



Algebra Policy in California

Great Expectations and Serious Challenges

HIGHLIGHTS

- California has used its academic content standards and accountability policies to push for earlier student participation and success in algebra..... 2
- The state has seen large increases in 8th grade algebra participation and proficiency..... 5
- Test scores, “repeater” data, and the NAEP all provide evidence that math performance falls well short of the state’s expectations for many students 6
- Critics are raising hard questions about the state’s algebra policies and pushing for clarification about what to teach and when 11
- The debate sheds light on shortcomings in California’s teacher credentialing policies and a lack of support for professional development..... 14

Most California policymakers and educators would likely agree that *all* students need to take and master algebra—and that they need to do so as early as possible in their school careers.

Agreement on this goal represents important progress in a state where—less than 10 years ago—the notion of algebra as a high school graduation requirement seemed like a radical idea. That said, the same Californians are much more divided regarding when exactly students should take algebra and how to assure them a reasonable chance for success. That division was reflected in strong reactions to a State Board of Education decision made last July—blocked by a California court ruling that is currently under appeal—that would have increased pressure for all students to take Algebra I by 8th grade.

Since the late 1990s, state officials have used assessment and accountability policies as powerful levers to encourage schools to enroll more 8th and 9th grade students in Algebra I courses. In the process, schools have raised expectations and afforded greater opportunity to thousands of previously underserved students. Nearly 45,000 more California 8th graders scored proficient

or advanced on the state’s Algebra I test in 2008 than in 2003. Nearly 26,000 more low-income 8th graders did so. However, too many California students still struggle to get through the Algebra I gateway leading to more rigorous math and science courses in high school. *Participation* for all clearly does not translate automatically into *success* for all.

Many call for strengthening math instruction, particularly in the late elementary and middle grades, as the crucial next step in moving California toward its goals. Some also say this is an opportune moment for California to consider its mathematics policies more broadly, including its academic content standards and annual assessments. Any of these would require investments of time and funding. What combination of state policies and school practices would be most effective to help students succeed? What investments in educator capacity would be most strategic? These are complex but important issues for California to explore, and they are the focus of this EdSource report.

EdSource thanks the **Noyce Foundation** for underwriting the research, development, and dissemination of this publication.



California continues to reach toward earlier student success in algebra

When California adopted academic content standards in mathematics in 1997, no one assumed that large-scale changes in math achievement and course-taking—including in algebra success in grade 8—would happen overnight. Early decisions by California policymakers establishing the content standards in math and the 2004 requirement that students complete Algebra I to graduate from high school left many debates for the future.

A brief history of the State Board of Education's algebra decision

In July 2008, the California State Board of Education (SBE) passed a motion—now blocked by a state court—that called for the state's Algebra I test to become the “sole test of record” in grade 8 mathematics for federal accountability purposes.

California and federal education policies make different assumptions about testing in grade 8 math.

- California policy assumes that the California Standards Test (CST) an 8th grader takes in math is connected to the math course she or he takes. Most commonly, 8th graders enrolled in Algebra I take the Algebra I CST and 8th graders not yet enrolled in an algebra course take the General Mathematics CST.
- In contrast, the federal No Child Left Behind law (NCLB) assumes that math testing in grade 8 is based on a state's content standards for that grade.

On Feb. 6, 2008, the U.S. Department of Education (ED) notified California that its General Math CST does not comply with federal requirements because it tests 8th graders on content defined by California's math standards as intended for grades 6 and 7. Failure to enter an agreement with the ED to align California's assessment system with federal expectations would result in \$1 million in Title I Part A administrative funds being withheld from the state and provided instead to California's local education agencies. (At the time of this writing, California and ED officials were discussing a settlement of this matter.)

One option for complying with federal expectations was to have all 8th graders take the Algebra I CST. With

SBE approval, the California Department of Education (CDE) also explored a second option: the development of a blueprint for a new grade 8 math test. This test, if approved by SBE and accepted by the U.S. Department of Education, would replace the General Math CST and be taken by students not yet enrolled in algebra. It would be based on a subset of the state's Algebra I standards, excluding more rigorous content such as factoring and quadratic equations.

This new CST blueprint sparked some intense disagreement:

- Some—including CDE, the California School Boards Association (CSBA), and the Association of California School Administrators (ACSA)—supported the blueprint as an improvement on the General Math CST that would allow local educators to make judgments about proper student placements.
- Other state leaders saw the blueprint as lowering the state's academic standards for what counts as grade-level math in grade 8. Three former state secretaries of education and four former SBE presidents signed a letter arguing that “anything less than Algebra I” should not be considered “grade-level proficient at eighth grade.”

One day before the state board was to consider the new blueprint further, in July 2008, Gov. Arnold Schwarzenegger also went public with his opposition to it. He sent a letter encouraging the state board to pursue the Algebra I CST as the sole test of record in grade 8 math for federal accountability purposes. By a vote of 8-1, the board passed a motion to this effect.

The board's motion directed state education officials to negotiate with the ED for:

- An agreement to make the Algebra I CST the sole test of record in California for grade 8 math;
- A transition period for building the state's capacity to ensure all 8th graders can succeed on the test; and
- In the long term, better accommodation of California's education policies under federal law.

In September 2008, CSBA and ACSA filed a lawsuit—later joined by the California Teachers Association (CTA) and State Superintendent of Public Instruction Jack O'Connell—to block the state board's decision. They claimed that SBE (1) violated the Bagley-Keene Open Meeting Act by not providing adequate public notice of the action it took that day; and (2) exceeded its legal authority by implicitly changing California's academic content standards to require Algebra I in grade 8, despite the fact that the math standards for grades 8-12 are organized by discipline rather than grade level.

In January 2009, the Sacramento County Superior Court ruled in favor of the plaintiffs on both grounds and issued a preliminary injunction preventing the state board from taking any further steps to implement its algebra decision. SBE is appealing the court's ruling that the board exceeded its legal authority but is not disputing the ruling pertaining to the Bagley-Keene Act.

A July 2008 decision by the State Board of Education (SBE) has raised issues not resolved 10 years ago. This decision—blocked by a Sacramento County court ruling that is currently under appeal—directed the state to enter an agreement with the U.S. Department of Education (ED) to make the Algebra I California Standards Test (CST) the “sole test of record” in grade 8 math for federal accountability purposes. Depending on the kind of agreement reached, this expectation would have gone into effect in three or four years. (For more information on what prompted the SBE’s decision, see the box on page 2: “A brief history of the State Board of Education’s algebra decision.”)

The SBE’s action would have set California apart from virtually all other states in effectively making Algebra I the default math course in grade 8. California’s prospective company in this expectation is Minnesota, which set a slower timetable for implementation. In 2006, Minnesota leaders decided that, beginning with the class of 2015, students must complete Algebra I by the end of 8th grade and complete Algebra II to graduate from high school.

The SBE’s decision stirred vigorous debate among California education leaders about whether testing all 8th grade students in Algebra I, even if phased in over several years, is a sound policy. Schools and districts would have been held accountable for the extent to which all 8th graders can succeed on the state’s Algebra I test. Currently, 43% of 8th graders take the General Math CST, which assesses student achievement on California’s math standards for grades 6 and 7.

At this moment, a preliminary injunction prevents the board from taking any further steps to implement its algebra decision. But the important issues raised by the decision remain, and districts are struggling to figure out what the board’s decision means for their student placement policies, instructional capacity, and instructional materials. The rest of this report explores some of these issues, describes where California currently finds itself with regard to K–8 math achievement, and discusses where it might go next.

figure 1 | How California’s academic content standards in mathematics are organized in grades K–7 versus grades 8–12

In grades K–7, the mathematics content standards were established for each grade level, using five common strands:	In grades 8–12, the mathematics content standards were established for nine specialized math disciplines:
<ul style="list-style-type: none"> ■ Number sense ■ Algebra and functions ■ Measurement and geometry ■ Statistics, data analysis, and probability ■ Mathematical reasoning 	<ul style="list-style-type: none"> ■ Algebra I ■ Geometry ■ Algebra II ■ Probability and Statistics ■ Trigonometry ■ Linear Algebra ■ Mathematical Analysis ■ Advanced Placement Probability and Statistics ■ Calculus

SOURCE: Mathematics Content Standards for California Public Schools: Kindergarten Through Grade Twelve

EDSOURCE 5/09

California’s math content standards left the state’s Algebra I expectations ambiguous

The State Board of Education adopted California’s academic content standards in mathematics in December 1997. These standards, in conjunction with state testing and accountability policy, have pushed schools to enroll students in algebra earlier, optimally in 8th grade. The state did not *require* 8th graders to take algebra, however. So far, the only official expectation has been that students in the class of 2004 and later must pass a course that meets or exceeds the standards for Algebra I to graduate from high school.

Three concepts help explain how algebra fits into the state’s math content standards and how those standards relate to what is taught in schools.

California’s math content standards are organized differently for grades K–7 than for grades 8–12

In grades K–7, California’s math content standards are set for each grade level. Teachers are expected to help students develop increasingly sophisticated computational and procedural skills, conceptual understanding, and problem solving along five interrelated “strands” that extend across grades K–7. (See Figure 1.)

In grades 8–12, however, California’s math content standards are organized into nine specialized *disciplines* rather than by grade level, beginning with Algebra I. (See

Figure 1.) As noted in the box on page 2, this California practice diverges from federal assumptions under the No Child Left Behind law (NCLB), which groups grades K–8 together and treats grades 9–12 separately.

The annual California Standards Tests (CSTs) in mathematics reflect the state’s approach. Students in grades 2–6 all take a single CST for each grade. A grade-level CST is also administered in grade 7, but a small percentage of 7th graders enrolled in algebra take the Algebra I CST instead.

Students in grades 8–11 take different math CSTs depending on what courses they take. Those 8th and 9th graders who are not yet ready for algebra take the General Mathematics CST, which is aligned with the math content standards for grades 6 and 7. The state’s accountability system provides schools with incentives to enroll students in Algebra I by grade 8, however. (See the discussion on page 4.)

Algebra as a content standard is different from algebra as a course or part of a curriculum

Every California high school must provide courses that fulfill the minimum criteria for eligibility to the University of California (UC) and the California State University (CSU). But California’s math content standards do not call for any discipline-specific course to be taught in any particular grade between 8 and 12. Instead, the standards acknowledge that districts might adopt

different philosophies and approaches toward their math curricula.

Districts might pursue a “traditional” curriculum that begins with Algebra I and continues with Geometry, followed by Algebra II. Districts might also offer these courses in a different sequence, such as placing students in Geometry only after they have completed both Algebra I and II. Districts might also adopt an “integrated” math curriculum that weaves together topics from these disciplines during several years, though this has become far less common in California.

That said, algebra is still the minimum standard for the content the state hopes a growing number of students will learn beginning in grade 8. This standard is the same regardless of what curricular approach a district takes. This distinction between algebra as a content standard and as a course was a key point of contention in the lawsuit brought against the state board. (See the box on page 2.)

