

THE MATH PROBLEM

Removing the Math
Barrier to College
Completion

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Introduction

Mathematics education in the United States is at a crisis level. In California and across the nation, students are entering college with individual math proficiency deficits that must be more effectively addressed. Resolution is essential in order for students to succeed in higher education, complete their degrees, and successfully compete in the modern job market.

The traditional method of placement tests and remedial or developmental math courses have failed to effectively resolve this math problem, and has severely handicapped many students from continuing in higher education pathways. Data clearly shows that the problem has disproportionately impacted under-represented minority student populations in particular.

A number of states, led by bold actions in California, have abolished placement tests and eliminated pre-requisite developmental math courses, either by legislative mandate or by executive order. In their place, multiple measures of prior learning are being used to place students in college-level math courses wherever possible. While this method is far more socially equitable, individual math proficiency deficits continue to persist.

To better understand this challenge and survey the experimentation occurring within community colleges and universities, the Precision Institute of National University commissioned a report to codify how the California Community Colleges and the California State University Systems are proceeding after having abolished placement tests and non-credit, pre-requisite developmental math programs because of AB 705 and EO 1110.

In the resulting report, *The Math Problem*, noted education writer Richard Lee Colvin examines the need to move from placement tests and traditional developmental education to evidence-based strategies that actually support meaningful student success. Colvin was the executive director of the Hechinger Institute on Education and the Media at Columbia University and was the Managing Writer at the U.S. Department of Education.

National University and our nonprofit research partner, the National Laboratory for Education Transformation, welcome further dialog and collaboration on these important issues and invite comments on this report and on the issues it highlights.

This report can be found online at www.MathProblem.org and comments can be forwarded to Info@nlet.org.

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Executive Summary

Global economic competition and the growing importance of advanced technologies across sectors of the economy ranging from communications and manufacturing to retail and transportation, coupled with the aging of the Baby Boomer generation and an increasingly diverse workforce, are intensifying the pressure on institutions of higher education in California and nationally to solve a longstanding problem: produce more graduates, even as non-traditional students account for a greater proportion of enrollments that are shrinking.

Currently, about 48% of working age Americans hold an industry-recognized credential, a certificate of work-related knowledge or skills, or an associate's degree or higher.¹ That percentage is 10 points higher than it was in 2008, before the beginning of the Great Recession. However, given current workforce trends, that figure needs to rise to at least 60% by 2025 to keep up with demand. The Lumina Foundation estimates that the nation needs to award 16.4 million postsecondary degrees or credentials to reach that goal by 2025.

Working adults in California as a whole are slightly more likely than the national average to have earned those credentials or degrees. However, the Public Policy Institute of California reports that, by 2030, California will have 1.1 million fewer baccalaureate degree-holders than the state economy will need.² PPIC estimates that 38% of the jobs in the state will require a bachelor's degree by then but projections show that only 33% of workers are expected to have one, unless the production of degree-holders increases. Areas such as San Diego, Orange, and Los Angeles counties as well as the San Francisco Bay Area are particularly affected by these shortages of highly skilled labor.

One of the ways California policymakers and educators are trying to meet the demand for more college graduates is to remove a barrier that blocks many from graduating: ineffective developmental education classes, particularly in mathematics, that bog students down and contribute to their decisions to drop out of school.

In response to the mounting evidence of the ineffectiveness of developmental courses nationally more than 20 states are working to reform or even eliminate those classes entirely. Florida, Virginia, Connecticut, Texas, Kentucky and, most recently, California, now have policies designed to limit or do away with such courses.



Tragically, studies have found that many students do not even need the classes. One study found that at least half of students required to take developmental classes could, given the opportunity, pass a college-level algebra class.³

In California, only one in four students who were placed in developmental education classes were passing.⁴ Students of color fared even worse. Only 2% of Latino students and 1% of African American students who started out in the lowest level of developmental education classes eventually passed a college math class.

Community Colleges and California State University campuses are moving quickly to develop new support strategies, supports that can take many forms: providing students with just-in-time help with a particular skill by either the professor or embedded tutors; requiring students to enroll in a companion support course that gives students extra time and attention to get up to speed; providing one-on-one or group tutoring; or connecting students to online platforms that use artificial intelligence to infer what content and in what format will be most helpful to students.

This report uses terms such as developmental education and remedial interchangeably as the general population and media often do. However, there are distinct differences. Developmental Education encompasses much more than just pre-collegiate courses. It includes supporting students through instructional strategies, counseling, advising, tutoring and study skills. Remedial courses are courses that are pre-transfer level, generally in mathematics and English reading and writing, and cover the same content that students previously had in their high school courses. In essence, the students are repeating classes that they have often already taken. Foundational courses include the remedial courses as well as some developmental education strategies. In addition, the content of remedial courses is foundational if students have not taken those courses in high school. While courses traditionally termed **remedial** are being phased out, other **developmental** strategies described above are very much still being used to support students.



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Removal of Developmental Mathematics in CA

In 2017, Timothy P. White, the Chancellor of the California State University, issued Executive Order 1110, ending the use of placement tests for entering freshmen and eliminating non-credit developmental mathematics and written communications classes across the 23-campus system by Fall 2018. The order was framed as part of a broader CSU effort to increase its four-year graduation rate from 19% to 40%. The stated goal of the directive was to give all students, regardless of their previous educational experiences, the opportunity to finish their graduation requirements in math and composition during their freshmen year.

A month later, the California Legislature passed, and Gov. Jerry Brown signed AB 705, which went into full effect in Fall 2019. The legislation required the 114 California community colleges to make significant changes to how students are placed in math and English classes, eliminate developmental classes as requirements, and find ways to better support for students not ready for college-level classes.

The legislation and the Executive Order set in motion a rapid redesign of courses, curricula and majors as well as decisions about staffing, advising, scheduling and how best to support students. The result is that many more students are enrolling directly in college-level classes and colleges are working in a variety of ways to help them polish their skills, refresh their knowledge, and keep up with their classmates. That support can take many forms: providing students with just-in-time help with a particular skill by either the professor or embedded tutors; requiring students to enroll in a companion support course that gives students extra time and attention to get up to speed; providing one-on-one or group tutoring by a graduate student or advanced undergraduates; or connecting students to online platforms that use artificial intelligence to infer what content and in what format will be most helpful to students.

It is too early to say how these new structures are working. The CSU policy went into effect in the fall of 2018 and the results of the first semester under the new policy were positive. In both the fall of 2017 and the fall of 2018, about 17,500 students were deemed to be in need of academic support. In 2017, only about 1,400 of those students enrolled in a college-level math class; in 2018, almost 12,000 students did so. In 2017, only about 950 students passed a for-credit math class, moving them a step toward graduation. A year later, almost 8,000 achieved that milestone.

Many California community colleges began implementing the changes AB 705 called for even before it was due to be fully in effect. As part of the Multiple Measures Assessment Project, funded by the Chancellor's Office of the California Community Colleges, more than 90 colleges had been working for years on moving away from using a single placement test for assessing student readiness for college level and developmental courses, and instead using high school GPA and other course taking data to place students. This shift had already produced impressive results and required colleges to re-evaluate their math pathways and course offerings. According to an analysis by the RP Group, the percentage of students enrolling in transfer-level classes has more than doubled in writing and math classes at a sample of almost half the state's 115 community colleges.



Reaction by the CSU and Community Colleges

Although outcomes were positive, the CSU and community college systems acknowledge the results were uneven, but they also expect results to improve even more as colleges refine and revise their initial response to the Executive Order and the legislation.

But many faculty members at CSU campuses and community colleges remain skeptical and fear the policies will do more harm than good. They worry about classes being watered down, especially in the community college system, where a portion of state funding is based on pass rates. They say the financial incentive to pass students will cause instructors and administrators to lower their standards. They also are concerned about the students who will still fail the redesigned classes, even with extra help. Where will they turn if all developmental education classes are eliminated? Finally, there is concern that these policies will not help students who are most likely to leave college without a degree, especially students of color, or that they will be directed disproportionately into less math-intensive fields that are less likely to lead to lucrative careers.

On the other hand, most faculty members interviewed acknowledged that developmental education was not working on most campuses as they were currently being taught and that it was time for other solutions to be tested. AB 705 and Executive Order 1110, both ambitious, sweeping, top-down policy directives, create the conditions for a grand experiment. Although reforms to developmental education seem to be succeeding, the evidence of how best to design co-requisite courses for different student populations and different educational and institutional contexts is limited.

Essentially, what these policies are calling for is change across every function and service of the campus—away from a view of higher education as a privilege reserved for the elite and toward a perspective that is more inclusive and recognizes the value of a degree or credential not just to the individual but to communities, states, and the nation.

Interviews with educators at community colleges and CSU campuses across the state reveal the enormous effort a cultural change of this magnitude entails, and the resource, campus governance, institutional organization, instructional quality, academic freedom, and technology issues it raises.

It will take sustained investments and an ongoing commitment to learning from these nascent efforts and helping them spread if they are to have a significant impact on student success.

