a new common assessment instead of the variety of tests currently in use.
- Based on the assumption that tests are inherently limited, they are **de-emphasizing tests** via use of multiple measures, differentiated placement, self-placement, and accelerated placement. The use of high school grades in addition to – or instead of – test scores is the most common approach. California community colleges have been at the forefront of these experiments, but one obstacle to expansion has been the difficulty of obtaining high school transcripts. At the state level, a multiple measures work group is analyzing how colleges can best use available indicators for placement.
- They are **supporting students' test-taking** through two primary avenues: college readiness tests and indicators in high school and refreshers and boot camps offered for students in college. Both address the concern that students may forget material learned in high school. The idea is that sending students who may just need a refresher into a full-semester arithmetic class at best delays their education, and at worst discourages and demoralizes them. Increasingly, community college reformers are promoting just-in-time remediation.

New Directions: Re-Contextualizing Placement Policy

As California's community college multiple measures work group studies scenarios for using various indicators to improve placement, its goal is to develop a systemwide algorithm. Use of the algorithm, which will take high school information into account to guide colleges in placing students, will be voluntary. This effort will ideally incorporate the following three questions to re-contextualize placement:

- Can the math knowledge expected of students be contingent on their educational goals?
- How can colleges use high school grades and other measures to determine whether a student requires remedial prerequisites? And which ones?
- Where are there opportunities for colleges to contribute to a coherent, equitable, and transparent vision of math readiness for California by voluntarily sharing placement practices?

Such changes could reverberate across the educational segments from the universities that enroll community college transfer students to the K-12 schools expected to get students college-ready. Using intended major as a placement measure for math conflicts with university entrance requirements, which don't distinguish by major. Reliance on students' high school records for math placement is compatible with the UC system's approach. But it could conflict with CSU's policies, which rely on a placement test.

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At the high school level, the implications would be different. Some analysts believe that giving college students choices about their math prerequisites is an idea whose time has come, but many are wary of extending that choice to high school students and allowing them to opt out of higher-level algebra classes prematurely. Using high school course-taking for placement in order to reduce remediation rates could reinforce or disrupt K-12 reform efforts, depending on how the policy is implemented. K-12 reforms have been accelerated in part due to concerns about large remedial enrollments.

Until now, expectations for students have been remarkably consistent. Completion of two years of algebra has been the standard for university admission, for access to the community college math courses required for transfer to a four-year institution, and for earning a two-year degree (in California and many other states). This is typically signified by the completion of Algebra 2 in high school or Intermediate Algebra as a college remedial course. The Common Core math standards retain this general emphasis, although the writers tried to make the algebra content more realistic.

But, if community colleges begin to emphasize high school course-taking for placement while the CSU system continues its reliance on test results, the signal transmitted by these readiness policies, and thus their potential to motivate stronger preparation, will be diluted.

Looking Ahead

College math requirements and associated assessments should serve as a foundation for students' academic success, not merely a filter to manage enrollment. In the face of research on math placement exams and remedial sequences, it has become increasingly difficult to justify sentencing students to multiple remedial courses based on a score on a one-hour test. Failure to address such barriers is tantamount to diverting a generation of students from earning a college degree and giving up on California community colleges' democratizing role.

Confronting these barriers will require California's higher education systems as well as state policymakers to adopt realistic policies in at least three areas: general education math requirements and prerequisites, higher education attainment goals and the resources to achieve them, and placement policies that give more students a fair shot at earning degrees.

California's higher education institutions should rethink their placement policies in the following ways:

- Community colleges should utilize their autonomy over placement policies to devise strategies that are pragmatic, transparent, and supportive of students' success. Students' high school grades and intended majors are potentially strong criteria to be utilized in placement decisions.
- Mandatory placement testing should be matched with opportunities for refreshers and pretests.
- Community colleges should consider aligning placement policies at the regional or state level, because greater consistency will enhance transparency, equity, and articulation with other segments.
- Policymakers and education leaders should collectively en-

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sure that longitudinal data is available for colleges' use in placement as well as for feedback to high schools about their students' remedial placements.

- The education systems should study CSU's Entry Level Mathematics (ELM) test, including its content and predictive validity, to understand its alignment with community college assessments, the Common Core state standards, and CSU's own undergraduate courses. The implications of using high school grades for placement at CSU should also be analyzed.
- The CSU system and community colleges should analyze Texas' new assessment to consider the possibility that the two systems could use a common placement exam.
- Researchers should study the effects of math anxiety and stereotype threat to support testing policies that mitigate these effects.

DEGREES OF FREEDOM: Probing Math Placement Policies at California Colleges and Universities

Foreword

Do community colleges democratize higher education by increasing access? Or do they divert students from earning a four-year degree? The debate has been long and robust (Rouse, 1995). Recent efforts to increase college completion rates have put two-year colleges in the spotlight. Amid efforts to strengthen their democratizing potential and ensure that the access they provide is matched with greater success, one key barrier stands out: the remedial math courses required of most community college students.

Take Erika. During high school in the Bay Area, she did well enough in math to move on to Pre-Calculus, a college-level class, in her senior year. But when she arrived at Berkeley City College a year and a half later, a low score on a math test landed her in a remedial sequence consisting of three classes she had already taken: Pre-Algebra, Elementary Algebra, and Intermediate Algebra.

"When I took the test, I was too nervous. It was really early in the morning. I had gone almost two years without taking a math class. I kind of blanked out," she recalled. "Once I got to the Pre-Algebra class (in high school), after the first two lessons, I knew everything. I even helped the teacher help students who didn't understand. If I wasn't so nervous or if I'd had some review beforehand, I'm sure I would have been able to answer the questions on the test."

At City College of San Francisco, Lulu's experience was similar: After taking a year off from school, she performed poorly on an ACCUPLACER test. She found herself assigned to a series of four courses, beginning with Arithmetic.

"I sat through an entire semester of basic addition, subtraction and fractions," she recalled. "It was a nightmare to start at such an elementary level all over again when all I needed was a refresher."

Anecdotes of students who thought they had completed their math requirements in high school only to have remedial courses delay their progress through college are legion. In fact, according to a new analysis described later in this report, more than half of California community college students who have complet-

ed high school Algebra 2, the final course in the college preparatory math sequence, are required to take one or more remedial math courses. Although these students are in the minority of remedial math enrollments – far more students did not take a second-year algebra class in high school – estimates reveal that, in California alone, there could be almost 50,000 of them per year.

Alternative remedial sequences are opening up options for students like Erika and Lulu who are pursuing non-STEM fields. But increasingly community college leaders are wondering whether all students assigned to remedial courses really need to take them in the first place.

As colleges in California and nationally re-think their placement policies and practices, these concerns are gaining more urgency. They echo what Alexander Astin wrote in 1998, while a UCLA education professor:

> Most remedial students turn out to be simply those who have the lowest scores on some sort of normative measurement – standardized tests, school grades and the like. But where we draw the line is completely arbitrary. The 'norms' that define a 'low' score are highly variable from one setting to another (Astin, 1998).

The reality that the vast majority of high school graduates who arguably have met the standard for college-level work can be assigned to up to four remedial courses at California community colleges only underscores the concern about unfair testing practices. So does the awareness that African American and Latino students, in particular, often face three or four remedial classes before they can take a math course required to graduate. For education systems focused on improving college completion, these trends suggest that redesigning placement policies and practices could be as important as redesigning the curricula into which they place students.