Mandatory testing and accountability policies push schools to meet standards and increase participation in higher math

The California Education Code establishes that the academic content standards are intended as models. The math content standards note, “except for the statutes, regulations, and court decisions that are referenced herein, the document [setting out the math standards] is exemplary, and compliance with it is not mandatory.” This language relieves the state from any obligation to reimburse districts financially for mandates related to the content standards themselves. Other regulations, however, underscore the expectation that districts’ standards will be at least as rigorous as the state’s.

For example, state funds for instructional materials can be used only for materials aligned with the content standards. In addition, schools are required to offer the annual CSTs in grades 2–11. The CSTs provide a strong incentive for local educators to align instruction with content standards because the tests are used to report publicly on the academic progress of schools and districts, and to identify those considered “in need of improvement.”

Federal education policy uses school accountability to encourage student participation in such testing. The No Child Left Behind Act of 2001 requires 95% of all students in a district or school to participate in relevant state tests for the institution to make “adequate yearly progress” (AYP). In mathematics in California, this includes grade-level and end-of-course math CSTs and, for high schools, the math section of the California High School Exit Exam (CAHSEE) in grade 10, which includes an Algebra I component. Failure to meet this federal requirement for any subgroup of students (based on ethnicity, disability, or English learner status) for two years in a row leads to a school or district being placed in Program Improvement. In part, NCLB emphasizes participation to discourage schools from excluding struggling students. (California law requires districts to exempt students from testing if parents request it, however.)

In addition, California accountability policy explicitly encourages participation in higher math courses, such as Algebra I. Rules adopted by SBE for the calculation of the Academic Performance Index (API)—which summarizes student achievement for a district or school and for its student subgroups for accountability purposes—

provide schools with two incentives to move students into higher math courses.

First, because the General Math CST assesses math content that is below the state’s expectations for grades 8 and 9, schools receive less credit on the API for high student scores on the General Math CST in these grades. Students may achieve one of five performance levels on a CST: advanced, proficient, basic, below basic, or far below basic.

- The scores of 8th graders who take the General Math CST are lowered by one performance level for the purposes of calculating a school’s API. For example, if an 8th grader scores “proficient” on this CST, a school only gets credit for a score of “basic.”

- The scores of 9th graders who take the General Math CST are lowered by two performance levels for the purposes of calculating a school’s API. For example, if a 9th grader scores “proficient” on this CST, a school only gets credit for a score of “below basic.” (The state does not penalize high schools for 9th graders who take the Algebra I CST.)

Second, schools are penalized on the Base API for any student not actively taking mathematics courses in the upper grades. All students in grades 8–11 who do not take an end-of-course CST in mathematics are automatically assigned a score of 200—or “far below basic”—for the purposes of calculating a school’s Base API. This penalty also offers schools an opportunity because increases in student enrollment in higher math courses from one year to the next can contribute to gains in a school’s Growth API. This “Assignment of 200” rule also applies for high school science courses.



Large increases in algebra participation in grade 8 since 2003 have brought encouraging results and some worries

Since the initial adoption of California's math content standards in 1997, growing numbers of students have been taking Algebra I, and taking it earlier. This section focuses on changes since 2003.

Notably, this growth in participation has been accompanied by a higher success rate on the Algebra I CST, with greater numbers of students scoring advanced or proficient. However, a great many students are not succeeding in the course, and large numbers repeat it once or more. Furthermore, some say that data from the National Assessment of Educational Progress (NAEP) paint a sobering picture of 8th grade math achievement in California compared with other states. CST data from grades 2–7 suggest that these problems become clear in the late elementary and early middle grades.

Many more students now take algebra

There are two ways to measure the success of California's policy decisions regarding algebra. The first is *student participation* in higher math courses; the second is *student success* in those courses. This report focuses

primarily on 8th graders who take the Algebra I CST, how well they do, and how this has changed over time. Considered together, these two measures show that California schools have changed their collective approach to when students take Algebra I.

To the extent that SBE policy has been motivated by concern that schools were not being held to sufficiently high expectations for student achievement in grade 8 math, there have clearly been important changes in the state. Early student participation in Algebra I has increased greatly in recent years. (See Figure 2A.)

In 1999, the first year California administered course-specific math tests in grade 8, only 16% of 8th graders took the test for Algebra I. By 2003, this percentage had increased to 32%. In 2008, 51% of 8th graders took the Algebra I CST. Some 7th graders—5% in 2008—now take the test as well.

Participation in the Algebra I CST has increased among 8th graders of all racial and ethnic backgrounds. (See Figure 2B.) The percentage of African American 8th graders taking the test nearly doubled between 2003 and 2008, from 24% to 47%. The same is also true for Latino 8th graders (26% to 48%).

The number of students taking the Algebra I CST in grade 9 has also increased. Many of these students are repeating the course, however, as will be explored in more depth later.

Student participation in Algebra I—the beginning of the typical high school math sequence—is just one measure of participation in higher math. Math CSTs in later grades also provide a rough measure of how many students successfully pursue a sequence of higher mathematics courses beyond Algebra I. For example, CST data show that 25% of 10th graders and 45% of 11th graders had completed or were enrolled in Algebra II in 2008.

figure 2A | More California students are taking Algebra I and are taking it earlier

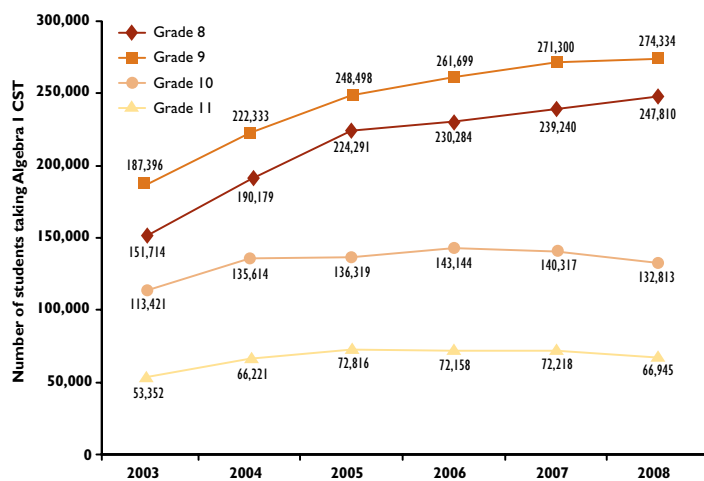
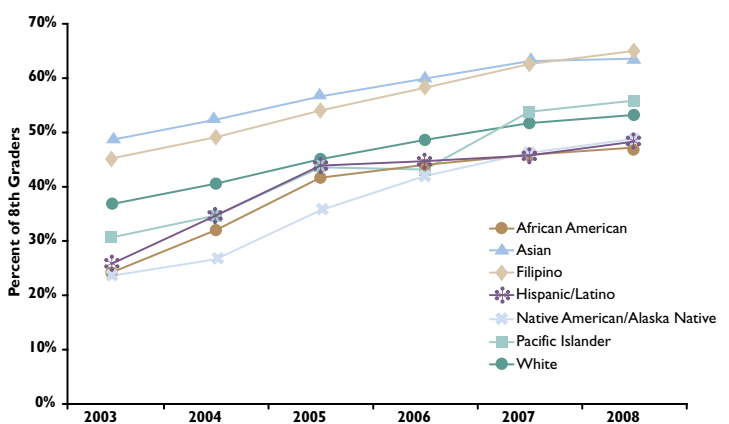


figure 2B | Estimated participation rates in Algebra I have increased among 8th graders of all racial/ethnic groups since 2003



Notes: Figure 2A: In 2007, 21,739 7th graders took the Algebra I CST. The number increased to 25,635 in 2008. (2007 was the first year that qualified 7th graders could take the Algebra I CST.) Figure 2B: These rates are calculated by dividing the number of Algebra I CST-takers for a student group in grade 8 (derived from STAR data) by that group's total grade 8 enrollment (derived from CBEDS data). STAR data do not include a count of total enrollments by subgroup in each grade at the time of STAR testing. CBEDS enrollment data, which are based on student counts at the beginning of the academic year, are used to estimate participation rates for subgroups.

Mixed results show the positive and negative consequences of increased algebra participation to date

Algebra I CST data provide evidence for several—at times conflicting—stories about California students' algebra achievement in grade 8 since 2003. Some find evidence that the state's schools and 8th graders are meeting high expectations in mathematics, while others point to results that suggest growing numbers of students are being placed in algebra courses for which they are not prepared. Consider some examples. (Additional charts showing 8th grade Algebra I CST outcomes among different student groups are available from the EdSource website at: www.edsource.org)

8th grade performance on Algebra I CST overall

First, consider all 8th graders who took the Algebra I CST in 2003 and 2008. (See Figure 3A.) In general, there was a slight improvement in the proportion of students scoring proficient or advanced, even given a large increase in participation. In addition, the percentage scoring in the lowest achievement category (far below basic) decreased slightly, from 9% to 7%.

The scale of change since 2003 is particularly notable:

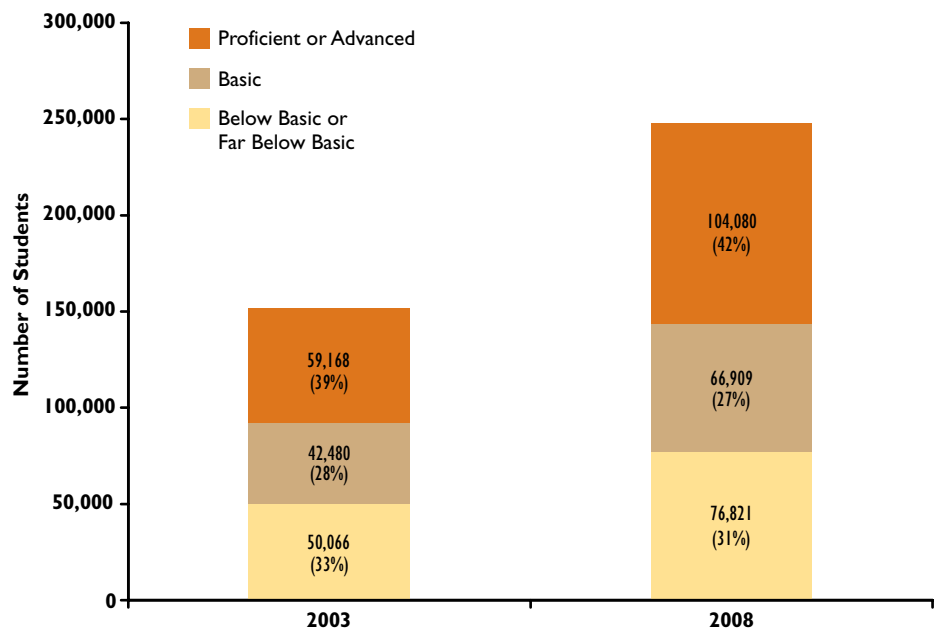
- 1.8 times as many 8th graders—about 104,100—scored proficient or advanced on the Algebra I CST in 2008 as in 2003.
- At the same time, 1.5 times as many 8th graders—about 76,800—scored below or far below basic on the test in 2008 as in 2003.