For this to occur, campuses will need to quickly gather and share data on their students and the effectiveness of their policies and be willing to make revisions as soon as they are indicated. Faculty and staff must be central to the success of these policies and campus as well as system leaders will need to create opportunities for faculty members to learn more about how their peers are approaching these challenges. Ideally, that will facilitate a process of continuous improvement. Increasing the number of Americans earning valuable credentials or degrees is a “hard problem, one that is worthy of sustained, iterative, and reflective policy investment at the state and local level.”⁵



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"Readiness [to do college-level math] has to do with students' level of understanding and also their desire and motivation to address their misconceptions, re-engage in the content, and use and apply new, correct understandings, and those are things that need to be considered as the state thinks about how to support students."—Kim Samaniego, Math Diagnostic Testing Project, University of California, San Diego

The purpose of this paper is to support that process, in San Diego and across California, by gathering information on the initial implementation of these policies.

Recommendations and Reflections

Summary of recommendations from the field:

- Define success appropriately. AB 705 considers "throughput," which means the number of students passing a transfer-level course, as a key indicator. That number is considered to be so consequential that 20% of community colleges' state funding is based on the pass rate in these courses. However, passing a course does not necessarily equate to learning the material well enough to pass subsequent math courses along with non-math courses having a math or statistics prerequisite, such as upper division psychology, nursing, and economic courses. It is important, therefore, to identify relevant, appropriate assessments that measure actual learning and can be compared across departments and campuses. Data are especially important for monitoring how well different groups of students are being served by these new approaches, ensuring that equity gaps are shrinking, not being made worse. Co-requisite classes and redesigned math pathways will undoubtedly help more students reach their educational goals. It is critical, however, to not merely accept those results in the aggregate. It is critical to ask who is benefiting from these policies and practices and who is not.
- Data also should be gathered, analyzed and distributed to highlight programs that are succeeding. Both the CSU and community college systems should find ways to facilitate the sharing of knowledge among their campuses through convenings, online discussions and opportunities for faculty and other campus personnel to travel to learn from colleagues in other parts of the state.



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- Both community colleges and the CSU system are offering professional development and mentoring opportunities to help their faculty members adapt their teaching methods to serve a broader range of students. But much more professional development is still needed and should be provided as well for counselors, academic advisers, and other support staff.⁶
- Community colleges reported that they will refer students needing more support to tutoring centers, hire “embedded” tutors who will help students and provide feedback to instructors, establish “early alert” systems to help instructors identify students falling behind, and provide more student counseling and advising. But colleges say they need more funding to pay for those services. Campus administrators should identify sources of new funding or reallocate existing resources to meet students’ needs. The Chancellor’s office should also identify funds it can reallocate or advocate for more funding from the state Legislature to support the changes in practice required by AB 705.
- The CSU system also should ensure that its campuses are providing funds to fully implement the executive order. Relevant and aligned support is necessary for co-requisite courses to serve the needs of students who might previously have been placed in developmental education classes. As of now, several CSU campuses reported that those support courses are being led by more advanced undergraduates rather than by either faculty or adjunct instructors. If helping more students pass is considered a high priority, then colleges will need to not only staff these classes with faculty members, they’ll also need to provide them with professional development opportunities or qualified graduate students.
- Campuses must reallocate resources to be sure they are offering enough sections of transfer-level courses to meet the demand not just for students pursuing STEM fields but also statistics and quantitative reasoning.
- The CSU and community college systems, as well as the campuses themselves, must also find ways to deal forthrightly with faculty apprehension about or even hostility toward these new policies. One researcher reported that some faculty believed the new policies were “just a shortcut to pass along underprepared students.”⁷ Another faculty member commented that students who don’t at least pass intermediate algebra should not be allowed to earn a degree. Campus and system leaders need to be willing to engage critics of the reforms, solicit their ideas and suggestions, and share data to foster healthy, productive discussions.



- It is critical that state, system, and campus leaders frame these reforms as a statewide effort, even as the policies are implemented on individual campuses. Given the size of the state, and the challenges of convening leaders from across the state in one place, it would be helpful to form regional consortia of CSU, community college, University of California, private non-profit institutions, K-12 educators, subject matter experts and business leaders to establish performance goals, identify roles and functions, share results, communicate expectations, conduct research, and monitor progress.
- Partnerships between UCs, CSUs, CCs, and private universities, such as National University, also are important for sharing expectations as well as techniques and, possibly, specific technologies. Intersegmental rivalries are unproductive. It may be, for example, that some math classes are better taught at CCs, where sections are smaller. Transfer rules need to be clarified.
- Advisers need to be fully briefed on the new placement guidelines as well as the tradeoffs for students who will have more discretion in deciding which classes to take. Some students, for example, will avoid options they think will be more difficult but that will also not help them make progress toward their educational goals.
- Faculty from non-mathematics departments also need to be involved in decisions about curriculum and expectations. Economics professors, for example, may think that newly designed courses do not provide students with the math knowledge and skills students will need to succeed in that field. They may respond by adding an additional math course specific to economics, which would defeat the purpose of accelerating students' progress that is the goal of redesigned math sequences. Institutions of higher learning are complex social organizations and strong leadership is needed to make sure all of a campus's assets are fully leveraged in this important pursuit.

Removing one of the barriers to student graduation by eliminating standalone developmental education classes is an important step. But it is only one element of what must become a comprehensive agenda for improving student learning and completion rates. All institutions of higher education in the state, including private colleges, must dedicate their efforts to the cause.



The Math Problem

Overview

Global economic competition and the growing importance of advanced technologies across sectors of the economy ranging from communications and manufacturing to retail and transportation, coupled with the aging of the Baby Boomer generation and an increasingly diverse workforce, are intensifying the pressure on institutions of higher education in California and nationally to solve a longstanding problem: produce more graduates, even as non-traditional students who often need more academic help account for a greater proportion of enrollments that are shrinking.

Currently, about 48% of working age Americans hold an industry-recognized credential, a certificate of work-related knowledge or skills, or an associate's degree or higher.⁸ That percentage is 10 points higher than it was in 2008, before the beginning of the Great Recession. However, given current workforce trends, that figure needs to rise to at least 60% by 2025 to keep up with demand. The Lumina Foundation estimates that the nation needs to award 16.4 million postsecondary degrees or credentials to reach that goal by 2025.

Working adults in California as a whole are slightly more likely than the national average to have earned credentials or degrees. However, the Public Policy Institute of California reports that, by 2030, California will have 1.1 million fewer baccalaureate degree-holders than the state economy will need.⁸ PPIC estimates that 38% of the jobs in the state will require a bachelor's degree by then but projections show that only 33% of workers are expected to have one, unless the production of degree-holders increases. In certain parts of California, including Los Angeles, San Diego, and Orange County, as well as Silicon Valley and the San Francisco Bay area as a whole, the mismatch between the demand for well-educated workers and the available, skilled workers is even starker.

In San Diego County, for example, the educational attainment numbers are better than both the statewide and national averages.⁹ About 45% of San Diego residents over the age of 25 have an associate's, bachelor's, or professional or doctoral degree, compared to 40% for California as a whole.

At the same time, however, because of the many technology- and data-dependent enterprises in the region, the demand for highly educated workers is strong and is likely to increase. San Diego is home to 600 companies that create sports-related products and services; 600 companies in biotech and other life sciences; 1,100 businesses focused on wireless and computer software products; 250 developing energy and environmental solutions; and 300 in fields related to defense and security.¹⁰ It also is home to more than 80 research institutes, among them such leaders as The Scripps Research Institute, the largest independent research organization in the country; the Salk Institute for Biological Studies; the Sanford-Burnham Medical Research Institute; the West Health Institute; and the J. Craig Venter Institute.



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A recent analysis by EMSI, a firm that gathers and analyzes labor market data for universities, workforce development agencies, and corporations, found that the number of biotech and research jobs in the region is growing seven times faster than the national average. For positions requiring advanced degrees, companies can recruit talent nationally and internationally. But these enterprises also need to fill jobs requiring basic data, communications, technical, and business-related skills, which can be acquired by earning a bachelor's or associate's degree or skill-based credentials in a relevant field. Applicants for those jobs are likely to come from the local labor market.

In San Diego, like the rest of the state, hiring locally will mean hiring more Hispanics, who now make up 34% of the county's residents. However, only 16% of Hispanics 25 years and older in San Diego County hold a bachelor's degree or higher. About 38% of the county's white residents, 50% of its Asian population, and 24% of its African American population have reached that educational milestone.¹¹

It will also require accommodating the widely varying needs of the growing number of adults who are either starting college or returning to college after a hiatus. About 35 million Americans over the age of 25 have attended college but did not finish a degree.¹² In San Diego, about 22% of adults have attended college without earning a degree.¹³

San Diego County has the institutional capacity to meet the challenge of increasing educational attainment. It is home to the University of California, San Diego, considered to be one of the top 10 public universities in the country. The county also has two California State University campuses, San Diego State University and Cal State San Marcos, which together enroll almost 50,000 students. National University, which primarily serves adults starting or continuing their education, Point Loma Nazarene University, and the University of San Diego are private, non-profit institutions in the county. Finally, the county has seven community colleges, several of which operate multiple campuses.

To meet this demand, the CSU campuses, the community colleges, and National University are rethinking how they serve the educational needs of enrollees who appear not to be ready academically to succeed in college-level mathematics and writing classes based on their performance on placement tests. Those students tend to become mired in developmental education courses that do not bring them closer to graduation while eating up their allotted financial aid. They also are far more likely to drop out of college.

In California, only one in four students in developmental education classes winds up graduating.¹⁴ Students of color fare even worse. Only 2% of Latino students and 1% of African American students who started out in the lowest level of developmental education classes eventually pass a college math class.