This is the third report in *Degrees of Freedom*, a series being published by LearningWorks and PACE (Policy Analysis for California Education) to explore the role of math as a gatekeeper in higher education. The first report looked at the growing diversity in how math is used in various academic disciplines, including the growth of statistics as a field, and how some of those changes are beginning to re-shape and diversify general education requirements.

The second report examined attempts by community colleges to expand alternative routes through math into the remedial courses that prepare students for undergraduate study – and the obstacles presented by requirements for students transferring to public universities. It also revealed the lack of clarity around Intermediate Algebra, a course that corresponds to high school Algebra 2 and is typically considered a prerequisite for general education math courses. That ambiguity may challenge the fairness of math requirements for transferring, even as the requirements serve to enforce state funding limits on university enrollment.

Together, the two reports underscore questions about whether students pursuing majors not requiring Calculus need the typical sequence of Algebra 2 followed by Trigonometry and College Algebra (or Pre-Calculus). This final report looks at the related issue of the placement policies that traditionally assign students to remedial courses. In particular, it examines concerns that these policies unfairly send the majority of students to remedial math, deterring them from completing college. It also considers how changes in these policies would interact with university placement practices as well as with K-12 college readiness strategies.

Remedial Math Placement: A Community College Penalty?

Community college developmental math sequences were designed to help students build skills needed for

success in college. But some in education have begun to see the courses as barriers – instead of bridges – to success, and there is growing discomfort with the way colleges use placement exams to assign students to them.

"It's extremely common for students to take a high-level math class in high school and place into a low-level math class at our college," said Hal Huntsman, a math instructor at City College of San Francisco.

"We're finding a lot of students who got an A or B in Statistics (having taken two years of algebra) in high school are testing into Elementary Algebra," said Janet Fulks, Dean of Pre-collegiate and Student Success at Bakersfield College.

A frequent response to such discrepancies has been to fault high school instruction or curriculum. But recently, colleges' placement practices are also being questioned. "I think there's a community college penalty," said Rebecca Wong, a dean of math and sciences at West Valley College in Saratoga, Calif., "At community colleges, not only do you have to take Algebra 2 to get into a college-level course, you have to remember it."

Wong points out that students earning a C or better in Algebra 2 can enroll directly in college-level courses at most University of California campuses, but they face placement tests at community colleges (Wong, 2013). This comparison is not straightforward, of course, given that few community college students would meet the UC system's highly selective admissions criteria. But a 2014 study lends credence to the idea that the community college policies may penalize students.

The study, by researchers at City University of New York (CUNY), found that, compared to similar students who enroll at non-selective and minimally selective four-year universities, community college students nationally are 19 percent more likely to take remedial math courses. Published in the journal *Educational Evaluation and Policy Analysis*, it was based on a longitudinal survey, including transcript data, of students who began college in 2004. "This is a particularly stark difference considering that we are comparing groups which are balanced in terms of high school math classes taken, high school grades, and SAT scores," noted the authors (Monaghan & Attewell, 2015).

The study did not uncover the reasons for the disparity. However, it resonates with anecdotal reports from faculty and administrators in some areas of California. "The high school counselors tell us, 'We know this student was in AP Calculus and you put them into (Elementary) Algebra. If they go to CSU, they'll get a higher placement,'" said Fulks. (Also see Headden, 2011.)

For students in STEM fields, another penalty lies in community colleges' lengthy math sequence: even students considered college-ready in math are frequently required to take two or more semesters of general education math there before taking Calculus, compared to one semester at most universities.

The CUNY findings also echo earlier research by the Community College Research Center (CCRC) at Columbia University's Teachers College showing that in one large community college system, about a quarter of tested students assigned to remedial courses were "severely under-placed" because they could have earned a B in a college-level course. The researchers found that simply assigning all students to college-level math courses would increase the proportion of students immediately taking and passing college-level math courses by 33 percentage points (Scott-Clayton et al., 2012).

What is important about this research is that, unlike typical validity studies, it goes beyond looking at whether students who placed into college-level math passed the course. It also examines what happens to students placed into remedial courses and analyzes measures of diagnos-

tic accuracy (Scott-Clayton, 2012). "Simply confirming that a placement exam predicts performance in college-level math does not, on its own, imply that students with low scores should be assigned to remedial math," noted researchers at CCRC (Hughes & Scott-Clayton, 2011).

The research also found that high school grades were a better predictor of student success in college math courses, and that placement tests accounted for only six percent of the variation in freshman math grades (Scott-Clayton, 2012). Research conducted in California also found that students' high school records had value in predicting students' success in college math courses. However, the level of math courses completed in high school was much more predictive than grades in math courses (Willett, 2013). Given evidence (described in the second report in *Degrees of Freedom*) of inconsistencies in the content of college courses such as Intermediate Algebra, this result suggests that with greater consistency in course content, high school math level might be an even better predictor. In any event, such findings call into question the common practice of using placement test scores as the sole or primary factor in determining students' eligibility to take a "gatekeeper" math course required for graduation.

This emerging research bolsters the impression that community college placement practices are arbitrary, particularly since there is no evidence at the community college level that the remedial math courses are effective. In fact, one recent study found that, while developmental English courses were associated with increased earnings, developmental math credits had a detrimental effect on earnings, particularly for those assigned to the lowest levels (Hodara & Xu, 2014). According to the authors,

> The negative impact of developmental math coursework on wages provides support for nationwide efforts to shorten the long-sequence structure of developmental mathematics, and to teach math skills that are applicable to students' real-world needs.

The findings may also implicate the placement system that sends students into developmental sequences in the first place.

Placement Policies in California and Their Limitations

Interestingly, if there is a community college penalty in California, it is, for the most part, self-imposed by the colleges. An estimated 85 percent of the state's community college students take remedial courses. The University of California (UC) and California State University (CSU) require community college students seeking to transfer to complete the equivalent of three years of high school math (i.e., through Algebra 2) as a prerequisite to any transferable math course. But they don't dictate how community colleges should use placement tests or other means to measure that proficiency. Those decisions are in the individual colleges' purview.

The way each system treats students' math skills reflects their enrollment priorities, ranging from UC's highly selective admissions to the community colleges' open door. (See Box, *Three Strata – Three Strategies*, pp. 10-11.) As a result, math readiness policies vary from the presumption of readiness at most UC campuses to community colleges' default assumption that most students are underprepared. The community college practices reinforce the role of math requirements as a filter, raising the risk that students could be unfairly delayed in earning a degree or diverted all together. As discussed in the prior report in this series, they also help the higher education system limit enrollment at public universities to the number of seats the state is willing to fund.

But it is a time of flux for placement in California. The community college system is preparing to pilot a new assessment, and individual col-

leges are experimenting with new placement algorithms. At the same time, K-12 schools will begin using Common Core-aligned tests that the CSU system will use to exempt some students from placement testing. The outcomes of this new testing ecosystem will play a major role in determining students' educational trajectories.

The California Community Colleges (CCC) have been part of a national move to re-think placement policies. Given remedial math sequences' high attrition rates, placement has a significant influence on whether students progress through college. In particular, the policies have serious implications for equity, since underrepresented minority students are more likely to be placed into remedial math courses (Perry, 2010). Placement exams also are increasingly playing a role in K-16 alignment, in particular by informing high schools about how well they are preparing their graduates for college. But these tests have limitations in at least three areas:

Appropriateness of test content. Researchers and education leaders have been raising questions about the alignment between test content and curriculum. One concern is that some community college placement tests don't align with high school curriculum, putting some students at a disadvantage (Brown & Niemi, 2007). On the other hand, even when they align with high school curriculum, they may not accurately reflect the true demands of college-level courses for all students (Burdman, 2012). The tests typically emphasize algebra skills, even though statistics and data analysis are increasingly considered core skills for college success (Burdman, 2015a).