These overall statistics obscure important differences in 8th grade Algebra I achievement among various student groups, however.

8th grade performance on Algebra I CST by economic background

Changes in algebra achievement for socioeconomically disadvantaged (SED) 8th graders contrast with those for nonsocioeconomically disadvantaged (non-SED) 8th graders. Students are categorized as SED if (a) they participate in a free or reduced-price meal program, or (b) the education level of their parents is coded as “not high school graduate.”

figure 3A | Performance of all 8th graders taking the Algebra I CST



Note: The counts of 8th graders shown here are based on the numbers tested on the Algebra I CST, rather than the preferable number of students with valid scores. This is because the latter data are not published for 2003 as they are for 2008. These counts are estimates derived from state reports of performance and may not match the number of students tested due to rounding.

DATA: CALIFORNIA DEPARTMENT OF EDUCATION, STAR. ACCESSED 1/09.

EDSOURCE 5/09

For non-SED 8th graders, California's push toward expanded algebra success in grade 8 has been comparatively successful. (See Figure 3B on page 7.) Only about 4,100 more non-SED students scored basic or below on the Algebra I CST in 2008 than in 2003, compared with about 21,200 more who scored proficient or advanced.

For SED students, the story is more complex. (See Figure 3C.) The percentage of SED 8th graders scoring proficient or advanced on the Algebra I CST increased by 8 percentage points between 2003 and 2008. In fact, 3.2 times as many SED 8th graders—about 37,600—did so in 2008. This shows that many SED students who might not previously have had access to an algebra course in grade 8 are not only taking the course, but also rising to the challenge.

At the same time, however, roughly the same number of SED 8th graders now scores below or far below basic on the Algebra I CST as took the test *at all* in 2003. This means that more SED 8th graders—53,900 in 2008—are at risk of failing and repeating Algebra I.

8th grade performance on Algebra I CST by ethnicity

The Algebra I story is also complex for 8th graders of different racial and ethnic backgrounds. Consider California's African American and Latino 8th graders. For both groups, 8th grader participation in the Algebra I CST increased substantially between 2003 and 2008.

- 2.6 times as many African American 8th graders scored proficient or advanced on the Algebra I CST in 2008 as in 2003, and the percentage scoring below or far below basic decreased. On the other hand, nearly as many African American 8th graders (about 9,000) now score below or far below basic as took the test at all in 2003 (about 9,900). (See Figure 3D.)
- 3.2 times as many Latino 8th graders scored proficient or advanced on the Algebra I CST in 2008 as in 2003, and the percentage scoring below or far below basic decreased. On the other hand, about 47,900 Latino 8th graders now score below or far below basic, or nearly as many as took the test at all in 2003 (about 51,200). (See Figure 3E.)

figure 3B | Performance of nonsocioeconomically disadvantaged 8th graders

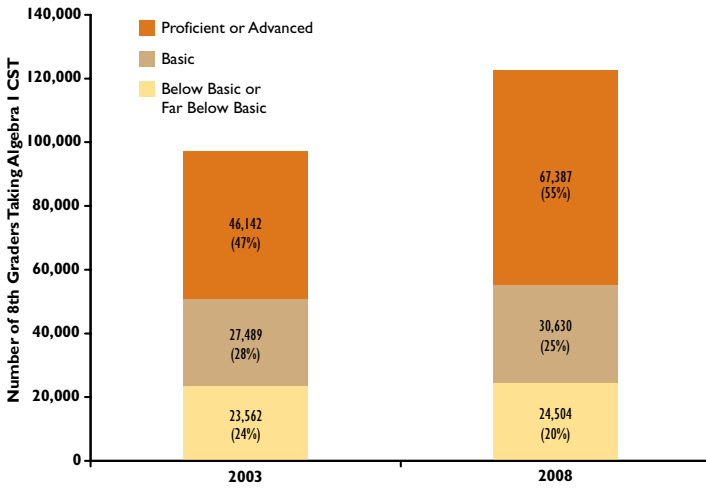


figure 3C | Performance of socioeconomically disadvantaged 8th graders

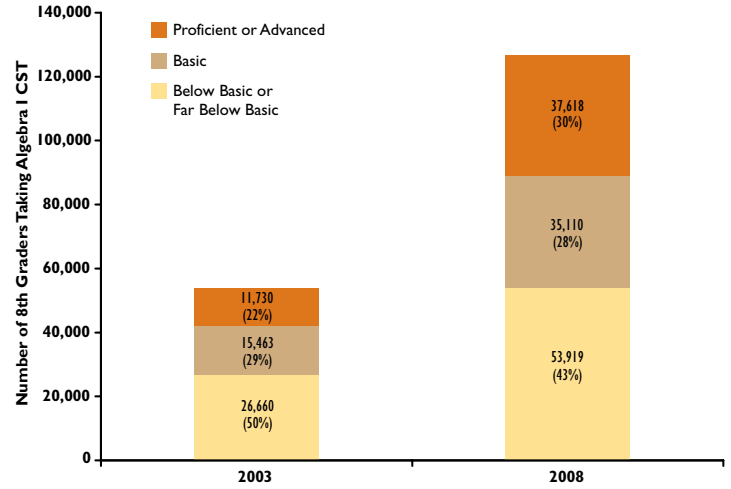


figure 3D | Performance of African American 8th graders

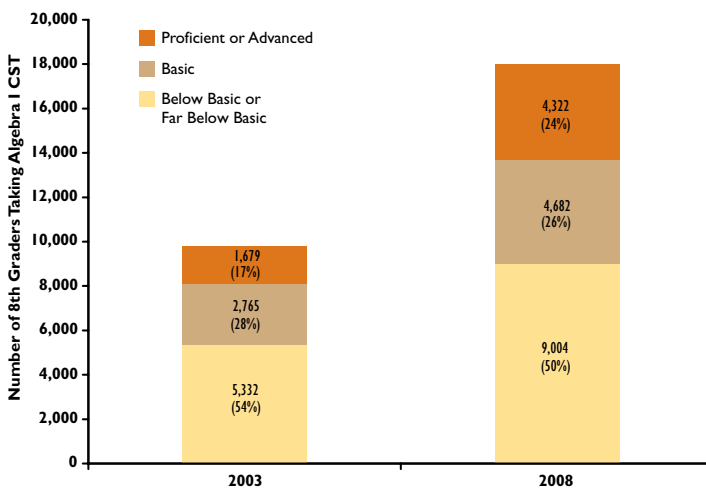
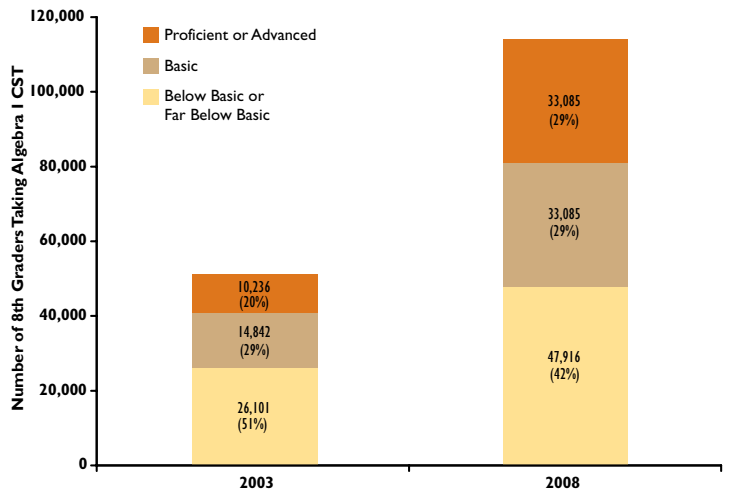


figure 3E | Performance of Latino 8th graders



Note: The counts of 8th graders shown here are based on the numbers tested on the Algebra I CST, rather than the preferable number of students with valid scores. This is because the latter data are not published for 2003 as they are for 2008. These counts are estimates derived from state reports of performance and may not match the number of students tested due to rounding.

DATA: CALIFORNIA DEPARTMENT OF EDUCATION, STAR. ACCESSED 1/09.

EdSource 5/09

These data tell two stories. One is a story about African American and Latino students succeeding when provided access to Algebra I in grade 8, whereas in prior years they may not have had such access. Another story is about unintended consequences and the substantial cohorts of African American and Latino 8th graders who might have been placed in Algebra I without adequate preparation and/or support and might need to repeat the course. About three in four Latino and three in five African American 8th

graders who took the test in 2008 were socioeconomically disadvantaged.

This stands in stark contrast to Asian and white 8th graders. For both groups, the number of 8th graders scoring proficient or advanced on the Algebra I CST has grown substantially more since 2003 than has the number scoring basic or below. Although about 1,100 more Asian 8th graders scored basic or below in 2008 than did so in 2003, about 5,800 more now score proficient or advanced. The comparable increases among

white 8th graders were about 3,600 and 10,200 students, respectively.

8th grade performance on Algebra I CST of English learners and students with disabilities

Algebra I CST achievement data for 8th graders who are designated as English learners or as students with disabilities warrant particular consideration. Students are placed in these two categories because they have been identified as needing additional support to be successful in California's public schools. English

figure 3F | Performance of English learner 8th graders

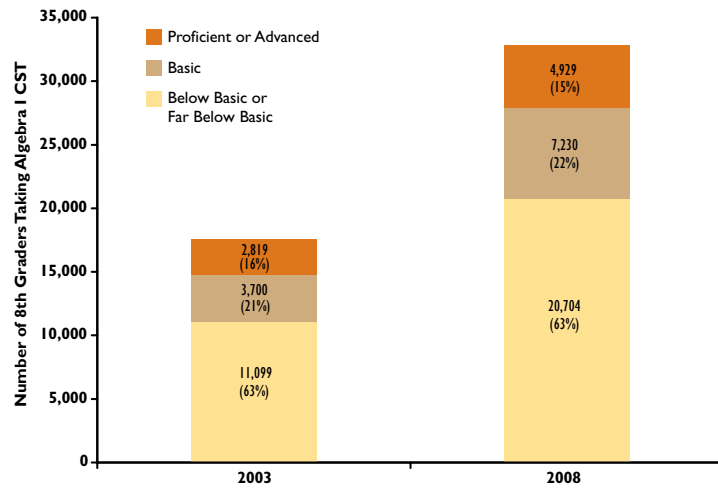
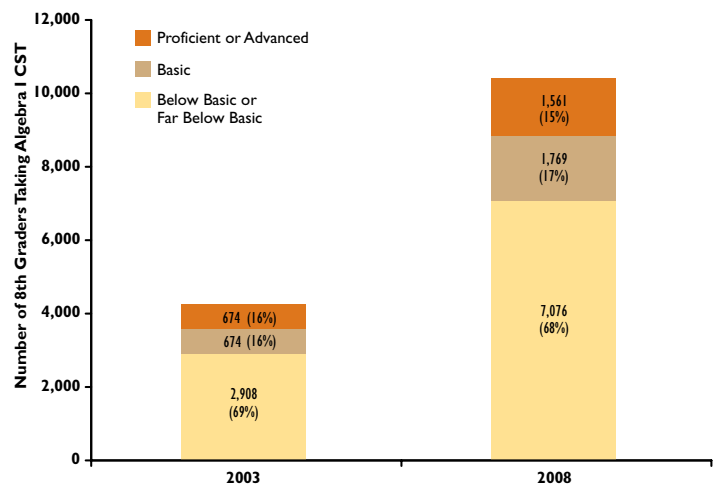


figure 3G | Performance of 8th graders with disabilities



Note: The counts of 8th graders shown here are based on the numbers tested on the Algebra I CST, rather than the preferable number of students with valid scores. This is because the latter data are not published for 2003 as they are for 2008. These counts are estimates derived from state reports of performance and may not match the number of students tested due to rounding.