Academic Issues a Barrier for Many

Of course, academic performance, particularly in math, is only one of many issues that divert students from the path to graduation. Financial strains, conflicting work or family obligations, poor time management, difficulty adapting to the independent learning expected of college students, inadequate academic counseling, and other factors contribute to students' decisions to leave college without a degree. A third of students who drop out do so before their sophomore year. Addressing these issues with more intensive advising, the formation of cohorts, mentoring, workshops on study skills, additional financial aid, funds to meet students' emergency needs, and other services are essential to boosting graduation, research on successful programs has shown.

But the problem of ineffective developmental education must be addressed if more students are to be able to reach their educational goals. The focus of this paper is the efforts underway in California as well as states and institutions of higher education across the country to identify and implement better ways to help students overcome academic weaknesses, particularly in mathematics.

Nationally, about 70% of community college students and about 33% of students entering four-year public colleges are deemed to be unready to enroll in college-level math and writing classes. Until relatively recently, the response of most colleges has been to require those students to take remedial classes in either composition or mathematics or both. In the case of math, that typically has meant requiring some students to take and pass three or even four non-credit courses, often starting with reviewing fractions, decimals, factoring, and calculating the slope of a line—concepts typically studied in middle school or before. The goal of developmental math classes has been preparing students to take and pass a college-level class in algebra. But that rarely happens.

Although well-intentioned, developmental math classes hold back rather than help many students, multiple studies have found. In 2012, researchers at Columbia University's Teachers College reviewed eight rigorous studies and reported that seven of them found that developmental classes had either no statistically significant benefit to students or even harmed them.¹⁵ Many other studies have reached similar conclusions.

In one study, Teachers College researchers tracked almost 67,000 college students who were expected to pass a sequence of three developmental math classes and discovered that only 11% ever completed college-level introductory algebra.¹⁶ More than a fourth of those students gave up before even attempting the remedial math classes to which they had been assigned. Others passed the first class but, recognizing the long road ahead, did not enroll in the next class in the sequence. Some even passed all of the required pre-college-level classes but never signed up for a college-level class either because they were not confident of passing it or because they had used up their eligibility for financial aid.



Moreover, the classes are expensive to offer. According to one calculation, colleges spend roughly \$7 billion per year on developmental classes.¹⁷ The cost to society of the unrealized human potential of students who start but do not complete college vastly exceeds that figure, if it can even be quantified.

Tragically, studies have found that many students do not even need the classes. One study found that at least half of students required to take developmental classes could, given the opportunity, pass a college-level algebra class.¹⁸ Moreover, many believe that students not intending to major in science, technology-related, engineering or math-related fields do not even need to know very much algebra, which has always been a stumbling block for many students. In fact, for many majors, studying statistics makes more sense.

National Movement to Improve Developmental Education

In response to the mounting evidence of the ineffectiveness of developmental education, particularly in mathematics, more than 20 states are working to reform or even eliminate those classes entirely. Florida, Virginia, Connecticut, Texas, Kentucky and, most recently, California, now have policies designed to limit or do away with such courses. The result is that many more students are enrolling directly in college-level classes and colleges are trying to find ways to help them polish their skills, refresh their knowledge, and keep up with their classmates. That support can take many forms: providing students with just-in-time remediation by either the professor or embedded tutors to help students needing help to master a particular skill; requiring students to enroll in a companion support course that gives students extra time and attention to get up to speed; providing one-on-one or group tutoring by a graduate student or advanced undergraduates; extending a one-semester class to two semesters to give students more time; or connecting students to online platforms that use artificial intelligence to infer what content and mode of instruction will be most helpful to students, based on what benefited similar students in the past.

Texas, for example, mandated that, by 2020, 75% of all developmental education is to be delivered via co-requisite classes incorporating support mechanisms rather than through prerequisites. Unlike separate remedial classes, these co-requisite classes count toward graduation. Prior to the policy change, only 3% of Texas students who scored at the lowest level of the ACT math placement exam, and who, therefore, would have been required to pass several developmental classes, ever completed an introductory college math class. Nearly 60% of similar students who took a redesigned co-requisite class met their college math requirement within two years of enrolling.



In 2013, Florida gave a majority of its state college students the option of skipping developmental education courses and enrolling in college-level classes for credit. The law also required colleges to adopt more engaging instructional strategies and provide additional academic support, such as tutoring and “early warning” systems to let professors know when individual students began to falter. The result, according to one study, was that 22% of students passed a “gateway” or introductory math class, compared to 17% before the policy change. The policies also were credited with narrowing the equity gap, with the number of credits earned by African American and Hispanic students growing faster than the number of credits awarded to white students.¹⁹

Tennessee was one of the first states to begin phasing out traditional approaches to remediation, adopting the co-requisite approach instead. Prior to implementing co-requisites, 12% of students completed their developmental requirements and a college course in one semester; in the first year of implementation, 60% of students completed those classes.²⁰ The college completion advocacy organization Complete College America reports similar success rates with co-requisite classes in Georgia, West Virginia, and Indiana.

California’s Bold New Developmental Education Policies

California is in the process of implementing the most sweeping reform of developmental education by, essentially, doing away with it.

In 2017, Timothy P. White, the Chancellor of the California State University, issued Executive Order 1110, ending the use of placement tests for entering freshmen and eliminating non-credit developmental mathematics and written communications classes across the 23-campus system by Fall 2018. The order was framed as part of a broader CSU effort to increase its four-year graduation rate from 19% to 40%.

The order called for a redesign of college-level classes as co-requisites. Colleges could help students who previously would have been assigned to remedial classes pass college-level classes by stretching a one-semester course over two semesters to give students more time, embed instructors in those classes for students needing extra help, or provide supplemental instruction in other ways. It also recast the system-wide Early Start program, a summer tutoring session some students had previously been required to enroll in and pay for although they did not earn college credit for it, as an optional class that counts toward graduation. The stated goal of the directive was to give all students, regardless of their previous educational experience, the opportunity to finish their graduation requirements in math and written communications during their freshmen year.



A month later, the California Legislature passed, and Gov. Jerry Brown signed AB 705, which went into full effect in Fall 2019. The legislation required the 115 California community colleges to:

- Adopt strategies to increase the number of students who enter and complete transferable English and mathematics or quantitative reasoning classes within one year of enrolling.
- Improve the accuracy of placement decisions by using a variety of information, such as GPA and performance in high school math classes; colleges can no longer use the results of placement tests, which extensive research has found underestimate students' math abilities.
- Develop additional support mechanisms for students who need them to complete transferable classes.
- Stop requiring students to complete non-college level classes that do not bring them closer to completing degrees. Subsequently, the leaders of the California Community Colleges decided that, while colleges could continue to offer developmental math classes, they could not require any student to take them.

Cultural Change Required

The legislation and the Executive Order set in motion a rapid redesign of courses, curricula, and majors as well as decisions about staffing, advising, scheduling, and how best to support students. However, achieving the specific goals of the legislation and executive order and increasing the chances of success for all students will require fundamental changes to the learning environment. For that to occur, colleges and universities need to take a larger share of the responsibility for student learning. Student effort and commitment is critical to student success. But the colleges must work to eliminate roadblocks to their success and, beyond that, to provide students with the academic and non-academic support they need to graduate. Instead of focusing on what students do not know, the colleges are being asked to acknowledge what students already know and supply them with what it will take for them to accomplish more. Essentially, what these policies are calling for is change across every function and service of the campus—away from a view of higher education as a privilege reserved for the elite and toward a perspective that is more inclusive and recognizes the value of a degree or credential not just to the individual but to communities, states, and the nation.



“We used to say students aren’t ready for us and now we say we need to meet these students where they are when they come to us.”

As one community college math department chairperson said in an interview, “We used to say students aren’t ready for us and now we say we need to meet these students where they are when they come to us.”²¹

Interviews with educators at community colleges and CSU campuses across the state reveal the enormous effort a cultural change of this magnitude entails, and the resource, campus governance, institutional organization, instructional quality, academic freedom, and technology issues it raises.

In response to these challenges to the status quo, community college and CSU faculty members are divided in their opinions. While the systems’ leaders and internal and external policy advocates believe that the policies will help far more students reach their academic and career goals, some math instructors and professors worry that the policies will do more harm than good. They worry about classes being watered down, especially in the community college system, where a portion of state funding is based on pass rates. They say the financial incentive to pass students will cause instructors and administrators to lower their standards. They also worry about the students who will still fail the redesigned classes, even with extra help. Where will they turn if all developmental education classes are eliminated? Finally, there is concern that these policies will not help students who are most likely to leave college without a degree, especially students of color, or that they will be disproportionately directed into less math-intensive fields that are likely to lead to less lucrative careers.

On the other hand, most faculty members interviewed acknowledged that developmental education was not working on most campuses and that it was time for other solutions to be tested. AB 705 and Executive Order 1110, both ambitious, sweeping, top-down policy directives, create the conditions for a grand experiment. Although reforms to developmental education seem to be succeeding, the evidence of how best to design co-requisite courses for different student populations and different educational and institutional contexts is limited. Implementation of these policies and their effectiveness will vary widely as colleges implement models based more on hunches than on evidence.