In practice, there is little agreement within and across California's three higher education systems about what math content should be expected of all students, not to mention how long they should be expected to remember it. An agreement on math readiness among the systems' faculty senates has not been widely disseminated and has little force. Current policies represent more of a compromise than a consensus. The de facto assumption that the standard curriculum best serves all students is changing, but not uniformly.

UC's deliberations over Intermediate Algebra for non-STEM students illustrate the tension. "I interviewed one of the faculty who teaches our Statistics class," said George Johnson of UC-Berkeley's engineering school. "I asked him what level of mathematics he assumes his incoming students have. He said almost none. He's not expecting them to be solving systems of linear equations or trigonometry or any of the stuff that might go along with Algebra 2. They need to be able to solve problems and understand numbers. He's making very low assumptions as to their mathematical content."

David Bao, math department chair at San Francisco State University, is one of many math professors who believes that remedial algebra content such as quadratic functions has an intrinsic value to students, regardless of what general education math course they take. Understanding the relationship between price and revenue involves quadratic functions when the number of items sold depends linearly on the price, he says. Quadratics are also essential for farmers estimating the size of a field to achieve a preset crop yield or to astronomers seeking to understand the trajectories of comets and planets. Allowing students who can't demonstrate proficiency in these areas to bypass this math content does them a disservice, he argues.

While other CSU math chairs appear to agree with Bao, there is a clear tension between them and CSU system administrators, who appear eager to reduce remediation rates. A 2010 executive order directed math departments to review cut scores on CSU's Entry-Level Mathematics (ELM) test every two years. Administrators outside of math departments, eager to improve their campuses' remedial math success rates, are pressing for more alternative prerequisites.

THREE STRATA – THREE STRATEGIES. California's three higher education systems' differing freshman admissions priorities drive their approaches to math readiness as well as their policies for community college transfer.
Source: Systems' websites

ENTRANCE REQUIREMENTS – Freshman admissions requirements range from the UC system's highly selective criteria to the CCC's open-access policies.	**MATH READINESS** – Policies on math readiness for freshmen range from UC's presumption of readiness to the use of placement exams at CSU and the CCC's 112 different policies.
University of California – Selective Admissions To meet its Master Plan target of admitting the top one-eighth of students, UC defines a pool of eligible students, from which the nine undergraduate campuses are free to admit any student: • a minimum high school GPA of 3.0, • C or better in Algebra 1, Geometry, Algebra 2, and other "a-g" courses, and • sufficiently high SAT or ACT scores (see below). A composite of grades and test scores determines students' eligibility. The higher the students' grades, the lower the test score that is accepted, and vice versa. For example, in 2015, a student with a GPA over 4.3 (counting extra points for honors courses) would be eligible with an SAT score of 1240, around the 20th percentile. In addition, students graduating in the top nine percent of their high school class are also considered eligible, with the right courses and grades. Most UC campuses do not have room to admit all eligible students. The most competitive campuses tend to select students whose performance puts them at the top of the pool of eligible students.	**University of California – Presumed Readiness** Admitted students, having met these benchmarks, are presumed to be "college ready" and free to take any entry-level math (or English) course. In practice, only students who intend to enroll directly in Calculus without taking a prerequisite course take placement exams. (An exception is UC Riverside, which has a math placement exam and offers a non-credit Intermediate Algebra workshop.)
California State University – Less Selective Admissions CSU is expected to admit the top one-third of students in the state, measured as follows: • minimum high school GPA of 2.0, • completion of Algebra 1, Geometry, Algebra 2, and other "a-g" courses, • high school diploma or equivalent, and • acceptable SAT or ACT scores (for GPAs below 3.0).	**California State University – Assessed Readiness Statewide** Entrance to credit-bearing math courses is restricted. Roughly half of entering freshmen are deemed ready for college-level math by one of the following measures: • SAT math (550 or above), • ACT math (23 or above), • AP Statistics or Calculus (3 or above), • SAT Subject Test in Mathematics (550 or above), • Early Assessment Program ("ready"), • Early Assessment Program ("conditional" plus completion of approved 12th grade math course), and • Credit for transferable college math course.

ENTRANCE REQUIREMENTS	MATH READINESS
Like UC, CSU uses an index to determine the combination of test scores and GPA that make a student eligible. Also like UC, CSU has a number of campuses that are "impacted" and therefore unable to admit all eligible students.	The remaining half of incoming students – about 27,000 students in 2013 – take the ELM (Entry Level Mathematics) assessment. About 9,000 passed. Another 2,000 met the readiness requirement through a summer program, leaving about 16,000 students – or 29 percent of entering freshmen – assigned to remedial courses in the fall. Campuses share a common cut-off score for college-level math, but each campus determines how to structure its remedial sequence and how to assign students to one or two semesters of remediation.
California Community Colleges – Open Access By design, the community colleges are supposed to be open to any state resident with a high school diploma or equivalent (e.g. a GED or high school proficiency exam). Recent legislation gives priority registration to students who participate in assessment and orientation, as well as develop an education plan.	**California Community Colleges – Assessed Readiness by College** Because many students have weak academic skills or have been out of school for years, their math level is assessed. While system-level regulations set broad rules for how colleges test and place students, each college chooses its assessment and sets its own policies for deciding whether students are ready for college-level math. Tests used by colleges to place students into college-level or remedial math courses (with some colleges using more than one) include: • ACCUPLACER (49%) • MDTP (Mathematics Diagnostic Testing Project) (35%) • COMPASS (13%) • Self-Assessment (4%) • Locally developed test (7%) This variation will decrease with implementation of a common test currently in development. For now, cut-off scores for college-level math vary widely. On ACCUPLACER, they ranged from 43 to 63, according to a 2010 study (Venezia et al., 2010). Colleges are supposed to use multiple factors to place students. College sequences generally include two to four remedial courses, ranging from Arithmetic to Intermediate Algebra.

To Rebecca Wong of West Valley College, the problem lies in the specificity of math testing. "In English, I'm hoping we're solely testing students on their ability to read and write. They do need those skills in college in every course they take," she noted. "We're not testing them in American Lit, for example, which is a traditional junior year course. Yet, in math, we test them on their freshman, sophomore, and junior level courses and their ability to remember them."

Wong and some math colleagues who favor alternative math options believe that assessments should focus more on areas of number sense and quantitative reasoning abilities than on specific algebraic manipulations.

Educators have also begun to embrace a more robust understanding of college readiness that encompasses cognitive strategies and learning skills in addition to content knowledge (Conley, 2012). But standard placement tests rarely assess such attributes. That concern has led some college systems to examine the use of non-cognitive assessments. However, few of the available instruments have been validated for use in placing students (Booth et al., 2014).

Uses of test results. While placement tests have not always been considered high-stakes tests, the failure rates in remedial sequences demonstrate that they are (Burdman, 2012). As the Washington Monthly put it, "If you bomb the SAT, the worst thing that can happen is you can't go to the college of your choice. If you bomb the ACCUPLACER, you effectively can't go to college at all" (Headden, 2011).