DATA: CALIFORNIA DEPARTMENT OF EDUCATION, STAR. ACCESSED 1/09.

EdSource 5/09

learners (ELs) and students with disabilities were about 13% and 4% respectively of 8th graders who took the Algebra I CST in 2008.

Algebra I CST participation increased substantially for both groups of 8th graders between 2003 and 2008. (See Figures 3F and 3G.) This is especially true for 8th graders with disabilities. Nearly 2.5 times as many 8th graders with disabilities—about 10,400 in all—took the test in 2008 versus 2003.

Even with this growth in participation, the percentages of these 8th graders scoring at different achievement levels on the Algebra I CST in 2008 was roughly the same as in 2003, with small decreases in the percentages scoring far below basic. One result is that greater numbers of 8th graders in both groups now score proficient or advanced. About 1.7 times as many EL 8th graders did so compared with 2003, as did about 2.3 times as many 8th graders with disabilities.

However, another upshot is that about two-thirds of 8th graders in both groups still score below or far below basic on the Algebra I CST. As a result, many more of these students may need to repeat Algebra I. About 1.2 times as many EL 8th graders and 1.7 times as many 8th graders with disabilities scored below or far below basic on the Algebra I CST in 2008 as took the test at all in 2003. To the extent that Algebra I becomes a default

course-taking expectation for grade 8, particular attention regarding how to support the math achievement of EL students and students with disabilities most effectively is clearly warranted.

General Math CST

Student outcomes are also mixed among 8th graders who do not take the Algebra I CST. In 2008, 43% of the state's 8th graders took the General Math CST because they were either not enrolled in algebra or enrolled in the first year of a two-year algebra course.

Pre-algebra success among 8th graders not yet taking the Algebra I CST is improving but remains a concern. Of these 8th graders, less than one-third (31%) scored proficient or advanced on the test, and 41% scored below or far below basic. In 2003, when 60% of 8th graders took the General Math CST, only 24% scored proficient or advanced.

Many students repeat Algebra I

California math educators and policymakers interpret the Algebra I CST data presented so far in differing ways. But most agree that too many students are repeating the course, sometimes multiple times.

California is now able to quantify this problem more precisely using student-level data. These data show that 38% of 9th graders

who took the Algebra I CST in 2008 had taken the test in a prior year. More than half of 10th and 11th graders who took the CST were repeating it as well. (See Figure 4 on page 9.) Repeating Algebra I in grade 10 or later is of particular concern because it can prevent students from completing college-prep courses in science that have algebra as a prerequisite.

These data also raise larger questions about current students' preparation to take advantage of earlier access to algebra. Many students who repeat the Algebra I CST may have struggled in math in earlier grades as well. Some worry that continuous lack of success in math can have the pernicious effect of convincing some students they are "unable" to understand and use mathematics. At the extreme, some say repeated algebra course failure causes some students to disengage from school entirely and drop out.

The California Department of Education (CDE) cautions that some uncertainty surrounds these repeater data:

- Some students in the state take Algebra I as a two-year course. CDE intends for students in the first year of such a course to take the General Math CST. Only students completing Algebra I are expected to take the Algebra I CST. However, whether all districts administer the CSTs

in this way is unclear. Some students in two-year algebra courses might take the Algebra I CST twice, even though they did not actually repeat the course.

- In addition, some students who pass Algebra I in grade 8 might be placed in the course again by high schools that criticize the quality of 8th grade courses.

California compares poorly in grade 8 math on a national assessment

The CSTs are not the only available measures of California students' math achievement in grade 8. The National Assessment of Educational Progress (NAEP), which is administered to a sample of California students, provides a way to compare California's grade 8 math achievement with other states. Some say NAEP provides an objective and valuable measure of California's overall mathematics curriculum.

Data from the 2007 NAEP (see Figure 5A) show that:

- California 8th graders generally score below the national average and below the other four largest states (Florida, Illinois, New York, and Texas).
- Texas in particular outscores California across all student groups.
- California's average NAEP scores in grade 8 math generally are also below those for Massachusetts and Minnesota. These two states are particularly notable in connection with yet another assessment: the Trends in International Mathematics and Science Study (TIMSS). Massachusetts and Minnesota are the only two states whose students' scores on the TIMSS are benchmarked separately against students from other nations—with greater average success in math than students in the United States as a whole.

Some in California insist that NAEP results in general should be interpreted with caution. The NAEP in grade 8 math is not specifically aligned with California's content standards, nor is it an Algebra I test. In addition, California's scores (1) for all students and (2) for Latino students are complicated by the fact that California excludes a much lower proportion of its English learner

figure 4 | Many students in the high school grades have taken the Algebra I CST more than once

Grade	Students in Grade Taking the Algebra I CST in 2008	Algebra I CST-takers Who Are First-time Examinees	Algebra I CST-takers Who Are Repeating the Assessment
7	25,573	25,573 (100%)	0 (0%)
8	246,587	242,062 (98%)	4,525 (2%)
9	272,353	167,819 (62%)	104,534 (38%)
10	131,415	62,834 (48%)	68,581 (52%)
11	66,108	31,901 (48%)	34,207 (52%)

DATA: CALIFORNIA DEPARTMENT OF EDUCATION, 2008 Standardized Testing and Reporting (STAR) Program Summary of Results, AUGUST 2008.

EdSource 5/09

figure 5A | 2007 NAEP 8th grade mathematics average scale scores

Student Group	CA	FL	IL	MA	MN	NY	TX	Nation
African American	253	259	*	264	*	*	271	259
Asian/Pacific Islander	293	*	*	315	*	302	309	296
Latino	256	270	265	270	269	264	277	264
White	287	*	*	305	297	*	300	290
English Learner	241	*	257	*	258	*	252	245
Not English Learner	278	*	*	299	293	282	288	282
All Students	270	277	280	298	292	280	286	280

* Difference with comparable California score is not statistically significant.

figure 5B | 2007 NAEP 8th grade mathematics English learner exclusions

Student Group	CA	FL	IL	MA	MN	NY	TX	Nation
Percentage of 8th Graders Identified as EL	22%	6%	4%	3%	5%	5%	8%	7%
Percentage of 8th Graders Excluded Due to EL Status	1%	1%	1%	1%	#	1%	2%	1%
Percentage of 8th Grade EL Students Excluded	5%	17%	25%	33%	#	20%	25%	14%

Rounds to zero.

DATA: NATIONAL CENTER FOR EDUCATION STATISTICS (NCES).

EdSource 5/09

students from participation in the NAEP compared with the nation and the other six states discussed here. (See Figure 5B.)

However, others see these results as compelling evidence that whatever progress students may have made relative to the state's

own standards and assessments, California students are not receiving a balanced mathematics education in grades K–8 compared with their peers in other states. For some, these data heighten their concern that California's students—and the public school

How NAEP and CSTs differ

The National Assessment of Educational Progress (NAEP) and the California Standards Tests (CSTs) in grade 8 mathematics are very different tests.

- The NAEP includes both multiple-choice and open-ended, constructed-response items. In contrast, the math CSTs that California 8th graders take are entirely multiple-choice questions.
- No student takes the entire NAEP exam, in contrast with the CSTs. The NAEP follows a matrix design: individual students take only two sections of the test, and the results for many sampled students are combined.
- In grade 8, the NAEP in mathematics assesses content pertaining to number properties and operations, measurement, geometry, data analysis and probability, and algebra at varying levels of mathematical complexity. In contrast, California 8th graders take different CSTs that assess different content depending on the math courses in which they are enrolled.

For more extensive discussion of NAEP and CSTs, see EdSource’s May 2008 report, *NAEP and the California Standards Tests: A Case of Apples and Oranges*.

system in general—are not prepared to make Algebra I in grade 8 a default curriculum and that the unintended consequences could be quite serious.

Math achievement problems begin in grade 5
Most California math experts, including policymakers and educators, agree that

California students’ math proficiency when they arrive in grade 8, on average, does not meet the state’s aspirations. The key data relate to students’ math achievement in grades 5–7.

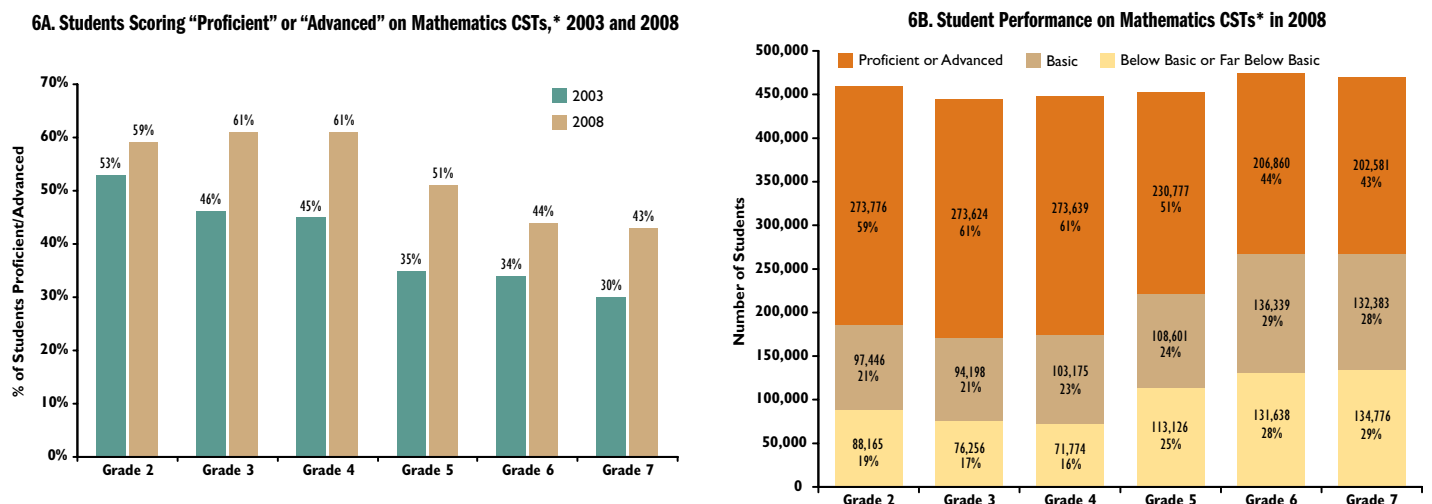
The good news is that the percentage of students scoring proficient or advanced on math CSTs increased in each of grades 2

through 7 between 2003 and 2008. (See Figure 6A.) In addition, 5% of 7th graders now take the Algebra I CST, with four out of five of these students scoring proficient or advanced.