But, as a recent report from the American Enterprise Institute observed, this variability should be seen as a benefit in the sense that, if some colleges are doing a better job of helping students, they may yield solutions that could become more widely used. For this to occur, campuses will need to quickly gather and share data on their students and the effectiveness of their policies and be willing to make revisions as soon as they are indicated. Faculty and staff will be central to the success of these



policies and campus as well as system leaders will need to create opportunities for faculty members to learn more about how their peers are approaching these challenges. Ideally, that will facilitate a process of continuous improvement. Increasing the number of Americans earning valuable credentials or degrees is a “hard problem, one that is worthy of sustained, iterative, and reflective policy investment at the state and local level.”²²

The purpose of this paper is to support that process, in San Diego and across California, by gathering information on the initial implementation of these policies.

Longstanding Problems with Math Instruction in U.S.

Mathematics education in the United States is a longstanding national problem.

In the most recent Programme for International Student Assessment (PISA) results, the mathematics performance of American 15-year-olds ranked 38th out of 71 participating countries.²³ Of the 35 member countries of the Organisation for Economic Cooperation and Development (OECD), 15-year-olds in the U.S. ranked 30th.²⁴ Consistent with those rankings, the most recent results from the National Assessment of Educational Progress showed that 67% of American eighth graders and 50% of American fourth graders had not mastered grade-level concepts. These results are on par with the results of earlier administrations of all of these assessments.

Years of efforts to improve those results have been wide-ranging. They led to new sets of expectations for what students need to learn, attempts to make instruction more hands-on and relevant to students, and calls for greater emphasis on problem-solving and thinking rather than just rote memorization of formulas and procedures. The Common Core State Standards, developed by the National Governors Association and the Council of Chief State School Officers and adopted by 43 states, including California, stressed reasoning, conceptual understanding, and fluency in multiplication, division and other procedures, and encouraged students to see mathematics as a discipline that was useful and could be learned with sufficient effort. Advocates of the standards believe that, if teachers are able teach to them effectively, the math performance of entering college students will eventually improve. Now, however, the standards are still too new to have fully benefited today’s students or the adults who are returning to college or entering for the first time.

Meanwhile, the weak mathematics skills of high school graduates affected their opportunities and performance in college. Colleges put in place math labs, offered tutoring, and, as access to higher education grew, assigned students they deemed unready for college work to developmental classes. They put the burden of improving math skills on the students themselves.



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CSU Worked on Developmental Education Policies for Decades

In the mid-1990s, about two-thirds of incoming CSU system freshman needed to take remedial classes to help them catch up in math or writing or both. In 1996, CSU trustees, bowing to legislative pressure to cut its spending on helping those students, adopted a plan to reduce the percentage of incoming students requiring remedial education to no more than 10% of the incoming freshman class by 2007. In 1999, the system cracked down, giving students only one year to show they were ready for college-level work and, if they failed to demonstrate proficiency, they were to be dis-enrolled and advised to enroll to community colleges. Thousands of students were affected. In 2002, for example, 46% of CSU's entering freshmen class had to take at least one remedial class in math—even though, to be eligible for CSU, California students had to finish in the top third of their graduating class and have taken and passed at least three high school math classes.²⁵

A few years later, the CSU system launched the Early Assessment Program, which used the results from a test taken by high school juniors to let them know whether they were prepared to take on college-level mathematics—which meant that they had passed two years of Algebra. The idea was that students would then spend their senior year working on their weaknesses. At the same time, CSU dispatched math professors to work with high schools to help them make their classes more rigorous. Even so, the system continued to fall far short of its goals. In 2010, the CSU system launched its Graduation 2020 initiative to double the percentage of students finishing their degrees within four years from 19% to 40%. Two years later, CSU, building on campus-level efforts, authorized Early Start transition programs at all of its campuses to help students brush up on their skills over the summer prior to starting their freshmen year. However, those Early Start programs were uneven in quality and not offered at every campus. Evaluations found that, overall, those programs had a negative effect on students' outcomes in mathematics.

Eventually, a growing body of research conducted nationally began to question the value of developmental education. Other states began acting on that research and overhauling their programs. In 2017, the California Legislature and CSU Chancellor White declared an end to developmental classes entirely.

Problems Also Well Known at California Community Colleges

California community colleges had been working for many years to improve outcomes for students deemed unready for the rigor of college classes. The 1960 Master Plan for Higher Education in California designated the community colleges as “open access” institutions that, in addition to preparing students for careers or for transfer to four-year colleges, were expected



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to provide “remedial instruction for those in need of it.”²⁶ In the 1990s and 2000s, as post-secondary education grew in importance and more students who would have previously entered the workforce right after high school began enrolling, colleges created an ever-growing number of developmental education classes to fulfill that obligation.

At the same time, however, the Academic Senate for California Community Colleges (ASCCC) became concerned that too many students were being placed in these courses and called for an evaluation of the effect of colleges’ placement policies on students. In 2007, the community college Chancellor’s office published a guide to effective developmental education practices, based on an extensive literature review and a survey of colleges’ strategies.²⁷ That report cautioned, however, that colleges adopting these practices would likely see only incremental improvements in outcomes.

That same year, the community college system launched its Basic Skills Initiative with \$35 million from the state Legislature. Colleges wrote plans to use the money to improve the effectiveness of their basic skills classes and appointed Basic Skills Coordinators, while the system provided professional development workshops for math faculty around the state to better address students’ needs. However, a three-year report on the outcomes of the initiative found it made little difference.²⁸ For example, according to a summary report on the project, 60.5% of students referred to developmental education passed in 2008 and 61.5% passed in 2010.²⁹

Starting in 2014, as part of the Basic Skills Initiative, the Research and Planning Group and Educational Results Partnership, a non-profit organization based in Sacramento, began the Multiple Measures Assessment Project to conduct research on ways to better assess students for college courses using more accurate data on their prior performance than just a placement test.³⁰ Over time, more than 90 colleges had implemented or begun the process of using high school performance data (GPA, courses taken, etc.) to make placement decisions. This created large increases in the number of students gaining access to college level courses, while these new students were performing at the same pass rates as previous students. Given this change, many colleges had already begun the process of re-designing their math pathways, increasing the sections offered and changing the culture among faculty about how to best support students. The project was faculty driven, campus by campus, and set the research and evidence base for what ultimately became AB 705.

Other efforts to address the problem included the use of a variety of online tutoring, placement, and diagnostic tools, among them ALEKS, which focused largely on assessing students’ knowledge of calculus, EdReady, another diagnostic and recommendation tool, MathLab, and others. In addition, the Carnegie Foundation for the Advancement of Teaching designed new courses—one called Statway and the other Quantway—and worked with faculty members in California and elsewhere to implement them in classrooms. Those classes proved to be successful but were not widely adopted.

Indeed, a 2018 memo from the president of the Academic Senate and the Chancellor’s office concluded that previous policy changes had not led to improvements in outcomes. The memo acknowledged that “increasing number of studies indicate that traditional placement practices and course sequences have had unintended consequences including requiring students to retake



course material they successfully completed in high school, placing students lower than in courses where they would be likely to succeed...and reducing students likelihood of completing the gateway course in the discipline.”³¹

In 2010, two community college teachers created a professional development network called the California Acceleration Project (CAP) to find ways to help more students complete transfer-level English and math classes. CAP advocated using students’ high school grades and course-taking patterns as the main criteria for placing students in an appropriate math or English class. CAP also promoted “co-requisite models, tailoring math remediation to students’ program of study and teaching with high-challenge, high-support pedagogy” in math, English, and English as a Second Language classes.

Legislative Mandates

AB 705 put those ideas into law. To help colleges implement the law with fidelity, the Chancellor’s office and the ASCCC issued “default” placement guidelines based on GPA and math classes taken in high school. For example, students with a GPA of 3.4 or greater would be allowed to enroll in advanced algebra or pre-calculus, which would then lead to calculus and majors in STEM fields. If students had passed high school calculus, they could have a GPA of 2.6 or better and still enroll. The evidentiary foundation for those guidelines was a study that looked at the performance of thousands of California college students in math classes correlated with their high school records. Using that data, the Chancellor’s office said colleges following the guidelines should expect that 75% of the students placed into those advanced classes using this methodology to succeed.³²

The guidelines recommended that incoming students with a GPA below 2.6 who had not taken pre-calculus be allowed to take advanced classes, as long as the college “strongly recommended” that students take a support course concurrently or that the college provide academic support in other ways. The guidelines predicted that 28% of students with high school records meeting those criteria would succeed. Colleges do not have to use the guidelines. They can use other methods for placing and supporting students, as long as they follow the law’s basic tenets, which are that students pass a college-level class within a year of enrolling and that all classes count toward graduation. However, if colleges do enact alternative policies, they have two years to show that at least as many students are passing a transfer- level math class as was projected by the guidelines.