Traditionally, most colleges have used test scores as the sole determinant of remedial placements. (Hughes & Scott-Clayton, 2011). Yet, psychometricians agree there is no meaningful difference between a test cut-off score and a point above or below it. As such, the reliance on test scores violates long-standing norms within the testing industry saying that test scores should never be the sole factor in a high-stakes decision (AERA et al., 2014). These norms are designed to protect students from having their performance on a one- or two-hour test trump other measures of their actual competence.

The guideline is important because a range of factors can influence test performance. Some of these are particularly salient for community college students and may partly explain the low predictive validity of the assessments:

- Affective factors such as math anxiety and stereotype threat can have a negative influence on students' performance in math classes and, especially, depress their scores on high-stakes math tests. Research has shown that anxiety can be specific to math, and that math-anxious students are "not simply underachieving across the board." Researchers theorize that math anxiety and stereotype threat compromise individuals' working memory capacity (Maloney et al., 2013). Moreover, a survey of community college students found that low math confidence was a reason some students avoided preparing for the placement test (Fay et al., 2013).
- Equity concerns are prominent because such barriers can disproportionately affect populations subject to bias. Stereotype threat, for example, occurs when people perceive that they risk confirming negative stereotypes about their race, gender, or other social group. For example, it can lower the performance of African Americans on the SAT (Steele & Aronson, 1995). Research has found that African American and Latino students tend to have lower confidence in their math abilities than white students (Fong & Melguizo, 2015).
- Lastly, students may simply have forgotten basic material that they learned years earlier, particularly if the classes weren't well taught or students weren't enthusiastic

about the material. The resulting snapshot may not provide an accurate picture of students' skills (Venezia et al., 2010).

These limitations of placement tests are concerning, especially given evidence that under-represented minorities are disproportionately taking courses that don't count toward transfer. Even when controlling for performance on high school tests, Latino and African American students appear more likely to require remedial courses (Kurlaender & Larsen, 2013).

Awareness and Consistency. Researchers have repeatedly cited students' lack of awareness about placement exams' high stakes as a reason for poor test results (Rosenbaum et al., 2006; Venezia et al., 2010). They fault poor K-14 coordination and communication for leaving students ill-prepared. But this problem is harder to cure without some consistency in testing practices. While CSU uses a single test systemwide, the concern about arbitrary practices has considerable salience at the community college level, where test instruments, along with cut-off scores, have historically varied across the state.

A 2010 study by WestEd found that scores to place into transfer-level math courses at California community colleges ranged from 43 to 63 on ACCUPLACER, the test used by about half of the colleges surveyed. Some students interviewed received different placements at different colleges based on the same scores. "Such variation in cut scores can send mixed signals to high school students across the state about what qualifies as college readiness," the report noted (Venezia et al., 2010).

Moreover, math placement tests are divided into various sub-tests, and there is no consistency in the way California colleges determine which sub-tests to administer to particular students. Interviews reveal a wide variety of practices. Some colleges allow students to choose whether to begin with a placement test in arithmetic, pre-algebra, or algebra, for example. Others start all students with arithmetic, then administer additional tests only if a student succeeds. Using its own algorithm, Chaffey College assigned 64 percent of students to an Arithmetic course after 84 percent of those assessed were given an arithmetic test. The college's researchers hypothesized that students' arithmetic skills had gotten rusty while they were studying geometry and algebra in high school (Wurtz, 2009).

These differences in test administration and cut scores contribute to an inconsistent pattern of placement distributions across colleges. Within a single district, one college placed more than half of students four levels below college-level (typically an Arithmetic class), while another placed only 2 percent of its students at that level, according to a recent study (Melguizo et al., 2014). These differences can have serious implications for students' chances of success. The same study found that only 2 percent of students whose first math class was Arithmetic ultimately passed a math class required to transfer to a four-year university, compared to 23 percent of those who placed into Intermediate Algebra and 70 percent of those who placed into a transfer-level class.

Cut scores are not the only area where colleges vary in how they treat test results. According to state regulations, students are allowed to bypass their placement recommendations. But it appears that not all colleges inform students of this option. Some colleges report that 98 percent of students follow their placement recommendations, while others say that as few as 25 percent of students do so (Venezia et al., 2010).

The Limitations and Their Casualties

Although these limitations may sound abstract and technical, in reality they can affect tens of thousands of California students. Consider just one measure: the proportion of stu-

dents passing high school Algebra 2 who must repeat the course in college. An analysis by the Research and Planning Group for California Community Colleges reveals that this constitutes a substantial number of students. Using an intersegmental data set from Cal-PASS Plus, the researchers found that, before enrolling in college, about 37 percent of community college students passed high school Algebra 2 or a higher-level high school math course with a C or better. And yet, half of these students are placed into remedial math, with many requiring two or more remedial courses (Willett et al., 2015). The exact number of students is hard to pinpoint because the data used represents a subset of K-12 and community college students.

Assuming that 250,000 entering students attended high school within the last six years (the same time period as the study's data set), about 47,000 would be Algebra 2 passers required to take remedial classes. (See Box, *High School Math Course Taking and Community College Math Placement.*) Some of these students, according to research from Columbia's CCRC, would be able to pass a transfer-level course. If a similar effect places students who have succeeded in Algebra 1 into Elementary Algebra or below, it is easy to imagine that a majority of students are repeating courses that they may not need to pass the subsequent course.

High School Math Course-Taking and Community College Math Placement

	Percent of Cohort	Placed in College-Level	Placed in Intermediate Algebra	Placed in Elementary Algebra	Placed below Elementary Algebra
All students	100%	29%	27%	24%	20%
No Algebra 2 in high school	46%	14%	24%	31%	32%
Algebra 2 in high school (Total)	54%	43%	29%	18%	10%
Algebra 2 in high school - C or better	37%	50%	28%	15%	7%

Source: Analysis commissioned by the Multiple Measures Assessment Project of the Common Assessment Initiative, performed by the Research and Planning Group using data from Cal-PASS Plus, a K-16 system of student data. Cohort constitutes all students in the data set with a high school record in the prior six years. Due to rounding, percentages may not total 100 percent (Willett et al., 2015).

What is not clear, however, is what sort of policies could mitigate these effects. That decision depends on how a college or system diagnoses the problem. If misalignment is to blame, the solution would involve changing test content. If the colleges' cut scores are overly restrictive, there is a need to relax them. If students have simply forgotten material, refresher courses might be an option.

But in other cases, the correct response is not obvious. Take the selection of sub-test: Does the practice of directing students to start with arithmetic sub-tests boost their confidence, since arithmetic is a comparatively easy subject? Or does it communicate low expectations, making students feel more anxious? Is it best to offer students a challenging test or an easy test first? Psychologist Gerardo Ramirez of UCLA, who studies math anxiety and stereotype threat, notes:

> Both of them can be stigmatizing. I would predict students who are given the lowest-level test are not going to perform as well as you would think. It could create a stereotype threat situation. It's important to significantly investigate what effects this is having on the students' performance. I would critique the assumption that the performance on the test is

indicative of what they actually know.

Nor does allowing students to select their own sub-test resolve the issue. Researchers at the University of Southern California (USC) found that only half of students at a Los Angeles area community college chose to take a math sub-test aligned with their math preparation, and the other half chose a lower-level sub-test. The researchers said this finding may, in part, have been due to "confusion around how the high school sequence aligns with the community college math sequence," but, in any case, under-represented minority students were more likely to choose a lower sub-test than their math preparation would suggest. (Fong & Melguizo, 2015).