However, some analysts caution that some of the improvement in grades 2–7 is likely a consequence of increased familiarity with the tests. Further, California observers are troubled by a decline in math achievement across grades, beginning in grade 5 and persisting in the early middle grades. Larger percentages of students in these grades score below or far below basic on math CSTs. Nearly three in 10 students in grades 6 and 7 scored in these lowest two categories in 2008, compared with just 16% of 4th graders. (See Figure 6B.)

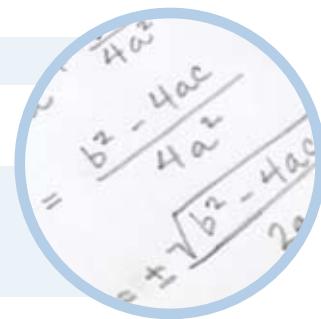
For many in the state, these data indicate a root cause behind California’s challenges in grade 8 mathematics, including later algebra repetition: students’ math preparation in earlier grades is inadequate and suffers beginning in grade 5. The math achievement gaps among different student groups noted earlier with respect to grade 8 Algebra I also appear across grades 2–7.

figure 6 | Although more students in grades 2–7 are scoring highly on math CSTs, student achievement declines beginning in grade 5



* Includes both 7th graders taking the Grade 7 Mathematics CST and those taking the Algebra I CST in 2008.

Note: The counts of students in Figure 6B are based on the numbers tested on the relevant CSTs, in order to remain consistent with Figures 3A–G. These counts are estimates derived from state reports of performance and may not match the number of students tested due to rounding.



The algebra debate raises hard questions about California's expectations for math achievement

The relationship between a state's academic content standards and actual classroom practice is highly complex. But California's algebra debate raises a question that goes to the heart of the state's standards-based reforms. Does California have the right expectations when it comes to algebra?

Different perspectives on the timing of algebra highlight the importance of support and the risk of unintended consequences

A decade ago, the big question in California was whether all students should be expected to take a year of algebra before they graduated from high school. State lawmakers responded “yes” to this question in 2000. Students in the class of 2004 were the first to be required to pass Algebra I to earn a diploma. But the transition was not easy. *Education Week* reported in May 2004 that nearly half of California districts applied for waivers from the requirement that year. Today, this requirement appears to be fully implemented as a minimum standard for high school graduation.

In contrast, California's Mathematics Framework states that one of its goals is to “prepare all students to study algebra by the eighth grade.” This aspiration is consistent with findings from TIMSS, reported by William Schmidt and others, that high-achieving nations in mathematics tend to begin instruction in algebra by grade 8. These findings fuel worries that other nations expect more from their students than do most states, with troubling implications for American economic competitiveness.

In addition, such nations frequently take a different approach to their math curricula than California. For example, content pertaining to introductory algebra and geometry might be taught to all students over the course of grades 7–9, rather than through two separate courses in just two years. High-performing nations also tend to focus on fewer important math topics in greater depth in the grades leading up to algebra.

There is broad agreement in California that earlier success in algebra would be good

for students and for the state generally. There is also general agreement that every California student deserves to be challenged academically, taught and supported by adults who believe strongly in his or her potential, and provided a fair chance to achieve academic success. But some California math educators and policymakers differ regarding how state policy might best support these ideals.

Consider the debate that surrounded the State Board of Education's response to federal demands that California bring its grade 8 assessments into compliance with NCLB. (See the box on page 2.) In the absence of a waiver allowing California to pursue its own approach to grade 8 math, the state board focused on two options:

- Pursue the Algebra I CST for all 8th graders, which would clearly meet federal demands and continue the state's emphasis on getting more students into the course.
- Pursue, if accepted by the U.S. Department of Education, a new grade 8 CST based on Algebra I but excluding such content as factoring and quadratic equations.

Some saw the proposed blueprint for a new grade 8 CST as undercutting the intent of the state's content standards to ensure high expectations for all students. The proposed test would have assessed less content than the Algebra I CST, but it would have been designated “grade-level” for federal accountability purposes. Critics argued this would confer “grade-level” status on lower expectations for some students. For them, the state board made a defensible decision when it insisted that all schools should be held accountable for universally

high expectations through the Algebra I CST in grade 8.

Others saw the proposed blueprint as an improvement on the General Math CST that would provide less prepared students with initial exposure to algebra and leave room for local educators to use their best judgment in making student placement decisions. For them, California policy should focus on accelerating early success in algebra only as appropriate for individual students—such as by grade 8 or 9—rather than use the testing system to insist on algebra in a particular grade. They worry that requiring the Algebra I CST for all 8th graders could set up many students for course failure and expand the already large number of students who repeat the course.

Recent studies have underscored concern that a grade 8 “algebra for all” policy could have unintended repercussions for students. The most recent is a 2009 study by two researchers from the Consortium on Chicago School Research, Elaine M. Allensworth and Takako Nomi. The study explored the outcomes of a 1997 Chicago Public Schools policy to require Algebra I for all students by grade 9 as part of an effort to broaden student access to college-prep curricula. Allensworth and Nomi looked at course data for 11 cohorts of first-time Chicago 9th graders between 1994 and 2004. The Chicago researchers found that more students enrolled in Algebra I, as intended under the policy. However, math course failure and absenteeism increased among those students who started with low and average levels of math achievement.

A 2008 report by Tom Loveless of the Brookings Institution, *The Misplaced Math Student*, reported on the extent to which some early algebra placements might be

inappropriate. Loveless looked at math outcomes for the lowest-achieving 10% of 8th graders on NAEP. He found that, whereas only 8% of these lower-achieving students were enrolled in Algebra I or higher in 2000, almost 29% were enrolled in such courses in 2005. However, these students were frequently unable to correctly answer test items that assessed such basic math concepts as rounding a decimal to the nearest whole number. Loveless concludes that policies aimed at more equitable access to rigorous math curricula had the unintended consequence of putting less-prepared teachers in algebra classrooms with students of widely differing levels of preparation. He argues further that this burden fell disproportionately on minority students in urban, low-income schools.

A recent UCLA analysis of CST scores at 112 randomly selected middle schools in the Los Angeles area raises similar concerns, suggesting that lower-performing middle schools are more likely to enroll 8th graders who scored below or far below basic on the grade 7 math CST in an Algebra I course. (Although the grade 7 math CST is not a diagnostic test and results are generally not available in time to inform grade 8 placement decisions, the UCLA study used the grade 7 CST to judge the restrictiveness of school placement policies.)

Some worry that minority students in hard-to-staff, urban schools who excel in math and wish to pursue the most challenging courses could, under an “algebra for all in 8th grade” policy, find themselves enrolled in algebra courses that are insufficiently challenging. This could effectively place these students on a less competitive math trajectory. At the same time, however, some research suggests that accelerated math course-taking in the middle grades can work, provided students receive adequate support to be successful. For example, a recent longitudinal study in Long Island, NY, by Carol Corbett Burris and colleagues, cites such practices as workshops for students needing additional help, common preparation time for teachers, and assigning math teachers to work in both accelerated regular classrooms and support workshops.

These studies highlight the challenge of achieving broader access to rigorous math curricula while assuring quality instruction and successful outcomes for students. Although the Chicago and Brookings studies are often interpreted as cautionary tales, these studies do not necessarily mean the goal of getting most 8th graders into Algebra I is not worth pursuing. Another interpretation is these studies highlight the importance of support for local capacity and instructional quality. For example, Loveless’s finding that some algebra students cannot round decimals to the nearest whole number raises the question of why these students were not prepared adequately in prior years. In this sense, student participation and success in a rigorous math curriculum, and the high expectations that accompany it, begin in elementary school.

Universal Algebra I in grade 8 may also have some important implications for high schools and postsecondary institutions. One reason often given for algebra in grade 8 is to ensure the broadest and earliest possible access to a rigorous high school curriculum that will prepare students for smooth transitions to some form of postsecondary study. Without question, preparation in mathematics is very important to colleges and universities. Many California students enroll in community college needing basic skills math courses before they can succeed in degree-applicable ones, for example.

Earlier participation and success in algebra could reduce the need for remediation among recent high school graduates, provided students take math courses every year during high school as California’s public universities recommend. It could also increase the demand for courses in higher math in high schools. Very different consequences are also possible, however. Widespread Algebra I in grade 8 could increase the numbers of students who, having completed the math course requirement for eligibility to UC or CSU by the end of grade 10, decide to *not* take math courses during their junior and senior years. This time away from the study of math could result in more high school graduates performing poorly on college placement exams and needing remediation in math. That said, students who have completed

or enroll in Algebra II by grade 11 could still receive early feedback about their college readiness in math by participating in the Early Assessment Program. (Through this program, high school juniors can take expanded CSTs to determine college readiness for the California State University system.)

Does the algebra debate raise deeper questions about California’s standards-based reforms?

California’s current math content standards were the product of a contentious adoption process often referred to as the “math wars.” The debate positioned supporters of a stronger statewide emphasis on basic operational skills and mathematical precision against those who stressed conceptual understanding and the practical relevance of mathematics (as in the model standards of the National Council of Teachers of Mathematics, for example).

Math educators and policymakers understand that these multiple aspects of math proficiency are closely interrelated and essential for students to learn. At the same time, most acknowledge that a “back to basics” approach to the standards won the day in California. The philosophical tensions that spurred this debate continue to linger. There is still disagreement among knowledgeable people in the state about whether the foundation provided by California’s math content standards, and the assessments of student achievement provided by the math CSTs, offer students and educators a world-class or a narrow vision of math proficiency.

For supporters of the choices California made, the current math standards are at the core of the state’s instructional capacity to expand algebra success by grade 8. They point to student achievement gains on the CSTs as evidence that students can succeed when held to high expectations and given a fair chance to meet them. Supporters also point to positive ratings of the state’s math standards by such organizations as the Fordham Foundation and the American Federation of Teachers. Further, the National Mathematics Advisory Panel, created in April 2006 by then-President George W. Bush, found in 2008 that

the K–8 math standards of six states—including California and Massachusetts—“on the whole, provide an emphasis on fewer important topics per year than most states.”

However, the panel added that this more coherent focus still falls short of what is done in high-performing nations, such as Singapore. Panel members also cautioned that standards must be accompanied by meaningful assessments, curricula, and effective teacher preparation and professional development—in effect, the other elements necessary to support continuous

improvement in teaching and student achievement. These observations bolster the argument of those who say that California’s lackluster performance on NAEP compared with other states shows that California’s policy choices have not provided students an adequate foundation for well-rounded math proficiency. From their perspective, California should be open to learning from other states about how to more effectively prepare all students for algebra. Some point to Texas, which outscores California on NAEP, and Massachusetts and Minnesota,

which are benchmarked independently against other nations on TIMSS.