The implementation guidelines encouraged faculty members to build on what they were already doing but also to be innovative and create new classes and pathways tailored to students’ educational goals. For example, colleges that serve a large number of non-STEM majors could create classes such as liberal arts mathematics and offer more statistics classes instead of requiring all students to pass algebra. Instead of a burden, the memo said, colleges should see AB 705 as an opportunity and “as an urgent call to innovate in order to serve their communities.”³³



Some Community Colleges Out Front in Addressing the Problem of Developmental Education

Some colleges had begun to do just that. According to an analysis by the Research and Planning Group, a non-profit policy analysis organization that works on behalf of California community colleges, the percentage of students enrolling in transfer-level classes in writing and math had more than doubled.³⁴

In 2016, Cuyamaca College in El Cajon replaced its developmental math courses with co-requisite classes. Placement policies were changed to allow most students to immediately enroll in those classes, along with a two-unit support class if they needed it. For students planning to major in STEM fields or in business but who had studied less than two years of algebra in high school, the college designed an intermediate algebra course as a co-requisite to put them on the path toward calculus, which they'd need for their degrees. Students who had never taken algebra, including those who had not even graduated from high school, were allowed to enroll in an introductory statistics class with supplemental instruction. Typically, algebra has been considered a pre-requisite for statistics, even though statistics draws on only a few algebraic concepts. A key feature of the support courses at Cuyamaca is that they're taught by the same instructor as the main course, ensuring that the two courses are closely linked.

Those changes had an immediate impact. Before, only 4% of students who had been assigned to developmental classes eventually satisfied the requirements to transfer to CSU or the University of California. Afterwards, more than 60% of the students reached that important milestone. The gains were only partly attributable to the new placement procedure and redesigned classes. Also contributing was professional development and coaching to help faculty teaching the co-requisite classes to better address the needs of a wider range of students. Transferable math classes now were to include students who had not previously been successful in school—not just those who had done well in high school math classes. For these less advanced students to make it, instructors needed to become more student-focused in their teaching, ask more questions, give students time to ponder before they answer, recognize that not all students are the same, provide opportunities for students to discuss possible solutions to problems with their peers, and take time to provide students with strategies for overcoming their fears of mathematics.³⁵

“If we believe students can do it, we do certain things without realizing it that makes it a reality,” one Cuyamaca math faculty member said. “If you change the structure, you will see improvements. But if you don’t change instructors’ mindset, you won’t see the improvements you might see otherwise.”

Faculty and administrators at Citrus College, a Hispanic Serving Institution located in Glendora, east of Los Angeles, visited Cuyamaca as they planned their response to AB 705. For the Fall 2018 semester, the college opened up its elementary statistics class to all students and, as at Cuyamaca, augmented it with a two-unit support class focused on relevant algebra concepts for students needing extra help. Demand for the class surged and the math department had to offer 12 sections.



Previously, students who had to make up the most ground had to pass as many as four classes to become eligible for statistics and fewer than one in 10 who started out that far behind ever made it to a college-level class. Under the new approach, more than six in 10 passed, and, in doing so, completed their math requirements for transfer in one semester. Attrition during the semester was greatly reduced.

Citrus also created new pathways, to serve students based on their educational goals. Starting in Fall 2019, for example, all prospective business majors were allowed to take a redesigned applied calculus class along with a two-unit support course taught by the same instructor. That class covered only the calculus concepts relevant to that major. Students planning to major in STEM fields who weren't ready for calculus were allowed to enroll in a newly created six-unit pre-calculus class covering key concepts in trigonometry, along with an aligned two-unit support course. That meant that eight units out of a student's typical full load of 12 to 16 units were in math. Faculty members were concerned that would discourage some students and disadvantage part-time students whose busy lives may not allow them to take six units at once. Previously, however, students might have to take as many as five classes before they were allowed to enroll in calculus and most never finished that sequence.

Adapting Pedagogy to Better Serve Students' Needs

Citrus also has taken several steps to help its math faculty adapt their instruction to suit a broader range of students. Cuyamaca instructors came to Citrus to put on two pedagogy workshops, share curricular materials, and propose guiding principles, including ensuring that the co-requisite courses continue to be rigorous. The math department organized a weekly "community of practice" session, in which instructors meet on Fridays to discuss common challenges, such as keeping students engaged or helping them master difficult concepts. In addition, members of the faculty serve as "embedded tutors," spending a couple hours each week in colleagues' math classes to help students but also to learn from their peers and then provide feedback to the instructor.

As at Cuyamaca, Citrus faculty work hard to convince their students they can succeed in math. One way they do that is to form groups in which students help one another. "We want to make them struggle but not alone," Michael Wangler, Dean of Mathematics and Business, said. "Maybe someone in that group will have an insight that will help them move forward."

Wangler also said administrative support for the changes is critical. "It's my job as the dean to make sure instructors have the tools they need to help students succeed," he said.³⁶

That has meant finding money to pay for the professional development sessions and the embedded tutors. He also used a state grant to replace single desks with tables, to facilitate group work; purchased white boards to make it easier for students to share their work; buy advanced calculators; and provide instructors with manipulatives such as dice to teach probability. Wangler advised other colleges to install white boards in their classrooms, even if they lack the financial resources to buy the rest of the equipment, because students who have to share with their peers are more engaged in the material than they would be by just taking notes during a lecture, he said.³⁷



Another college that has fully embraced the changes called for by AB 705 is Foothill College, located in the affluent community of Los Altos Hills, although the majority of its students commute from elsewhere. With strong support from its dean, other administrators, and the college's curriculum committee, the math department fall 2018 began allowing students to enroll in the transferable entry level math class of their choice—statistics, pre-calculus, math for liberal arts, or math for elementary school teachers. The college provides tutors and additional instructors in class for all students and requires some students taking pre-calculus to take an additional, aligned support class.³⁸

The year before the changes, about 68% of statistics students passed the introductory class; after, the pass rate was 62%, but far more students were enrolled. Faculty members have said that they expect that figure will improve as they adjust their instruction. The pass rates were similar for a co-requisite pre-calculus class. The pass rates for both classes were almost triple the rate at which students who started in a remedial class eventually passed a transferable class.

Most of the classes at Coastline Community College in Fountain Valley, California, including 85% of the math classes, are offered online, to serve students finishing degrees started elsewhere; working adults with children who can only study at night; people who do not have access to transportation; adults who are not seeking an associate's degree but who want to polish their professional skills; and members of the military. Serving all of those students' needs is a challenge and "supporting underprepared students in an online environment is a real challenge, to say the least," a member of the college's math faculty said.³⁹

Prior to the 2018-2019 school year, students at Coastline were expected to take as many as four developmental courses before they were allowed to take math classes that would help them reach their educational goals. Nearly but not all of those classes were eliminated to comply with AB 705 and the vast majority of students were placed into one of three classes: liberal arts math, introductory statistics, or college algebra, all of which were paired with aligned support courses. The weakest students, those who had a high school GPA of lower than 2.6, were required to take a support course while others were encouraged to do so.

Designing Effective Co-requisite Supports

In designing the new classes and the concurrent support classes, Coastline followed five tenets. First, support courses should not be a time for students to just get help with their homework and they should not be lecture-driven. Instead, the support courses should provide "just in time remediation" to help students with the topics and skills in the main class. Second, primary and support classes should focus on the content that will be most helpful to students should they take subsequent math classes. Third, both should use a "thinking curriculum" that allows students to solve conceptually complex open-ended problems that may have multiple correct answers or solution methods. Fourth, the classes should include frequent formative assessments so the instructor can closely track what students are getting and where they need extra help. Finally, Coastline has designed the support classes to include time for helping students overcome fears about math and develop productive attitudes and beliefs about their abilities.⁴⁰



Support courses should focus on what students will encounter in class. “Here’s what’s coming up in class, here’s where we’re going, here are the big topics, here are some skills to help you understand what we’re doing, and then spend some time on the affective domain, before starting in on the college- level material,” one instructor who has taught those classes said.⁴¹

Some members of the Coastline faculty are reluctant to teach the introductory classes and concurrent support classes. Like faculty members elsewhere, some only want to teach students who can handle college-level material. They warn that the acceleration driven by AB 705 will result in “epic failure,” as one instructor said. Adjunct instructors also are concerned that pass rates will fall and that that will reflect poorly on them.

To help address those concerns, Coastline used a small state grant to develop new curricula, bring in guest speakers, and put on workshops to help faculty members work with underprepared students and provide them training in helping students develop a productive mindset about math. “You can’t put faculty teaching these classes in isolation and expect them to deal with this,” one instructor leading these efforts said.⁴²

The importance of changing the pedagogy in developmental classes as Cuyamaca, Citrus, Foothill, Coastline, and other colleges are attempting to do, is reinforced by a recent Teachers College analysis of a program at The City University of New York that is succeeding in helping academically weak students do well in college math.⁴³ That program, called CUNY Start, provides instructors with a “highly detailed curriculum”; emphasizes real-world contexts and number relationships instead of focusing solely on procedures and skills; uses questions to elicit students’ ideas and misunderstandings; and pays “explicit attention to students’ organizational and study skills.

The Potential of a Statistics Pathway

These pioneering community colleges also have in common that they, like many across the state, are encouraging many more students to take a statistics class, instead of a college level algebra class. Students typically take beginning algebra for the first time in middle school or early high school; most California high school students also take an intermediate algebra class. Prior to AB 705, the state’s community colleges used an assessment to determine whether students had mastered intermediate algebra and, as has been noted throughout this paper, those who could not demonstrate proficiency were placed in developmental education classes. To move on, they had to pass the equivalent of intermediate algebra, which meant, in some cases, first passing three or even four developmental classes before becoming eligible even to take that class. However, while Intermediate algebra met the requirements for an associate’s degree, it did not make students eligible to transfer to Cal State or UC campuses. That required passing college algebra, statistics or other qualifying math classes, such as mathematical ideas.⁴⁴

The move to statistics and other non-algebra math classes is part of a larger movement to redesign the “pathways” colleges make available to help students satisfy math requirements. The pathways movement is predicated on the principle that students should not be required to master mathematical content that is unrelated to their intended major.