A separate dilemma is how to address the concern that students aren't aware of the high-stakes nature of placement assessments. Would informing them of these stakes enhance their performance by prompting them to try harder? Or would awareness of the stakes, in fact, subject minority students to stereotype threat, and depress their scores? At the moment, the question of how placement policies interact with students' self-perceived math ability and influence their test performance remains ripe for research and experimentation.

Changes in the Works

The growing awareness that ineffective and inconsistent placement practices may be harming community college students and that lengthy remedial sequences can impede students' success has led colleges and college systems around the nation to adopt three types of reforms (Burdman, 2012). Frequently, colleges and systems are experimenting with more than one. Each is grounded in different, but not necessarily incompatible, assumptions, and each seeks to more accurately place students:

Assessment Reform	Assumption
Some are **changing the tests**, with several state systems developing new instruments that are better aligned to their curricula.	Assumes test content or design is flawed, but can be improved.
Some are **de-emphasizing the tests** – using, for example, **multiple measures** to determine students' placement, or replacing tests with measures such as high school records. Other approaches include **differentiated placement**, **self-placement**, and **accelerated placement**.	Assumes tests are inherently limited and therefore test results shouldn't have too much weight.
Some are investing in efforts to **support students' test-taking**, such as college-readiness signals in high school and other test preparation assistance to students in high school and college.	Assumes existing test – or a newly designed test – is acceptable (or at least that it's here to stay) and that greater awareness and preparation will allow more students to pass.

Source: Burdman, 2012

Community colleges in California and nationally are exploring all three:

Changing Tests. In recent years, the concern about placement accuracy has led nearly a dozen community college systems to seek to improve their tests. New tests were intended to align better with the colleges' expectations, provide more diagnostic information, or both. As many of these tests were conceived when the Common Core State Standards were in development, most states made an effort to align with the new standards as well. As noted in the second report in *Degrees of Freedom*,

the Common Core math standards cover more algebra content than many community college remedial math programs. As such, many of the new community college tests retain the traditional emphasis on algebra. So far, only Colorado, Indiana, and Texas have set college-level competencies in alternative math pathways (Booth et al., 2014).

States have adopted a variety of testing strategies as well as scoring rubrics. Florida's Postsecondary Education Readiness Test (PERT) replaced ACCUPLACER with test questions developed by faculty. A separate diagnostic test is available after students' initial placement is determined (Burdman, 2011). North Carolina and Virginia both designed new tests to go along with their new modularized math curricula. Texas, which previously allowed institutions to use four different instruments, implemented a new assessment for all public colleges and universities in 2013.

In California, community colleges currently have the autonomy to choose their own tests and placement policies (unlike CSU campuses). They are required to assess students, but they have the freedom to choose one of several tests that have been validated by the system office or select a different test and perform their own validity studies. However, a new initiative aims to unite the colleges behind a single test.

The idea, incorporated in 2011 legislation (and subsequently funded by the 2012 Student Success Act), is that colleges choosing a test other than the common assessment won't be eligible for funding through the state's Student Success Initiative. To facilitate students' transferring between colleges as well as to support research on student outcomes, a system-level data warehouse will also contain scores from the common assessment, as well as some high school transcript information.

Work on the common assessment began in 2013. To date, faculty teams have developed competency maps to determine the test's scope, and the system has chosen a vendor to assist in developing content. The new test will be piloted in Fall 2015 and rolled out in early 2016.

The faculty teams attempted to align the competencies with the Common Core state standards as well as with two sets of community college indicators intended to capture commonalities in the colleges' math curriculum. "As far as alignment, it was much more difficult in math, because colleges structure their math programs and progression very uniquely," noted California Assessment Initiative Project Manager Jennifer Coleman. As a result, the competency maps don't align precisely with either Common Core or the system indicators, but participants made an effort to minimize discrepancies.

If successful, the new test could go a long way toward addressing the variability in test practices across colleges. Other goals include improving placement accuracy and, ultimately, reducing remedial placements. The assessment will operate differently from some systems' statewide tests. Individual colleges will retain their autonomy to determine curricula, set cut scores and establish related policies.

De-emphasizing tests. Concerns about test practices have led states to downplay the instruments in various ways. An extreme example is the Florida legislature's decision to bar colleges from requiring recent high school graduates to take placement tests, which came, ironically, shortly after its new placement test was developed. The more common approach to de-emphasizing tests has been to apply less weight to test results.

Most commonly, colleges use high school grades, along with test scores (or, sometimes, instead of test scores), to determine placement. The research on the predictive validity of tests makes it clear that high school grades, either alone or in combination with test scores, would represent an improvement over the common practice of relying solely

on test scores to determine placement.

While systems such as North Carolina's have developed a statewide policy that relies on high school grades to exempt students from placement tests, other systems leave those decisions to individual campuses. Texas, for example, requires all colleges and universities to use the same test and cut-off scores, but gives them the flexibility to introduce other measures to determine how students are placed.

California's community colleges are ahead of those in most states (and also ahead of CSU) in the use of multiple measures for placement. A 1991 settlement of a civil-rights lawsuit forbids colleges from using test scores as the sole factor in sending students to remedial courses. But the way this requirement has been adopted in many colleges has historically been more perfunctory than thoughtful. About 40 percent of colleges embed questions within their computerized assessment asking students about their prior experiences in math, their high school grades and other background characteristics (Venezia et al., 2010). Often, those measures have very little weight or are not used unless students challenge their initial placement (Bunch et al., 2011). As a result, in one district only 6 percent of all assessed students were able to place into a higher level course on the basis of multiple measures (Melguizo et al., 2014).

Some recent experiments, however, are pushing the envelope. Long Beach City College (LBCC) has been at the forefront of efforts to use multiple measures more effectively. According to president Eloy Oakley, the innovations arose out of the college's partnership with the local K-12 school district:

> We were able to see that the high school faculty and even the middle school faculty in Long Beach Unified were doing a lot of good work around getting students college and career ready, focusing on accountability, looking hard at the numbers, and improving college readiness. But that wasn't translating into data when they got to LBCC. Our data still suggested that 80-some percent were below college-level. That triggered the question: what is wrong? Why does it look like they're still coming in underprepared? Our research team looked at the success indicators and found that one of the worst indicators was ACCUPLACER.

In 2012, when LBCC adopted a new algorithm that heavily weighted students' high school achievement to determine placement in math, the proportion of students starting in college-level math increased from seven to 30 percent. And these students succeeded in the course at similar rates to those placed into the course based solely on the test (Daggar et al., 2015). In simulations at 10 community colleges, researchers found results similar to LBCC's analysis—namely, that using high school data would improve placement accuracy (Willett & Karandjeff, 2014).

A handful of community colleges around the state are experimenting with similar approaches, although some report applying greater caution in math than in English.

- It is not unusual for colleges to exempt students from placement based on scores on the SAT, AP, or other high school tests, but Rio Hondo College in Whittier is going a step farther. The college has experimented with basing students' placement on the highest math course completed with a C or better in the preceding two years.
- Bakersfield College recently started exempting students from placement based on high school course-taking. In math, the requirement is a high school GPA of 3.0 or higher, including a B or higher in a fourth year of math.

The standard for high school English is lower, a 2.6 GPA.

- Sierra College in Rocklin has introduced multiple measures in English, but not yet in math. "We don't have a consensus from our math department yet," said Erik Cooper, dean of planning, research and resource development. "We haven't been able to get a formula that works to the degree we would like."