Massachusetts, for example, is reviewing its Mathematics Curriculum Framework, which includes the state’s math standards, to identify possible revisions. The revision panel’s progress report, discussed by the Massachusetts Board of Elementary and Secondary Education in March 2009, considers the streamlining, prioritizing, and vertical alignment of the state’s math standards through grade 7. The goal is to support increased, successful participation in algebra in grade 8 while still allowing students who

California’s target math standards for algebra readiness

California’s current Mathematics Framework sets out the state’s expectations for “algebra readiness” instructional materials, to be used with 8th graders not yet ready for algebra. These materials build on key math standards from grades 2–6, with the goal of achieving 16 “target” standards from grade 7 and Algebra I that prepare students for a full algebra course.

13 targeted math standards from grade 7

Number Sense strand:

- Add, subtract, multiply, and divide rational numbers (integers, fractions, and terminating decimals) and take positive rational numbers to whole-number powers.
- Convert fractions to decimals and percents and use these representations in estimations, computations, and applications.
- Know that every rational number is either a terminating or repeating decimal and be able to convert terminating decimals into reduced fractions.
- Understand negative whole-number exponents. Multiply and divide expressions involving exponents with a common base.

Algebra and Functions strand:

- Use variables and appropriate operations to write an expression, an equation, an inequality, or a system of equations or inequalities that represents a verbal description (e.g., three less than a number, half as large as area A).
- Simplify numerical expressions by applying properties of rational numbers (e.g., identity, inverse, distributive, associative, commutative) and justify the process used.
- Interpret positive whole-number powers as repeated multiplication and negative whole-number powers as repeated division or multiplication by the multiplicative inverse. Simplify and evaluate expressions that include exponents.
- Graph linear functions, noting that the vertical change (change in y-value) per unit of horizontal change (change in x-value) is always the same and know that the ratio (“rise over run”) is called the slope of a graph.
- Plot the values of quantities whose ratios are always the same (e.g., cost to the number of an item, feet to inches, circumference to diameter of

a circle). Fit a line to the plot and understand that the slope of the line equals the ratio of the quantities.

- Solve two-step linear equations and inequalities in one variable over the rational numbers, interpret the solution or solutions in the context from which they arose, and verify the reasonableness of the results.
- Solve multistep problems involving rate, average speed, distance, and time or direct variation.

Measurement and Geometry strand:

- Use measures expressed as rates (e.g., speed, density) and measures expressed as products (e.g., person-days) to solve problems; check the units of the solutions; and use dimensional analysis to check the reasonableness of the answer.
- Know and understand the Pythagorean theorem and its converse and use it to find the length of the missing side of a right triangle and the lengths of other line segments and, in some situations, empirically verify the Pythagorean theorem by direct measurement.

Three targeted math standards from Algebra I

- Students understand and use such operations as taking the opposite, finding the reciprocal, taking a root, and raising to a fractional power. They understand and use the rules of exponents [excluding fractional powers].
- Students simplify expressions before solving linear equations and inequalities in one variable, such as $3(2x - 5) + 4(x - 20) = 12$ [excluding inequalities].
- Students solve multistep problems, including word problems, involving linear equations and linear inequalities in one variable and provide justification for each step [excluding inequalities].

need an extra year to undertake an algebra readiness option. The panel is also considering new high school course options. One would support student readiness for Algebra II in high school. The other would provide math instruction beyond Algebra II for students hoping to pursue college majors or careers that are not math-intensive. A first draft of the revised math framework will be submitted to the Massachusetts board in fall 2009.

What is the fate of California's algebra readiness instructional materials?

Although California currently has no process for periodically revising its math content standards, the state does update its Mathematics Framework every six years to reflect changes in research and practice. The framework provides guidance to local educators and textbook publishers on how to use California's mathematics standards to inform curriculum development and classroom instruction. Uncertainty about the state's algebra policies has complicated statewide and local efforts to make decisions about middle grades math instructional materials, however.

California's current math framework was adopted in March 2005. Based on its goals, the State Board of Education adopted new "algebra

readiness" instructional materials in November 2007, intended for 8th graders who are not yet ready for algebra. These materials are designed to strengthen students' foundational skills and conceptual understanding in math. To do this, algebra readiness materials build on key math standards from grades 2–6, with the ultimate goal of achieving 16 "target" standards: 13 standards from grade 7 and three from Algebra I. (See the "California's Target Math Standards for Algebra Readiness" box on page 13.) Ideally, these materials should help local educators determine their students' instructional needs and help students recognize their own capacities to learn and understand mathematics.

In January 2009, the state board approved a timeline for another update of the state's Mathematics Framework. It is unclear how the update will address algebra readiness, however. CDE has recommended that the board revisit the state's algebra and algebra readiness instructional programs to bring the next framework "into alignment with SBE policy on statewide assessments."

At this writing, state education leaders have not resolved this issue. As a result, there is a great deal of uncertainty among districts as they pilot and make decisions about which state-adopted K–8 mathematics programs to

purchase for their students. On the one hand, most agree that algebra readiness materials could be of great value. Further, a new Algebra I policy—such as the one contained in SBE's suspended July 2008 motion—would still provide districts with several years during which they could enroll 8th graders in math courses below algebra, while working to prepare students in earlier grades for the Algebra I CST.

On the other hand, districts that have already invested time in piloting algebra readiness materials are in an ambiguous position. The new state budget allows districts to delay the purchase of instructional materials in mathematics until July 1, 2010, at which time they are expected to have materials from the most recent state-approved list in place in both math and English language arts. Districts must consider whether algebra readiness materials could soon be obsolete for some instructional purposes and whether more extensive investment in Algebra I materials is warranted. If districts invest textbook funds in algebra readiness materials now, they will not have these funds available to purchase additional Algebra I materials later.



The algebra debate puts teacher capacity in the spotlight

Beyond instructional materials and other resources, public education is ultimately about people.

As California looks to help more students succeed in algebra earlier, no resource is more important than qualified teachers who have a deep and continuously growing understanding of math content and pedagogy.

This section provides an introduction to key considerations in two areas of state teacher policy: credentialing and professional development. The preparation of multiple-subject teachers for math instruction in the elementary and middle grades is of particular concern as California looks ahead, as is improving the professional capacity of the state's existing teacher workforce

to teach math well. These underlying challenges pre-date California's current policy debate about grade 8 math and will continue to be pressing regardless of how this debate is resolved.

Teacher credentialing for math in grades K–8 is an ongoing topic of policy discussion

Credentialing for math instruction in grades K–8 is a central question as California works to enable more students to succeed in algebra early. In October 2008, the California Commission on Teacher Credentialing (CTC), which grants teaching

credentials in the state, began reviewing the state's math authorizations. An advisory panel recently convened by the CTC has begun to review the state's future credentialing needs for math instruction.

California's supply and distribution of prepared middle grades algebra teachers is a concern

Even without a change in state policy regarding grade 8 math, teacher qualifications are an issue in California. According to the Center for the Future of Teaching and Learning (CFTL), about one-third of middle grades Algebra I

teachers may not be adequately prepared to teach the course effectively. (See Figure 7.)

Altogether 8% of middle grades Algebra I teachers had not received a preliminary or clear teaching credential, and 23% held either a single-subject credential in another subject or a multiple-subject credential without a subject-matter authorization in math. Moreover, CFTL notes, although “students who are struggling to reach proficiency on the Algebra I CST are in particular need of teachers who are especially skilled at remediation,” students in lower-performing schools are less likely to be taught by teachers with a strong math background.

Teachers with varied backgrounds can teach Algebra I

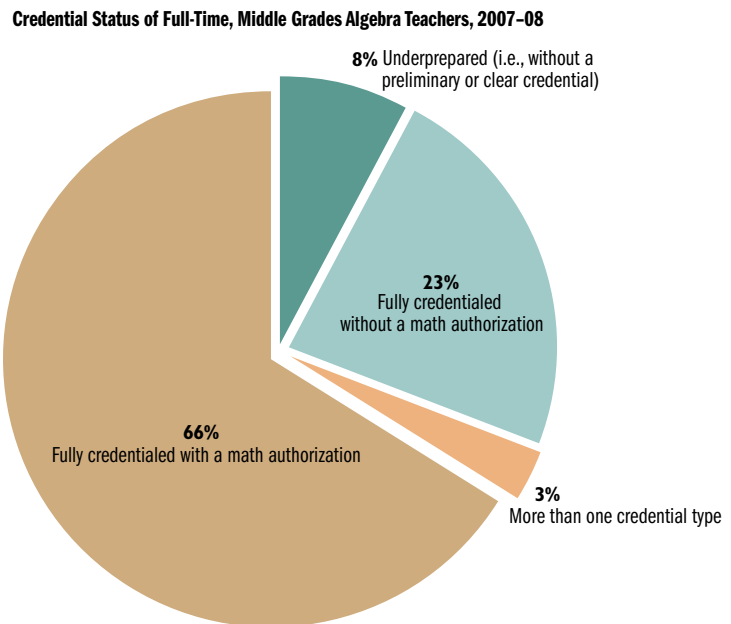
In general, middle grades teachers in California earn either:

- A single-subject credential, similar to high school teachers; or
- A multiple-subject credential, similar to elementary school teachers.

Currently, California accepts several options regarding which educators are authorized to teach Algebra I in the middle grades. This flexibility enables schools serving the middle grades to pursue an array of approaches to organizing their classrooms:

- Teachers may teach algebra in a departmentalized setting with a *single-subject credential in mathematics*.
- Middle grades teachers may also teach Algebra I with a *multiple-subject credential* if they do so in (1) a “self-contained” classroom in which all subjects are taught; or (2) a “core” classroom in which two or more subjects, such as science and math, are taught to the same group of students.
- Teachers with a multiple-subject or single-subject credential in another subject may also secure a *subject-matter authorization in mathematics*. This “add-on” authorizes math instruction in courses covering math content for grades 9 and lower in a departmentalized classroom. The authorization requires a “degree equivalent” 32 semester units of course work, including certain minimum course-taking requirements.
- In 2003, the CTC established the *single-subject credential in foundational mathematics*. The foundational math credential

figure 7 | One-third of middle grades Algebra I teachers may not be prepared to teach the subject



DATA: CENTER FOR THE FUTURE OF TEACHING AND LEARNING (CFTL), 2008

EDSOURCE 5/09

authorizes a teacher to provide instruction in such areas as algebra, geometry, and probability and statistics, but it excludes calculus and math analysis. The credential can stand alone for teachers wishing to teach only those courses, or it can be added to a credential in another subject area.

CFTL attributes much of the recent rise in the number of math credentials granted statewide to the introduction of the foundational math credential. They expect this trend to continue among teachers who wish to teach Algebra I but need more background and training.

- In 2002–03, before the foundational math credential was offered, CTC issued 1,005 new single-subject math credentials.
- Four years later, in 2006–07, CTC issued 1,804 new single-subject math credentials, with almost 40% of these in foundational mathematics.