For example, statistics is more relevant than algebra for most non-STEM majors, such as sociology, psychology, history, and other humanities majors. It is also widely accepted that it is easier for most students to pass statistics, which is less abstract than algebra and can readily be taught using real-world situations and data.

College of the Canyons, a community college in southern California, began offering a pre-statistics course eight years ago that replaced elementary and intermediate algebra as the pre-requisite(s) for transfer-level statistics. The course, *Intermediate Algebra for Statistics*, provided just-in-time algebra remediation on topics such as rounding significant digits, slope of the line, and linear equations that were relevant to the statistics curriculum. The college found that students taking this new course more than doubled their chances of completing statistics, compared to those that attempted the traditional algebra sequence.

In response to AB 705, the college doubled down on statistics. It developed a co-requisite version of the class and expects that at least 70% of students will successfully complete the course. For the group that comes in with the weakest academic record, data suggests that half will be able to pass a transfer-level course, compared to only 1% of those students previously. In response to all the changes, the college has quadrupled the number of statistics sections and has been providing a plethora of professional development opportunities for instructors to improve their pedagogical skills in this difficult-to-teach course.

Despite the benefits of studying statistics, some math instructors and professors around the state worry that algebra skills are being undervalued. They say that algebra is valuable in a wide range of careers and that students who don't master it will find themselves shut out of many non-STEM as well as STEM careers. They also worry disproportionately large numbers of African American and Latino students will be advised to take statistics rather than start down the mathematics pathways that would lead to calculus. Faculty members at several colleges said that could result in a higher education version of ability tracking in pre-collegiate classes, a practice that systematically underestimated students' abilities based on their race or ethnicity.

But the College has found that starting out in statistics has not prevented students from going into STEM fields. Passing statistics has given some students enough confidence in their math abilities that they then move on to trigonometry and pre-calculus and then on to the calculus sequence and beyond, one instructor said.

That observation was supported by the results of a randomized controlled trial involving about 1,000 students at the City University of New York that showed the benefits of assigning students to introductory statistics with a weekly workshop as an alternative to developmental math classes.⁴⁵ About 40% of the students who took a developmental algebra class passed; but about 55% of those who took a statistics class with co-requisite support did so. By the end of the year following the experiment, those who had taken the statistics route had accumulated an average of 19 college credits while those who started out in the remedial class had, on average, racked up only 16. The researchers followed those students for three years to see if they continued to do well. More of those who took statistics had satisfied the college's life and physical sciences by that point than had those who took the traditional remedial class. In addition, the statistics students eventually took more advanced math classes than did the remedial students, meaning that it was not necessarily an unproductive detour.



"What we've seen in our work is that a lot of students who go through statistics get fired up about mathematics, and they begin to see themselves as mathematical thinkers, and then go on to pursue algebra and calculus, and they were still getting through more quickly than they would have if they'd completed a remedial sequence and then gone on to calculus," said Chris Thorn, a sociologist who was director of knowledge management for a project at the Carnegie Foundation for the Advancement of Teaching that developed a statistics class designed to increase student success. "Statistics probably gives students a leg up in many fields in which calculus is not helpful but it is also probably the best way to get to calculus for students who have been traditionally underserved, because they have succeeded in something that is deeply conceptual."

Skepticism Remains Strong and Implementation Uneven

While some community college math departments and professors have seen AB 705 as an opportunity to try out other approaches to developmental education, many others are fearful that, instead of helping students, they will be doing more harm. One concern expressed by professors at a number of colleges is that large numbers of under-prepared students will fail college-level classes, even with co-requisite support. One math department chairperson at a college in Northern California said many students arrive with shaky knowledge of arithmetic, including such basic concepts as the relationship between fractions and decimals, let alone algebra. Some colleges have just eliminated more difficult concepts from statistics classes so that students who are particularly weak in math can pass, he said.

Another concern expressed in multiple interviews is that colleges do not have sufficient resources to redesign courses, teach support classes, and help faculty adapt their teaching to the needs of students needing extra help. Funds from a variety of preexisting state programs can be used for these purposes but campus leaders have to make a decision to do so.

Faculty members also worry that requiring students to take an additional support class will discourage students who are attending school part-time and who have obligations to their jobs and families in addition to their course work from taking math or even enrolling in college in the first place.

A number of faculty members interviewed around the state say that when AB 705 was passed they were already working to improve placement decisions, going beyond assessments to consider such factors as what students had studied in high school and how well they had performed. Several also said they were aware that not all students need to take algebra and were developing alternatives. In interviews, they say they recognize that developmental education programs weren't working for all students and they were striving to improve them. In some cases, efforts that were showing positive results had to be scrapped because of the law, math instructors said. Instructors said they were not opposed to AB 705 but they believe the community college system's implementation guidelines are too restrictive and the timetable for implementation was too rapid.



In 2015, a coalition of national education policy groups concerned with improving remedial education issued a set of six broad principles they believed should guide such efforts. The principles stress the importance of helping students choose an academic direction at the beginning of their education careers and the supports and courses they will need to pursue it successfully. They espouse enrolling students in college-level courses relevant to students' academic intentions. But they also assert that the necessity of "rigorous, streamlined remediation options that align with the knowledge and skills required for success in gateway courses in their academic and career area of interest."⁴⁶

These and other faculty concerns illustrate the dilemmas associated with changing practices across the largest system of higher education in the United States, which serves 2.1 million students on 115 campuses. The colleges vary greatly in terms of the quality of leadership, the availability of resources, the strength of faculty governance, and the mix of students they serve. From the perspective of the system as a whole, the problems of developmental education and low graduation rates are statewide issues and, given their importance, should be addressed with statewide policies, especially considering that many students attend more than one college while pursuing a degree. But from the perspective of the campuses, these problems play out differently from community to community and can only be solved if faculty members and college leaders are committed to doing so.

That does not mean that each campus should have complete discretion over how, or whether, to make improving graduation rates a priority. However, that also does not mean that the same policies are appropriate for every campus. Indeed, the challenge for system-wide leaders is to encourage and inspire campus and faculty leaders to respond creatively to the needs of their students and facilitate the spread of effective strategies, while also insisting on progress.

Some campuses, as noted, have responded aggressively to the specific policy changes called for by AB 705. But others lag behind, perhaps believing those policies will eventually go away or not be enforced.

A study of implementation at 47 community colleges found that, in the aggregate, colleges doubled the number of transfer-level, introductory English and math classes in the fall 2019 semester.⁴⁷ The report also said the number of colleges of those studied providing co-requisite sections grew from five to 33 in statistics and zero to 30 in calculus-track courses. However, at many of the colleges a large proportion of math classes continue to be remedial in nature. However, remedial classes constituted more than 10% of the math and English offerings at 40 of those colleges and, at 21 of those colleges, remedial classes accounted for more than 30% of the math offerings. The problem with continuing to offer below-transfer courses is that, unless informed of the fact that they are less likely to reach their educational goals, many students will sign up for less demanding classes that move them no closer to reaching their educational goals.

The report also said that colleges are not offering enough transfer-level classes with support in statistics. It's likely that many of those colleges do not have enough math faculty who are either willing or able to teach statistics.⁴⁸



CSU Confronts Similar Issues

The leaders of the California State University, which serves nearly 500,000 students on 23 campuses and eight off-campus centers, stretching from Humboldt State University 100 miles from the Oregon border to San Diego State University in the south, faced similar challenges in implementing Executive Order 1110 in time for the fall 2018 semester.

The system made professional development available to interested faculty members, provided campuses with technical support, hired outside consultants, established a partnership with the Dana Center at the University of Texas, which has worked with schools, colleges and states across the country to help them improve math outcomes, and shifted institutional resources to support the effort.

The results of the first semester under the new policy were positive. In both the fall of 2017 and the fall of 2018, about 17,500 students were deemed to be in need of academic support. In 2017, only about 1,400 of those students enrolled in a college-level math class; in 2018, almost 12,000 students did so. In 2017, only about 950 students passed a for-credit math class, moving them a step toward graduation. A year later, almost 8,000 achieved that milestone.

James T. Minor, CSU's Assistant Vice Chancellor for Student Success, said the data from the first semester of implementation were positive but that he expects outcomes to improve even more as campuses refine their strategies. "Nobody thought we would change the policy one semester and be done," he said.

He acknowledged that support for the new policies is not uniform across the system. A third of the campuses, he estimated, welcomed the new policies. Another third agreed with the policy changes but were unsure of how to put them in place. "Then, a third sat on their hands and hoped this would go away," he said. "We see the variation in terms of implementation."

Experience with Co-requisite Supports

About 35% of colleges nationally offer co-requisite classes for the purposes of remediation in reading and writing while 16% have created co-requisite classes in mathematics, according to a national survey conducted in 2016 by the Center for the Analysis of Postsecondary Readiness at Teachers College, Columbia University.

Northern California's Humboldt State University, which was already using a co-requisite model instead of traditional developmental education classes, was ahead of many other CSU campuses when the executive order to move away from developmental courses was issued. About 40% of Humboldt State students pursue majors in the school's College of Natural Resources and Sciences that require them to pass calculus. After many years of requiring some students to take as many as two semesters of remediation before enrolling in a college-level math class, Humboldt State had piloted for one year a shorter pathway to credit-bearing courses, reducing the remedial requirement to one semester, with co-requisite support.