One obstacle to expanding these efforts has been the challenge of obtaining high school transcripts. Rio Hondo's pilot is an example: the college asked students to provide their own high school transcripts, but the majority of students did not take this extra step. Although the state doesn't have a longitudinal data system, many colleges use the Cal-PASS Plus system. Through Cal-PASS, they can access students' grades from participating high schools. Long Beach started its program using Cal-PASS data, supplemented by additional files from the district, in order to get 12th grade data more quickly. The college's alternative placement system has since expanded to four other districts.

At the state level, a multiple measures work group is analyzing how colleges can best use these and other available indicators for placement. Besides using multiple measures, colleges are also downplaying tests through differentiated placement, acceleration and self-placement. (See Box, *States Downplay Test Scores*.)

A barrier to allowing students in non-STEM majors to opt out of the standard curriculum in some states is the concern that they might change their majors. If a student majoring in history subsequently decides to study physics, that student would likely need the Intermediate Algebra course (or modules) that he or she avoided as a humanities student in an alternative pathway. Both the Carnegie Foundation and Texas' New Mathways Project are developing bridge courses for this very situation. But implementing them may necessitate policy changes as well. At CSU, for example, students who have already been designated "college-ready" are not allowed to take remedial classes.

Support Students' Test-Taking. Instructional improvements in K-12 schools ought to enhance students' math skills, but it is not known whether students will retain more math content as a result. There are two primary avenues for supporting students' success on placement exams: college readiness tests and indicators offered in high school, and refreshers and boot camps offered once students enroll in college. Both address the concern that students may forget math learned in high school.

High Schools. High schools are offering college readiness tests and courses to give students a chance to get caught up before they go to college. California has been a pioneer in this area with CSU's Early Assessment Program (EAP). Over the past decade, that program has provided high school juniors with an indication of their readiness for college-level work based on an augmented version of the California Standards Tests.

Those who are not yet ready can use their senior year to catch up. CSU designed a transition course for English readiness, and designates a set of acceptable senior year math courses. Students who pass such courses can waive placement testing at CSU. Research on the EAP has shown that it may reduce the need for remedial math courses by about 2 percent (Kurlaender et al., 2014).

In 2009, the community college system began participating in EAP on a voluntary basis, and nearly two-thirds of colleges have since become involved. More recently, CSU launched Early Start, which directs incoming students who need remedial courses to summer programs. While no formal study has been published, that program appears to have reduced remedial enrollments by about 10 percent, according to data on CSU's website.

STATES DOWNPLAY TEST SCORES

Multiple Measures

North Carolina, whose community college system participated in one of the CCRC studies on placement testing, was one of the first to introduce a statewide policy to use high school grades for placement. The system uses high school GPA as the first filter, with a 2.6 plus four years of math exempting students from a placement test. Similarly, in 2013, **Massachusetts'** higher education board revised its assessment policy to exempt students from placement tests if they have a high school GPA of 2.7 (or a 2.4 with four high school math courses).

But obstacles are preventing some college systems from climbing on board. The **City University of New York**, for example, also had early exposure to the findings about multiple measures, having participated in a CCRC study, but the system declined to change its placement methodology. "It would have created such administrative chaos here," explained David Crook, dean of research for the CUNY system. "Our placement algorithms are embedded in a common administrative software throughout the system. Any change in policy involves an expensive re-write of the software. We decided for the improvement in accuracy that adding grades would give, it wasn't worth the cost in changing administrative systems."

Differentiated Placement

In adopting new tests, both **Virginia** and **North Carolina** converted their statewide remedial math curricula to a modular approach. Instead of providing a score, these tests direct students to specific modules, based on their test performance and intended major. North Carolina offers eight modules and Virginia has nine. A recent study found that under Virginia's new assessment, the proportion of students placed into college-level math more than doubled. Although conditional pass rates in the course declined, overall completion of college-level math more than doubled because far more students were able to take the course.

Acceleration

New curricular approaches are also leading colleges to approach placement differently. Various models by which students are accelerated beyond where their test score would traditionally place them are another way that colleges and states are de-emphasizing test scores. One example is co-requisite courses, in which students who test into a remedial sequence are assigned to take a college-level course with extra support. Another example is redesigning curriculum to cover two semesters of material within one semester.

Self-Placement

Lastly, some colleges have experimented with self-placement approaches. **San Francisco State University** is doing so in remedial English. However, a self-placement policy would need to be carefully crafted due to evidence that students tend to under-place themselves in math.

Sources: Burdman, 2012; Bracco et al., 2014; Booth et al., 2014; Felder et al., 2007; Rodriguez, 2014.

The Southern Regional Education Board, an association of southern states' educational systems, also has promoted the use of 11th grade college readiness tests paired with senior year transition courses in math and English to help students who are not considered ready for college-level courses. Florida's assessment is now primarily used as an 11th grade readiness indicator, since colleges can no longer require recent high school graduates to take it.

The Common Core State Standards are intended to boost students' readiness for college, which may translate into better test scores. As California transitions to new Common Core-aligned tests developed by the Smarter Balanced Assessment Consortium, CSU plans to use these tests, which will be taken by all high school juniors, as the new college-readiness signal in its EAP program. Most states adopting Common Core intend to do the same.

Colleges. Research reveals that more than two-thirds of students do not prepare for math placement exams. Most were aware they would be taking the tests, but a third of students found out about the test the day they took it, giving them no opportunity to review the material (Fay et al, 2013). To address this problem, some colleges are offering refresher courses for students who may simply have forgotten material, such as how to add fractions, that they learned many years earlier. One college, Rio Hondo, has piloted a policy requiring students to take a pretest before they sign up for a placement exam. In a similar vein, California's assessment initiative will offer students practice tests and other information about placement testing.

"In all frankness, high school students will often experience a course, then forget it," notes Wong, a former high school math teacher. "If we test them on how much they retain, it's going to be less than 50 percent." Of course, not retaining the content is a problem for those students who actually need to use it. Some math educators believe this low retention relates to how math is typically taught. Notes Eric Hsu of SF State:

> I think people underestimate how much decay happens for specific techniques. If they don't understand what they're doing, they're not going to retain it. No matter how well they do in (Intermediate) Algebra, they're going to have to redo that Algebra stuff in Pre-Calculus. They're going to have to redo it in Calculus. They have to keep re-learning it.

Of the incoming freshmen who take CSU's ELM test, only about a third pass, even though they would not be eligible to enroll had they had not passed high school Algebra 2 with a "C" or better. At UC Berkeley, professors who teach introductory math and science classes confirm that even some of their students forget how to add fractions.

Although there is little scholarly research, some experiments with refreshers have revealed promising outcomes. For example, at Cañada College in Redwood City, Calif., a voluntary one-week intensive Math Jam program resulted in 84 percent of students placing into college-level math, about the same proportion of students who typically require remedial math statewide. Of those students, 62 percent passed, better than the usual 51 percent (Booth et al., 2014).

The thinking is that sending students who may just need a refresher into a full-semester Arithmetic class delays their education at best, and at worst discourages and demoralizes them. Increasingly, community college reformers are promoting just-in-time remediation. They argue that it makes the material more relevant than a forced march through an entire high school course.

Katie Hern of the California Acceleration Project uses learning PowerPoint on the job as an example:

> This is a basic skill for many professionals today, but when we're hired at a new job, we

> don't attend extended trainings on the features of PowerPoint, or make our way from chapters 1 through 24 of the user's manual. Instead, we start our jobs. Then, at the moment we need to give a presentation, we figure out how to use PowerPoint, drawing upon people or resources to address what we need ("How do I embed a graph?") (Hern & Snell, 2013).