Policymakers are concerned about the preparation of multiple-subject teachers for math instruction

Algebra instruction by multiple-subject teachers has become a key topic of concern for CTC. A school facing a shortage of math teachers can assign a teacher with a multiple-subject credential to teach Algebra I in a

self-contained or core classroom. But the examination requirements for the multiple-subject credential are “aligned to the K–7 academic content standards in mathematics,” as CTC notes in its January 2009 meeting agenda. In light of this, CTC is considering how to address “the misalignment between what the Multiple Subject credential holder is authorized to teach with respect to Mathematics and the content preparation required for the credential.”

The capacity of multiple-subject teachers to teach mathematics effectively in the *elementary* grades is also a topic of concern for CTC, given the decline in CST achievement that begins in grade 5. Questions raised by the commission in October 2008 include whether preparation programs for multiple-subject teachers are adequate as they relate to math instruction and whether the examination taken by multiple-subject candidates assesses their understanding of mathematical content sufficiently.

The adequacy of elementary math instruction is also a topic of national conversation. For example, the 2008 report by the National Mathematics Advisory Panel drew national attention by recommending that schools devote “ample time” to three “critical

foundations of algebra.” These include strengthening students’ fluency in working with (1) whole numbers, (2) fractions, and (3) particular aspects of geometry and measurement. The panel suggested that fluency with fractions in particular is inadequately developed in the nation’s schools and called on teacher education programs to make understanding of the three foundations a focus of teacher preparation for elementary and middle grades mathematics.

In addition, a 2008 report by the National Council on Teacher Quality found little consensus among elementary teacher preparation programs at 77 institutions nationally—of which three were in California, including two California State University (CSU) campuses—regarding the math content that multiple-subject, elementary teachers are expected to learn. The study did note “one unfortunate area of agreement” among most institutions in the sample, however—“widespread inattention to algebra.”

CTC is considering a math specialist credential

One topic on the agenda of the new CTC advisory panel is whether California should revive a mathematics specialist credential originally adopted in 1985. Although this credential has not been used much in California, a similar authorization for reading specialists has been popular and could serve as a model for mathematics.

Math specialists could fulfill three roles:

- Work in small groups with students who are having serious difficulty with math.
- Help teachers improve their subject-area and pedagogical knowledge.
- Lead the development of math programs in their school, district, or county office.

CTC noted in its December 2008 agenda that math specialists could support multiple-subject teachers in the elementary and middle grades in particular. Math specialists “might provide professional development, demonstration lessons and observations in the multiple subject teacher’s classroom focusing on mathematics,” possibly with a “focus on the elementary and middle school years.” This might provide a new rung on the career ladder for veteran teachers.

California’s efforts to recruit and retain math teachers

A 2007 study estimated that California needs about 3,300 new middle grades and high school math and science teachers annually during the next 10 years. California’s public universities are working to increase the number of math and science teachers they send into the teaching workforce:

- The California State University’s **Mathematics and Science Teacher Initiative** intends to double (from 750 to 1,500) the number of new math and science teachers that CSU prepares by 2010. For more information, see: www.calstate.edu/teacherED/MSTI/index.shtml
- The University of California’s **California Teach** program aims to place 1,000 new math and science teachers into California classrooms annually—a fourfold increase from the 250 who previously graduated from UC each year. See: www.universityofcalifornia.edu/academics/1000teachers

Retaining California’s current mathematics teaching force is also important. Recent efforts to recruit and retain knowledgeable math teachers, particularly in low-performing schools, include the following:

- **Senate Bill 1660** authorizes school districts to use professional development funds to compensate new and existing math, science, and Special Education teachers in schools in the lowest 30% of the Academic Performance Index (API).
- **Assumption Program of Loans for Education (APLE)**, run by the California Student Aid Commission, pays a portion of students’ loans (up to \$11,000) for every year they teach in hard-to-staff schools or subjects, such as middle and high school math and science.
- **California Mathematics Project Supporting Teachers to Increase Retention (CMP STIR)** program provides induction and support for mathematics teachers in grades 6–12, particularly in schools with high need or which are in Program Improvement under the federal No Child Left Behind (NCLB) law. CMP STIR is currently in the second year of a five-year grant through the California Postsecondary Education Commission’s Improving Teacher Quality Grant program.

Reviving the math specialist credential would require CTC action. The outdated standards for the credential would need to be aligned with California’s current academic content standards in mathematics, and CTC would need to approve preparation programs.

The state’s current professional development approach in mathematics falls short of what is needed to meet goals

Along with addressing the qualifications of teachers of mathematics, California also needs to consider its approach to the professional growth of the state’s existing teachers. This is particularly the case in the elementary and middle grades as teachers work to meet escalating academic expectations in math. Currently, teachers in California receive professional development in math through a variety of sources, such as conferences held by professional

organizations like the California Mathematics Council or through county offices of education. This section focuses on two state-funded programs: the Mathematics and Reading Professional Development Program (MRPDP) and the California Mathematics Project.

MRPDP focuses on training for locally adopted curricula
The 2007 *Critical Path Analysis* by the California Council on Science and Technology (CCST) and CFTL calls the state-funded MRPDP the “predominant mathematics professional development currently organized and offered by state or local officials.” The program was established in 2001 through Assembly Bill (AB) 466 and reauthorized in 2006 through Senate Bill (SB) 472.

The MRPDP provides districts with incentive funding for training in mathematics and reading connected to each district’s

adopted instructional materials. In K–8, these instructional materials must be from the SBE-adopted list. Forty hours of initial training through an SBE-approved provider and 80 hours of follow-up are at the MRPDP’s core. SB 472 also provides funds for SBE-approved follow-up training for teachers of English learners, which teachers may pursue as part of the 80-hour follow-up or in addition to it. Districts receive \$1,250 for each program component a participating teacher completes, of which up to \$500 per reimbursement may be used for a teacher stipend.

Recent disagreements between CDE and the Bureau of State Audits over the MRPDP’s success to date suggest it has not been utilized to the extent policymakers had initially hoped. School districts surveyed by the bureau for a 2006 report most often cited lack of teacher interest as a reason for low MRPDP participation. Some teachers see the training as “either too long or too closely tied to textbooks, as opposed to a broader focus on understanding state standards,” according to the report. CDE also cited lack of teacher interest in its response to the bureau’s findings, as well as competing demands on teachers’ time.

According to CFTL, a recent legislative update of the MRPDP during the 2007–08 legislative session—AB 2391—is intended to make follow-up training under the program “more relevant, and therefore more appealing to teachers.” AB 2391 allows teachers to devote up to 40 hours of the 80-hour follow-up to professional development in such areas as data analysis, the use of data to improve student achievement, and the use of differentiated instruction and student grouping.

In the initial 2008–09 budget, the Legislature allocated about \$57 million for MRPDP categorical funding. However, MRPDP was among about 40 categorical programs that were subsequently cut by 15%, with districts given full flexibility in their use of these funds. At this writing, it was not yet clear how this would affect the program’s operation.

California Subject Matter Project offers discipline-focused, standards-based professional development

The California Subject Matter Project, administered by the University of California

Office of the President, provides teachers with standards-aligned professional development to strengthen their content area and pedagogical expertise, especially in low-performing districts. This work is organized into nine disciplines, including the California Mathematics Project (CMP). The projects provide these services through about 100 sites on college campuses across the state.

Originally launched in 1988, the Subject Matter Project was revised to reflect California’s standards-based approach to public education in 1998 through AB 1734. The law emphasized helping teachers “develop and enhance the content knowledge and pedagogical skills necessary” to meet the state’s academic content standards and improve student learning.

Despite general praise for the projects, financial support has been uneven. State funding peaked in 2000–01 and 2001–02 at \$35 million but then decreased dramatically. Although federal funds have been used to offset some of the reduction, funding since 2003–04 has been only about \$10 million annually for the projects as a whole.

CMP has received state and federal Title II funds totaling between \$1.2 million and \$1.4 million annually during the past several years and currently offers professional development through 19 sites. CMP sites and their partnering districts secure grants through many sources, including:

- The federally funded California Mathematics & Science Partnership, administered by CDE;
- The federally funded Improving Teacher Quality Grants, administered by the California Postsecondary Education Commission (CPEC);
- National Science Foundation grants;
- Philanthropic grants; and
- Contracts with schools and districts.

CMP programs include monthly workshops; intensive programs focused on particular content, materials, or practices; support through coaching or lesson study; and other programs.

CMP is drawing on experience to address algebra and algebra readiness

At the request of CDE, CMP’s Algebra Initiative Committee recently drafted concept papers for addressing the professional development needs of California teachers related to algebra readiness and algebra instruction. CMP estimates that \$8.5 million would be required to provide algebra readiness programs for 2,000 elementary and 2,000 middle grades teachers, plus programs for 1,500 middle grades algebra teachers. About 3,800 teachers taught algebra in the middle grades in 2007–08. This estimate does not include stipends for participating teachers or expenses for project monitoring and administration.

The California Algebra Forum supports regional professional development

The California Algebra Forum is one model of regional collaboration to build local algebra capacity. The forum is a collaboration of the California Comprehensive Center at WestEd, the California Department of Education (CDE), and the Curriculum and Instruction Steering Committee of the California County Superintendents Educational Services Association (CCSESA), supported by federal grant funding from the U.S. Department of Education.

The forum’s goal is to strengthen the research grounding of technical assistance to local educators. Each of CCSESA’s 11 regions has a forum leadership team composed of regional math stakeholders, such as math teachers, math coaches, representatives from local higher education institutions, and local California Mathematics Project leaders. These teams identify needs in their local areas, with the goal of strengthening local students’ proficiency in math. For example, the Sacramento County Office of Education has helped design professional development modules for teachers in grades 4–7 that focus on critical prerequisites for student success in algebra. To support this work, the statewide forum organizes annual conferences in which regional teams learn about current research and hear from math education leaders.

The approaches currently envisioned by CMP build, in part, on algebra institutes conducted in the early 2000s as part of the California Professional Development Institutes in mathematics. Drawing on this model, middle school algebra teachers could participate in an academy that provides 40 hours of professional development focused on subject area and pedagogical content knowledge, followed by 60 hours of support and several weeks during the summer that combine teaching with feedback and reflection. These teachers would receive additional support during the next two years.

No state funds are currently available for a statewide program of this kind. Absent such support, these program plans will provide a basis for grant proposals or contracts that local CMP sites and their partner districts might develop. They could also enable CMP to respond quickly if funds for a statewide program become available.

More extensive professional development in math could be a sound investment for California

Whatever algebra policies California ultimately pursues, professional development is clearly an area in need of further discussion.

To put this in perspective, consider again the number of students who currently repeat Algebra I. According to data released by CDE, about 211,850 students repeated the Algebra I CST in grades 8–11 in 2008. This does not include students who may have repeated the course in grade 12.

California may have devoted the equivalent of about 1,695 full-time Algebra I teachers to re-teaching students who repeated the Algebra I CST in 2008, assuming a full-time Algebra I teacher instructs 125 students (i.e., five course sections of 25 students each). This estimate would be even higher if available data included 12th graders who repeat the course.

The scale of California's current investment in re-teaching Algebra I makes clear that professional development that leads to improved math instruction in grades K–8 would be a sound investment in schools' effectiveness. If successful, such investments could also reduce California's need for algebra teachers.