Student outcomes in the first semester of implementing the new approach were significantly better. For example, about 51% of students taking the college algebra class with co-requisite support passed. Previously, only 45% of similar students passed the two required remedial class and the college class, meaning it took them three times as long to reach the same level; the pass rate for the redesigned statistics class with support was 72%, compared to the only 43% of students who had passed the class after completing the remedial requirement. About 68% of students passed statistics without support. Previously, 72% of students who had to first take remedial classes eventually passed the older version of statistics.

The new approach is clearly beneficial for students whose majors require them to take only one algebra or one statistics course. STEM majors need to also pass trigonometry and calculus to earn a degree. What is not yet known is how well the students on the accelerated pathway perform in subsequent classes.

“We’re removing obstacles but we’re also removing support and we’re asking students to master a lot of algebra at a pace faster than what we’re asking other students to do,” the math department chairperson said. “There is a sense that the model will work well for liberal arts and business students but there really is a worry that disadvantaged students who come in unprepared will struggle with calculus. The hallmark of success will be whether they will be able to complete subsequent classes they need.”

Cal State Dominguez Hills in Los Angeles also was a leader in offering co-requisite support prior to the CSU executive order. Because of that, the campus was ready to comply with the order, the chair of the university’s math department said. After trying several different models, the math department is offering for non-STEM majors a three-unit statistics class that includes an additional hour each week with an instructor as well as a lab session staffed by a more advanced undergraduate student to help students with homework. The additional time with the instructor allows for more student participation and discussion and the lab improves students’ study skills and deepens their understanding of the content.⁴⁹

Separate Track for STEM Students

Dominguez Hills, like other CSU campuses, has a separate track for STEM students. Students coming in who are the least well prepared can take a two-semester “stretch class” that is an introduction to college algebra and trigonometry with co-requisite support and then continue on to a pre-calculus class with support. STEM students get to calculus more quickly than they would have in the past using this route.

The overall pass rate in the co-requisite courses for Fall 2018 was slightly lower than for the developmental classes they replaced. However, students who did pass were closer to completing their math requirements than they would have been in the past, resulting in savings



of time and money, the math chair said. But it is too early to say whether more students will be able to get through calculus or other advanced classes students may need for their majors. In the past, very few students were able to make the leap from developmental education all the way to calculus, but it is too early to know whether more students will succeed with the new classes, the math chair said. “It won’t be hard to show we’ve improved but those students who do get through will have a tougher road.”

Meanwhile, the math department is discussing ways to help more students complete the math requirements for the STEM fields, including trying to make the content of calculus and other classes more relevant. “We’re trying to get them to understand that, like success in anything, a large part of it is putting in the work and spending the time to get better, just like they’ve done in other areas, such as video games or skateboarding,” he said. Professors also are making parts of the class competency-based, which allows students to study material until they can demonstrate mastery.

Rewriting curricula and recruiting and training undergraduate student assistants has been costly and required significant effort by faculty members but the campus leadership has been “extremely supportive,” he said. “The provost said let me know what you need and we’ll support it.”

Redesigning Introductory Courses

The executive order caused math faculty at Cal State San Marcos to take a close look at all of their introductory classes to make sure they could serve students who previously would have started out in developmental classes. That examination led to substantial changes focused on better serving students based on their educational goals. They realized the department’s liberal arts math class dealt with big ideas and required almost no knowledge of basic calculations, such as adding fractions.⁵⁰ In the past, students would have picked up those skills in non-credit developmental classes but because those classes would have to be eliminated by the executive order, the faculty felt an obligation to add those topics to the course to give students an opportunity to develop these critical skills.

The college algebra class, the other entry point to math, had a heavy emphasis on equations and other mathematical processes and would have been very difficult for students with weak skills to pass. So, they developed a new class called quantitative reasoning that covered linear and exponential growth; paying off installment debt and the compounding value of saving regularly; probability; and descriptive statistics. Those topics would give students plenty of opportunities to practice skills such as fractions and decimals while also learning useful real-world mathematical applications.



The department also created a second version of the college algebra course tailored to category 3 students, according to CSU's placement guidelines. Everyone who enrolled in that class had to also attend twice-weekly support sessions. The only option for students who needed to take algebra, but who didn't want to attend those sessions, was to enroll in the unsupported class that already existed. However, students with the weakest skills, those in category 4, were not allowed to enroll in that class and had to first take the quantitative reasoning class.

Category 3 students planning to major in business and STEM fields were required to take the supported algebra class before they could go on to take either business calculus, for business and economics majors, or a pre-calculus class, in the case of STEM majors. Category 4 students planning to major in business or STEM fields are required to take both the supported quantitative reasoning class and the supported college algebra course before starting the required BSTEM sequence. In addition, the department created a new version of its pre-calculus class called "Transition to Calculus" for weaker STEM majors.

When the department launched the revised classes in Fall 2018, graduate students taught college algebra as well as the accompanying support sessions. Results were uneven and department leaders realized they had to better communicate to the instructors their expectations for what students should learn.

The department offered a dozen sections of quantitative reasoning, about half of which were taught by graduate students, as well as about 30 support groups, also led by graduate students overseen by a tenured faculty member. The content of the quantitative reasoning class was developed almost on the fly, with the department chair sending out Power Point slides shortly before class. About half the students in the new quantitative reasoning class passed.

A number of changes were made to the quantitative reasoning class for the spring 2019 semester in an attempt to help more students pass. The department worked to improve coordination with the math lab on campus so tutors there are better able to help students before exams. The department also reorganized the course so that students encountered more difficult material throughout the semester and moved probability, which the department thought would be easier for students, to the beginning. It turned out that probability was not as easy as faculty had hoped but it did have the effect of keeping students more engaged in the next topic, linear and exponential growth.

Eventually, the faculty member overseeing the quantitative reasoning course said, the introductory classes will be like a "course in a box" so that the course can run with less day-to-day supervision by the tenured faculty.

The San Marcos example illustrates how the process of complying with EO 1110 is iterative, based on results for students.



Starting from Scratch on Developmental Education

The Department of Mathematics and Statistics at Cal State Sacramento had a blank slate in designing its response to EO 1110 because developmental classes on that campus had been taught by the College of Education, not by math professors. The policy then was that students were prohibited from enrolling in college-level algebra or statistics until they satisfied their remedial requirements. That requirement was waived in 2016 and, in 2017, the remedial classes were eliminated. The math department, having no experience with placement, and lacking information about their students' math backgrounds, had required students who finished the remedial sequence to take one of two placement tests, both of which produced flawed results.

The math department chair described the process this way: "Can we make something that will take any student and put them on the pathway they want to be on. For engineering students, for example, we'd have to prepare them to take advanced algebra, pre-calculus, and calculus. For another group, we realized they don't need that stuff."⁵¹

The process led to the creation of four courses: mathematical reasoning, an algebra class for STEM majors, another algebra class for non-STEM majors, and a "stretch" statistics course for students planning to study nursing or business. The department also developed supplemental instruction for each of those classes for students needing it. Students who enroll in Math 10, for non-STEM majors, or Math 12, for STEM majors, were required to take a placement test, the results of which did not affect their grades. Students who score too low, however, are required to take a one-unit supplemental course. The supplemental courses are being taught by other undergraduates, who may or may not be math majors. Even so, the grades for students who took the supplemental classes in the fall 2018 were, averaged across all math classes, about a half a grade higher than those who did not.

Results Better than Expected

Some faculty members were skeptical of the changes, but the Fall 2018 results were better than expected, easing some of those concerns.⁵² In the past, typically about a third of the students taking the algebra class for STEM students would fail. The redesigned class did not change what students were expected to learn but instructors used more active learning strategies to engage students more fully and provided them with more targeted support. The failure rate was cut in half. Historically, about 45% of the students who started off taking remedial classes would fail their first math class; only 7% failed the first semester the redesigned class was offered. Students who did not pass tended to be those who did not attend class or do assignments. To change that, the supplemental instruction sessions were changed to focus more on teaching students what it takes to succeed in college.



San Diego State University created a new general education course to comply with the order, called “Math for Life,” which teaches students about personal finance and how to understand newspaper articles involving statistics or mathematics, as well as a support course to go with it. The department also created support courses for college algebra and business statistics.

The department had previously revised the pre-calculus class to start with more elementary concepts and slowed it down so that it didn’t cover as much material as in the past because too many students were earning grades of C or lower. Students passing pre-calculus with a C had less than a 50% chance of passing calculus and less than a 30% chance of earning a B- or better. With the elimination of developmental classes, the problem would likely get worse. The department then made college algebra a prerequisite to pre-calculus so that professors could make it more rigorous and comprehensive.

The chairman of the math department said the executive order caught him and his colleagues by surprise and that the compressed timeline for complying with it was a challenge. He also said he was concerned that the new courses covered material better taught in a rigorous high school class. SDSU’s large class sizes also is an issue, he said. Business statistics classes, for example, enroll about 250 students.

Some Effective Programs Eliminated by Executive Order

Just as in the community college system, some programs that were producing strong results had to be scrapped because of the executive order. One such program was the developmental education classes at Cal State Northridge, in the San Fernando Valley area of Los Angeles. In that program, underprepared students were required to attend a Summer Bridge program, which used an on-line assessment and support program called ALEKS to identify and address students’ weaknesses. Students required to attend the summer program then took a developmental class in the fall and a college-level class the following spring. Students who went through this sequence did better on average than students who had come to college not needing any developmental classes. After the order to abandon that approach, underprepared students will take a class that, while it earns them college credit, is essentially a high school math class with students assigned to solve more complicated problems but does not require knowledge of more advanced mathematics.