Various other changes also have been found to enhance students' scores. For example, Bakersfield College decided to try testing students at their high schools instead of at the college testing center. The proportion of students who placed out of remedial courses quadrupled from 3 percent to 12 percent.

New Directions: Re-Contextualizing Placement Policy

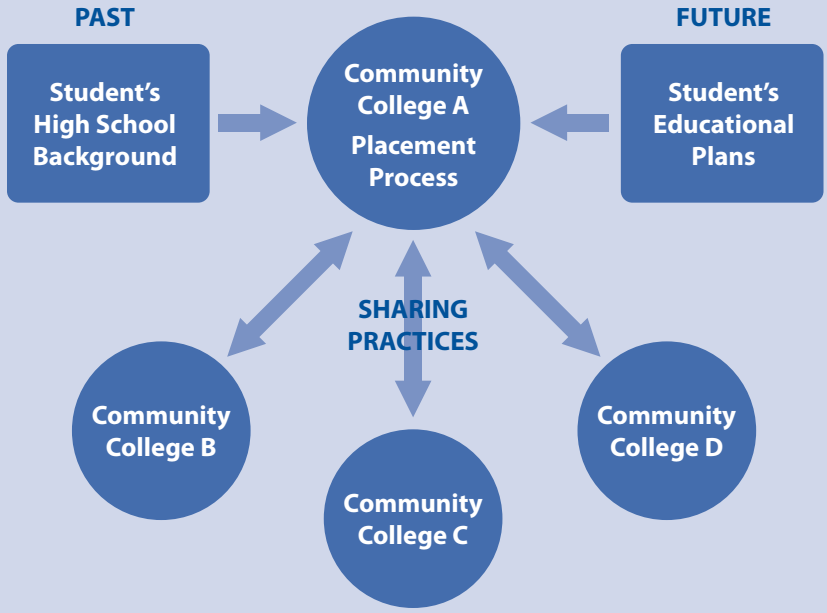
Viewed as a whole, many of the critiques of traditional community college placement policies, as well as of recent reforms, reveal the ways that placement has been de-contextualized: In effect, the process is disconnected from students' **pasts** when their high school experiences are not considered – and when tests do not reflect the curriculum taught in high school. It is disconnected from their **futures** when it does not reference students' academic or career plans.

And in states such as California, the wide variability in colleges' testing practices results in an opacity that may confuse students. It also disconnects the placement process from **other community colleges** as well as four-year universities, which frustrates the goal of providing relevant and transparent information to high schools about how to prepare their students and to four-year universities about incoming students' math backgrounds.

As the community college system moves to implement a new test, a team of researchers from the Educational Results Partnership and the Research and Planning Group is studying various scenarios for using multiple measures to improve the process. The goal of this multiple measures work group is to develop a systemwide algorithm that takes high school information into account. Using that algorithm, colleges will be given guidance about the level of coursework in which students will likely succeed. However, its use will be voluntary. Colleges remain free to use their own algorithm.

Such changes could reverberate across the educational segments, from the universities that enroll community college transfer students to the K-12 schools expected to get students college-ready.

New Directions in Placement



PACE

Re-Contextualizing Placement

The effort to develop new tests and placement policies might be thought of as re-contextualizing placement by addressing three sets of questions:

CONTENT. Can the math knowledge expected of students be contingent on their educational goals? What math knowledge should be expected of all students and what should be required only of students in certain majors?	Research on this question is limited. It is estimated that only about a quarter of university graduates, and a lower proportion of community college graduates, use algebra in their careers (Burdman, 2013). Positive preliminary results of statistics and quantitative reasoning pathways, as well as several states' modularized curricula, illustrate the potential of multiple math pathways to enhance success for non-STEM students.
MEASURES. How can colleges use high school grades and other measures to determine whether a student requires remedial prerequisites, and if so, which prerequisites? In particular, can passing designated high school math courses constitute readiness for college under any scenario?	In a simulation conducted by researchers at USC, a placement algorithm that puts more weight on students' prior math course-taking, in addition to course grades, "disproportionately assists students at the lower levels of the math sequence." Fewer students were placed into the two lowest courses – Arithmetic and Pre-algebra. Placements into Intermediate Algebra and college-level math increased across racial groups (Fong & Melguizo, 2015).
CONSISTENCY. Where are there opportunities for colleges to contribute to a coherent, equitable, and transparent vision of math readiness for California by voluntarily sharing placement practices?	There is not clear evidence that uniform placement policies are more effective. However, if evidence emerges that certain practices are more effective than others, more colleges in California may choose to voluntarily adopt them. Experiments such as Long Beach City College's, as well as the development of a common placement test, also could set the stage for colleges in California to share additional policies voluntarily.

Consider the high school Algebra 2 passers who may be sent to remedial courses. Accepting a C or better in Algebra 2 (or higher-level math) in lieu of placement could relieve up to 47,000 students a year from remedial math courses without violating UC and CSU transfer policies. If a cut-off of a B or better were used, then about 21,000 students could potentially be considered ready for college-level math (Willett et al., 2015).

University implications. As discussed in the second report in this series, both UC and CSU expect incoming freshmen and transfer students to have completed high school math through Algebra 2 (or the Common Core equivalent). While both systems have allowed a few exceptions, neither has altered its two-year algebra requirement, in principle. The resulting tension makes it difficult to use intended major as a placement measure for students who may transfer.

However, when it comes to using high school course-taking for placement, there are no policy obstacles, since placement is a community college prerogative. In interviews, UC faculty leaders confirmed that they would not object if community colleges allow students who have passed Algebra 2 (or the Common Core equivalent) with a C or better to enroll in college-level math classes.

In fact, such an approach would be fully consistent with policy at UC: The system requires entering students to have earned a minimum of C on each course in the prescribed "A to G" course pattern, but most campuses do not require further testing, unless students wish to take a Calculus course.

"I'd be perfectly happy to let those students take whatever they want because they've met the 'A to G' as high school students, and we shouldn't worry about it," said George Johnson, a UC Berkeley professor of mechanical engineering and former chair of the UC system's Board of Admissions and Relations with Schools.

"If someone's completed their three years of math, and have been admitted to UC, they ought to be allowed to take a Statistics course at UC," said Bill Jacob, a UC Santa Barbara math professor and former president of UC's academic senate. "If they can pass it, they're off and rolling. That's what UC has always done. We've been very clear. If they complete three years of mathematics, they're done. We do have a writing placement test. We don't have one in math."

The reaction at CSU could be different, however, because that system uses its own placement exam. Since the system has lower admissions criteria than UC, CSU faculty worry about students' math readiness. According to CSU's admissions requirements, incoming students have also earned a C or better in their high school Algebra 2 classes. Yet, about a third must take remedial courses due to low test scores. Unlike community college math faculty, who are often ambivalent about their placement tests (Melguizo et al., 2014), many CSU math faculty believe that their current test, the Entry-Level Mathematics test, does a good job of capturing the algebra, geometry, and numeracy skills their students need.

"The ELM is an excellent test," said Kate Stevenson, a Cal State Northridge professor who coordinates her campus' remedial math program. "It's so predictive of student success. It tracks very well with how students do in the basic gen ed math courses." Stevenson says that CSUN data show a positive impact of remediation on students' performance in most college-level math courses, though the effect is not as strong for statistics.