To the extent that California is serious about algebra success in grade 8, policymakers might also explore options for leveraging and building on the state's existing

professional development structures and expertise:

- The algebra and algebra readiness programs proposed by CMP could be one place to start.
- CFTL has suggested that California consider reinstating its former algebra institutes. In July 2008, CFTL estimated it would cost \$3.6 million to provide these programs to middle grades algebra teachers "currently teaching Algebra I without the necessary background."
- Other options, cited in State Superintendent of Public Instruction Jack O'Connell's Algebra I Success Initiative, include further investments in MRPDP, professional development for administrators, California Mathematics and Science Partnership Grants, education-industry partnerships, and the California Algebra Forum (see the box on page 17). O'Connell's initiative, proposed after SBE's July 2008 decision, estimated a cost of almost \$154 million for various professional development options pursuant to the goal of algebra success in grade 8.



Algebra in grade 8 raises broader questions for California

When they were adopted in 1997, California's academic content standards in mathematics set algebra as an expectation for 8th grade. This positioned California as a national leader in encouraging high expectations for its students. But many difficult decisions—such as whether to make Algebra I a required course for all 8th graders and how to effectively support such a policy—were left for another day.

That day seems to have arrived, thanks in part to federal accountability requirements under No Child Left Behind that last year prompted state officials to take up the question.

It appears there is general agreement among many different groups of K–12 stakeholders that enabling more California students to enroll and succeed in algebra early is a worthy goal. Most also appear to agree that,

in a changing economy that places a higher premium on abstract knowledge and reasoning, algebra should not be a hurdle separating future "haves" from "have-nots."

California has made progress but remains far from reaching its goals

Compared to only five years ago, many more 8th graders are taking algebra, with both

encouraging and worrying results. California's student achievement data show that many students who previously did not have early access to algebra are embracing the opportunity and rising to high expectations. Two-and-a-half times as many African American 8th graders and more than three times as many Latinos now score proficient or advanced on the Algebra I CST. At the same

time, however, more than 200,000 students repeated the test last year in grades 8–11.

A candid review of these data—and a willingness to examine California students' math performance against those in other states on the National Assessment of Educational Progress—should make it clear that although California has made real progress, it faces a serious math problem. It is time to either reassess the state's goals related to algebra success, or maintain those goals and strengthen strategies for achieving them.

California's education leaders face questions beyond 8th grade algebra

Ongoing debates about the State Board of Education's decision last July regarding Algebra I in grade 8 could serve as the catalyst for a deeper look at mathematics instruction in California. This could be an ideal moment for such a discussion, despite the fact that forming consensus among groups with opposing views is often an uncomfortable process that costs time and money.

Regardless, the state's decisions about when students should take Algebra I involve issues that go beyond a particular course, grade level, or test.

Could California strengthen its approach to mathematics standards, curricula, and assessment in grades 5-8, including Algebra I? California's standards-based reforms have made a real difference in the math success of the state's schools and students in the past decade. But the steep decline in math achievement that starts in 5th grade underscores the need to examine every possible strategy for continued improvement.

In addition, it appears many districts whose students could benefit from the algebra readiness materials the state recently adopted have yet to implement them. Clear signals from state education leaders to local districts about the wisdom of using scarce dollars to purchase these instructional materials—or not—could help local educators improve math instruction more quickly.

And although the state is a leader in standards-based education reform, California may also have something to learn from other states and nations that take a different

To Learn More

California Agencies and Organizations

- **California Algebra Forum.** Contact the California Comprehensive Center at WestEd for more information. www.cacompcenter.org
- **California Commission on Teacher Credentialing (CTC).** See the math-related commission agenda items for Oct. 2008 (Item 2D); Nov. 2008 (Item 2G); Dec. 2008 (3G); Jan. 2009 (3E); and April 2009 (3E). www.ctc.ca.gov
- **California Department of Education (CDE) and State Board of Education (SBE).** See California's academic content standards and curriculum frameworks, the SBE's July 2008 algebra motion, and the board agendas discussed in this report. www.cde.ca.gov
- **California Mathematics Project (CMP).** See CMP's Fall 2008 algebra concept papers. www.cmpso.org
- **The Center for the Future of Teaching and Learning (CFTL).** See the reports discussed in this publication, including *California's Teaching Force 2008* and the July 2008 *Center View* algebra brief. www.cftl.org

Also Cited

- Allensworth, E.M. & Nomi, T. "College-Preparatory Curriculum for All: The Consequences of Raising Mathematics Graduation Requirements on Students' Course Taking and Outcomes in Chicago." Paper presented at the Second Annual Conference of the Society for Research on Educational Effectiveness, March 2009, Arlington, VA. www.educationaleffectiveness.org/conferences/2009/conference.shtml
- American Federation of Teachers. *Sizing Up State Standards 2008*. Washington, D.C. www.aft.org
- Burris, C.C., et al. "Accelerating Mathematics Achievement Using Heterogeneous Grouping." *American Educational Research Journal*, Spring 2006, 43(1). <http://aerj.aera.net>
- Gallagher, H.A., et al. *Evaluation of the California Subject Matter Projects (CSMP): Final Report*. Prepared by SRI International, fulfilling the requirements of Assembly Bill 2950 (2002) and Senate Bill 611 (2003), December 2005. <http://csmf.ucop.edu>
- Greenburg, J. & Walsh, K. *No Common Denominator: The Preparation of Elementary Teachers in Mathematics by America's Education Schools*. Washington, D.C.: National Council on Teacher Quality, June 2008. www.nctq.org
- Klein, D., et al. *The State of State Math Standards 2005*. Washington, D.C.: Thomas B. Fordham Foundation, 2005. www.edexcellence.net
- Kriegler, S. & Lee, T. "Using Standardized Test Data as Guidance for Placement into 8th Grade Algebra." Department of Mathematics, University of California, Los Angeles. www.introtoalg.org/resources.htm
- Loveless, T. *The Misplaced Math Student: Lost in Eighth-Grade Algebra*. Washington, D.C.: The Brookings Institution, Brown Center on Education Policy, September 2008. www.brookings.edu
- Massachusetts Board of Elementary and Secondary Education. Progress Report on the Work of the Mathematics Curriculum Framework Revision Panel, March 13, 2009. www.doe.mass.edu/boe/docs/0309/item4.html
- National Mathematics Advisory Panel. *Foundations for Success: The Final Report of the National Mathematics Advisory Panel* and Task Group reports. Washington, D.C.: U.S. Department of Education, March 2008. www.ed.gov/about/bdscomm/list/mathpanel/reports.html
- Sack, J.L. "California High Schools Lining Up For Algebra 1 Waivers." *Education Week*, May 5, 2004, 23(34), p. 27. www.edweek.org
- Schmidt, W., et al. "A Coherent Curriculum: The Case of Mathematics." *American Educator*, Summer 2002, 26(2). www.aft.org/pubs-reports/american_educator/summer2002/

approach to pre-algebra and algebra instruction and whose students, by some measures, have greater math success. When and how do their standards emphasize different aspects of algebra? Are their standards more coherently focused? Is their approach to instruction different? Does this have implications for California's annual assessments as well?

Do California's teachers in grades 5–8 have the math content knowledge and pedagogical skills they need to teach California's students most effectively? Clear signals about what students should learn are one part of the equation, but so is the capacity of educators to provide effective instruction. Policymakers are already considering whether and how California's teacher credentialing requirements need to respond to increased math expectations for grades K–8. In addition, California's investments in and policy approach to professional development fall short of what many experts believe are warranted, given the state's goals.


What policy changes in teacher preparation and credentialing would help ensure that new teachers enter the classroom with the skills and knowledge they need to teach the state's math curriculum well? How can California build the teacher capacity required to usher the highest possible number of students, especially low-income students, to early success in algebra—if not in grade 8, then in grade 9? Can the state build on its existing professional development infrastructure as a first step, and what else could it do?

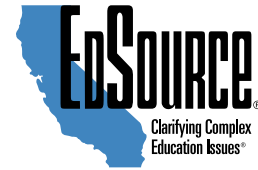
Finally, if California policymakers decide to make Algebra I a default course-taking expectation for grade 8, this will have particular implications for high schools. Currently, Algebra I content is an 8th grade standard,

the most advanced content in the math section of the California High School Exit Exam, and the minimum course-taking requirement for high school graduation. It also falls short of university eligibility requirements. Greater clarity about the minimum level of math proficiency California should expect from its high school graduates could provide much-needed guidance to local educators. Moreover, more students completing the three-year college preparatory math sequence in 10th grade raises additional questions. For example, what should schools or the state do to encourage or compel students to continue taking math so that their skills remain fresh for college entrance and placement exams?

California could seize this opportunity for a fresh look at its math expectations

California's ambition to improve the math proficiency and understanding of all its K–12 students deserves support and investment. The State Board of Education, the California Department of Education, and most other state leaders agree on the big goal: more students, especially low-income students, mastering Algebra I sooner in their K–12 schooling. This goal is also consistent with President Barack Obama's call for more U.S. students to become proficient in math and science.

As California undertakes a new review of its Mathematics Framework, state education policy leaders could consider more broadly how well the state's math standards, curricula, assessments, and teacher policies support schools in teaching—and all students in learning—the math needed for earlier algebra success. Perhaps this is an opportune time for a thoughtful review and candid discussion of math education in California. 



Trish Williams
EdSource Executive Director

2008–09 EdSource Board of Directors

Davis Campbell, President
*President, California School Boards Association
Governance Institute*

Lawrence O. Picus, Vice President
*Professor, Rossier School of Education,
University of Southern California*

Martha Kanter, Fiscal Officer
*Chancellor, Foothill–De Anza Community
College District*

John B. Mockler, Secretary
President, John Mockler & Associates, Inc.

Susan K. Burr
*Executive Director, California County
Superintendents Educational Services Association*

Carl A. Cohn
*Clinical Professor of Urban School Leadership,
Claremont Graduate University*

Christopher Cross
Chair and CEO, Cross & Joftus, LLC

Kenneth F. Hall
*Executive in Residence, University
of Southern California*

Reed Hastings
CEO, Netflix, Inc.

Gerald C. Hayward
*Co-Director (Retired), Policy Analysis for California
Education*

Janis R. Hirohama
President, League of Women Voters of California

Santiago Jackson
*Director, Office of Legislative and Governmental
Affairs, Los Angeles Unified School District*

Kelvin K. Lee
*Superintendent (Retired), Dry Creek Joint
Elementary School District*

Jo A.S. Loss
President-Elect, California State PTA

Paul J. Markowitz
Teacher (Retired), Las Virgenes Unified School District

Amado M. Padilla
Professor, School of Education, Stanford University

Don Shalvey
CEO and Co-Founder, Aspire Public Schools

Gloria Taylor
*Co-President, American Association of University
Women–California*

Acknowledgments

This report was researched and written by:

Matthew Rosin, Ph.D.

Heather Barondess

Julian Leichty

With research support from:

Kathy Wilson

Edited by:

Mary Perry