Starting in the August 2019, the Summer Bridge programs offered at CSU campuses since 2012 began earning students credits toward graduation. Recasting what had been remedial boot-camps as college-level classes, while still serving the needs of the least prepared students, proved to be a challenge. The summer program at CSU Monterey Bay began in 2007 and later became the model for the entire system.

The summer program at CSU Monterey Bay began in 2007 and was later the model for programs across the system. That program had used an adaptive machine learning platform which provided students with targeted instruction and practice. For 2019 classes, the Monterey program tried out several such platforms, including the Precision Math classes designed by National University.



The Monterey Bay program had used an adaptive machine learning platform to provide students with targeted instruction and practice. This summer, the math department at Monterey Bay will be trying out and comparing the results from several such platforms.

But the technology alone is not enough. The chair of the math department at Monterey Bay said students need a support system that gets them engaged and excited about mathematics. “You have to make math fun and interesting and show them that math is not difficult, and once they are motivated it will be easy and the technology can help motivate them,” he said. “You take an assessment, you get a score, and it will show you which part you need help with and then you take the assessment again and if you score high enough you can move on.” This summer, Monterey Bay will be trying out different technologies with local high schools and community colleges as well as in the Summer Bridge program.

Building a Sustainable Culture of Success in Higher Education

The efforts to improve postsecondary education outcomes for all students are a response to powerful economic, technological, social, and demographic forces. These forces—global economic competition, rapidly changing technologies, looming shortages of skilled workers, the social and political effects of income inequality, the uneven distribution of opportunity by race, and the shrinking of the number of college-age students—have caused all institutions of higher education to reconsider their mission. Today, highly selective colleges as well as those that are open to all need to help their students succeed while also providing an education that allows them to develop their skills and maximize their potential. California’s AB 705 and CSU’s Executive Order 1110 brought greater attention to a longstanding problem and spurred every community college and CSU campus in the state to come up with and implement ways to increase the likelihood of all students succeeding. It will take sustained investments and an ongoing commitment to learning from these nascent efforts and helping them spread if they are to have a significant impact.

A critical step for ensuring these policies have the intended effect is to define success appropriately. AB 705, for example, considers “throughput” as a key indicator of success. Throughput means the number of students passing a transfer-level course that moves them closer to completing an associate’s degree or to satisfying the requirements to transfer to a CSU or a University of California campus. In fact, as has been noted, 20% of community colleges’ state funding is based on the pass rate in these courses. One way to evaluate the impact of AB 705 is to compare the percentage of students passing a transfer-level course with the percentage of similar students passing those classes after having been required to first take developmental education classes.

However, passing a course does not necessarily equate to learning the material well enough to pass subsequent math courses. It is important, therefore, to identify relevant, appropriate assessments that measure actual learning and can be compared across departments and campuses. A Fall 2018 survey of colleges conducted by the Research and Planning Group of the California Community Colleges found that 38% of the respondents had created common assignments and exams across sections for purposes



of monitoring outcomes. That group also found that colleges plan to use exam and other data to strengthen their offerings over time. Data is especially important for monitoring how well different groups of students are being served by these new approaches, ensuring that equity gaps are shrinking, not being made worse.

Outcome data needs to be finely grained in order to be as useful as possible. Data needs to be collected on variations in instructional strategies, class sizes, student backgrounds, and other details of co-requisite models. For example, at some colleges, the same instructor leads both the main class as well as the additional support sections for students needing extra help. At others, the class and the sections are led by different instructors. Some models may work better for some students than for others.

An August 2018 report by the Public Policy Institute of California said that “by design, AB 705 implementation will have an immediate effect on equity gaps in access to transfer-level courses.” Colleges should “make sure that they have academic and non-academic support structures in place to improve the likelihood of success of all students, especially underrepresented students.”⁵³ The report said that ongoing monitoring and data collection is needed to “identify and address unintended consequences of the reforms.” Co-requisite classes and redesigned math pathways will undoubtedly help more students reach their educational goals. It is critical, however, to ask who is benefiting from these policies and practices rather than just accept results in the aggregate.

Data also should be gathered, analyzed and distributed to highlight programs that are succeeding. Both the CSU and community college systems should find ways to facilitate the sharing of knowledge among their campuses through convenings, online discussions, and opportunities for faculty and other campus personnel to travel to learn from colleagues in other parts of the state. The RP Group survey found that most community colleges are offering professional development and mentoring opportunities to help their faculty members adapt their teaching methods to serve a broader range of students. But the colleges also responded that much more professional development is still needed. The PPIC report said that professional development also should be provided for counselors, academic advisers, and other support staff.⁵⁴

Community colleges reported that they will refer students needing more support to tutoring centers, hire “embedded” tutors who will help students and provide feedback to instructors, establish “early alert” systems to help instructors identify students falling behind, and provide more student counseling and advising. Colleges say they will need more funding to pay for those services. Campus administrators should identify sources of new funding or reallocate their existing resources to meet students’ needs. The Chancellor’s office should also identify funds it can reallocate or advocate for more funding from the state Legislature to support the changes in practice required by AB 705.

Community college campuses also must reallocate resources to be sure they are offering enough sections of transfer-level courses to meet the demand not just for students pursuing STEM fields but also statistics and quantitative reasoning.

The CSU system should ensure that its campuses are providing funds to fully implement Executive Order 1110. Relevant and aligned support is necessary for co-requisite courses to serve the needs of students who might previously have been placed in developmental education classes. As of now,



several CSU campuses reported that those support courses are being led by more advanced undergraduates rather than by either faculty or adjunct instructors. If helping more students pass is considered a high priority, then colleges will need to not only staff these classes with faculty members, or trained adjuncts, or graduate students, they'll also need to provide them with professional development opportunities.

The CSU and community college systems, as well as the campuses themselves, must also find ways to deal forthrightly with faculty apprehension about or even hostility toward these new policies.

Finally, it is critical that state, system, and campus leaders frame these reforms as a statewide effort, even as the policies are implemented on individual campuses. Given the size of the state, and the challenges of convening leaders from across the state in one place, it would be helpful to form regional consortia of CSU, community college, University of California, private non-profit institutions, K-12 educators, subject matter experts, and business leaders to establish performance goals, identify roles and functions, share results, communicate expectations, conduct research, and monitor progress. One ongoing purpose of these consortia would be for representatives of the different educational systems to compare notes on student performance. CSU and UC representatives could provide their perspectives on how students transferring from local community colleges and high schools are performing to identify programmatic weaknesses as well as to identify ways to strengthen their programs and learn from one another about the challenges they and their students face.

Partnerships between UCs, CSUs, CCs, and private universities, such as National University, also are important for sharing expectations as well as techniques and, possibly, specific technologies.

Intersegmental rivalries are unproductive. It may be, for example, that some math classes are better taught at CCs, where sections are smaller. Transfer rules need to be clarified.

Replacing developmental education with co-requisite or other approaches will not automatically lead to greater student success. Advisers need to be fully briefed on the new placement guidelines as well as the tradeoffs for students who will have more discretion in deciding which classes to take. Some students, for example, will avoid options they think will be more difficult but that will also not help them make progress toward their educational goals. Faculty from non-mathematics departments also need to be involved in decisions about curriculum and expectations. Economics professors, for example, may think that newly designed courses do not provide students with the math knowledge and skills students will need to succeed. They may respond by adding an additional prerequisite math course specific to economics, which would defeat the purpose of accelerating students' progress that is the goal of redesigned math sequences. Institutions of higher learning are complex social organizations and strong leadership is needed to make sure all of a campus's assets are fully leveraged in this important pursuit.

California's political and educational leaders have made bold and potentially risky policy changes in developmental education, showing that they're serious about eliminating at least one of the barriers to academic success. But this is only one element of what must become a comprehensive agenda for improving student learning and completion rates. All institutions of higher education in the state, including private colleges, must be persuaded to dedicate their efforts to the cause.



Author Biography

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Richard Lee Colvin is a Georgia-based speechwriter, editor, and communications consultant specializing in education at all levels. Recent clients include National University in San Diego, the Aspen Institute, Achieve, the Asia Society, Teach for America, the Wallace Foundation, the Gates Foundation and many others.

Previously, Colvin was the managing writer for the U.S. Department of Education in Washington, D.C. under Secretary John B. King. In 2009, as executive director of the Hechinger Institute on Education and the Media at Columbia University, Colvin created the award-winning Hechinger Report, which deploys a team of journalists to cover education for a variety of publications and online sites.

From 2002 through 2011 Colvin led non-profit organizations dedicated to improving journalism about education and clearly communicating complex ideas about education policy to broad audiences. From 1989 until 2002 Colvin was a reporter at the Los Angeles Times, concentrating for most of that time on education in California as well as nationally and internationally. In that role, Colvin reported extensively on mathematics instruction, curricula, and research. He has published widely and authored the 2013 “Tilting the Windmills: School Reform, San Diego, and America’s Race to Reform Public Education” published by Harvard Education Press.

He is a 1976 graduate of Oberlin College and earned a master's degree in journalism at the University of Michigan.



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