Tyler Evans, a Cal State Humboldt math professor who chairs the system's placement test committee, says the test performs well on validity studies. The last such study was conducted about eight years ago. CSU officials declined to provide a copy, but an official at the Educational Testing Service indicated that, in the opinion of math faculty surveyed at 10 CSU campuses, more than 85 percent of students were appropriately placed. Of students placed in developmental courses, the faculty judged that 13 percent were underplaced. A predictive validity study (to see how well test results predict students' course outcomes) was not performed.

Each year, about 11 percent of Cal State students leave the system because they fail to complete remediation in math and/or English, but the exact proportion for math is not published. Because most campuses are oversubscribed, and the attrition rate in developmental math at CSU is considered low, there is little discussion within the system about allowing students to waive placement testing based on high school grades. Stevenson and some colleagues are concerned about anecdotal evidence that, in some parts of the state, community colleges' placement exams set a bar higher than the ELM. But exempting students from testing goes farther than most CSU mathematics faculty recommend.

Yet, more test exemptions may be coming, via a different route. Starting in 2015, the new Smarter Balanced assessment will become the college readiness signal for the EAP program. Administrators are concerned that fewer CSU students will

demonstrate readiness on the new test.

A 2015 study by ETS for the state Department of Education found that, of a sample of high school students, 45 percent were "conditionally ready" on the original EAP instrument, but just 30 percent reached that benchmark on the Smarter Balanced field test (ETS, 2015). Conditionally ready students are eligible to waive placement if they pass a senior year course. For 2015 graduates, CSU has expanded routes to conditional readiness by accepting a 490 on the math SAT or a 20 on the math ACT – vs. 550 or 23 for unconditional readiness (Brynelson & Cardenas, 2014).

High School Implications. A move toward differentiated placement – i.e., making placement decisions contingent on students' choice of major – could also have unpredictable effects on high schools. While some analysts believe that giving college students choices about their math prerequisites is an idea whose time has come, many are wary of extending that choice to high school students and allowing them to opt out of higher-level algebra classes prematurely. However, Common Core does have a subset of standards just for STEM students. So, to some degree, this is already happening.

A policy to use high school course-taking for placement could also have implications for K-12 schools. K-12 reform efforts in recent years have been accelerated due to concern about the large proportions of college students needing remedial courses, and the Common Core standards were developed with existing remediation rates in mind. For colleges to shift their expectations – and thereby reduce those rates – could disrupt that agenda.

Until now, expectations for students have been remarkably consistent: Completion of two years of algebra has been the standard for university admission, for access to the community college math courses required for transfer to a four-year institution, and for earning a two-year degree (in California and many other states). This is typically signified by the completion of Algebra 2 in high school or Intermediate Algebra as a college remedial course. The Common Core math standards retain this general emphasis, although the authors tried to make the algebra content more realistic.

Ironically, the reforms centered on the Common Core standards rely on testing as a way to standardize expectations and improve students' preparedness. But the experience of community college placement testing illustrates the challenges to doing this effectively. So community colleges' growing wariness of college readiness testing coincides with K-12 systems' embrace of it.

Ultimately, how community colleges would implement the use of high school course-taking for placement would affect that policy's impact on high school reforms. If the policy were tied to explicit approval of the new high school math content, it could reinforce current K-12 reform efforts centered on Common Core. If the policy ends up blessing historical K-12 practices by default, it could undermine the new policies. In a state like California, which requires only two years of high school math to graduate, awareness that students could qualify for college-level courses might lead more to take at least three years of math. Currently almost half of community college students did not take the typical three-course high school math sequence in high school (Willett et al., 2015).

But if community colleges begin to emphasize high school course-taking for placement while the CSU system continues its reliance on test results, the signal transmitted by these readiness policies, and thus their potential to motivate stronger preparation, will be diluted. That, in turn, would diminish the ability of new Common Core assessments to serve as a valid readiness indicator. As the New America Foundation noted in a recent report:

> Public colleges and universities will need to adopt more consistent and reliable policies around placement decisions. Otherwise, the inconsistent use of inadequate college course placement tests will continue to be the norm, and students who pass those college- and career-ready assessments will be only a little better off than they were before (Tepe, 2014).

Looking Ahead

Degrees of Freedom began with an examination of the evolution in college math requirements. While the quantitative demands of various fields are growing and expanding, leading to emerging diversity in undergraduate math curricula, general education math requirements and, particularly, remedial requirements have been slow to reflect this diversity. Math requirements serve as a filter for transfer from community colleges to universities. In the process, community college students may be held to a higher standard than their similarly qualified university peers. Furthermore, underrepresented minority students may be particularly disadvantaged by the placement system.

College math requirements and associated assessments should serve as a foundation for students' academic success, not merely as a filter to manage enrollment. Otherwise, they have a diversionary effect. Given what research shows about community college math placement exams and the remedial math sequences to which they assign students, it has become increasingly difficult to justify sentencing students to multiple remedial courses based on a score on a one-hour test. The CSU system's relative satisfaction with its test suggests that the ELM could be an exemplar of a more effective test – but that exam merits greater scrutiny by the research community.

While Erika and Lulu both found pathways out of the long remedial sequences to which they were assigned, many of the tens of thousands of students who find themselves trapped in a similar maze are not as fortunate. A failure to address such barriers is tantamount to diverting a generation of students from earning a college degree and to giving up on California community colleges' democratizing role.

As *Degrees of Freedom* has shown, confronting these barriers will require California's higher education systems, as well as state policymakers, to adopt realistic policies in several areas:

- general education math requirements and prerequisites,
- higher education attainment goals and the resources to achieve them, and
- placement policies that reduce the likelihood of under-placing students, in order to give more students a fair shot at earning degrees and the state an opportunity to increase college attainment.

It also entails re-thinking some assumptions commonly held within higher education about how we determine who is college material. As UCLA's Astin wrote:

> The real problem here is that we value being smart much more than we value developing smartness. In our relentless and largely unconscious preoccupation with being smart, we forget that our institutions' primary mission is to develop students' intellectual capacities, not merely to select and certify those students whose intellectual talents are already well developed by the time they reach us (Astin, 1998).

To heed Astin's call, California's higher education institutions should rethink their placement policies in the following ways:

- Community colleges should utilize their autonomy over placement policies to devise strategies that are pragmatic, transparent, and supportive of students' success. In particular, students' high school grades and intended majors are potentially strong criteria

to be utilized, in addition to test scores, for placement decisions.

- Colleges should differentiate between requiring certain high school preparation and requiring students who have had that preparation to remember it when taking a placement exam, regardless of whether they will need to use the knowledge later. As such, mandatory placement testing should be matched with opportunities for refreshers and pretests.
- Community colleges should also consider aligning their placement policies at the regional or state level to the extent possible. Consistency across colleges will further transparency and equity for students and promote alignment with other segments.
- Policymakers and education leaders should collectively ensure that longitudinal data is available for colleges' use in placement as well as for feedback to high schools about their students' remedial placements.
- The education systems should study CSU's ELM test, including its content and predictive validity, to understand its alignment with community college assessments, the Common Core standards, and CSU's own undergraduate courses. The implications of using high school grades for placement at CSU should also be analyzed.
- The CSU system and community colleges should analyze Texas' new assessment to consider the possibility that the two systems could share a placement exam.
- Researchers should study the effects of math anxiety and stereotype threat and their interactions with placement testing practices and conditions. The evidence should be used to support policy changes that mitigate these effects.

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