Research Report

JULIA H. KAUFMAN, LAUREN COVELLI, PIERRCE HOLMES

Elementary and Middle School Opportunity Structures That Factor into Students' Math Learning

Findings from the American Mathematics Educator Study

This first report of results from the RAND American Mathematics Educator Study (AMES) shares findings about school structures that may facilitate or limit K–8 student access to mathematics learning opportunities. The AMES is focused on understanding the factors that could improve mathematics learning opportunities for K–12 students, especially Black, Hispanic, and lower-income children (Kaufman, Steiner, and Woo, 2023). In 2023, researchers began gathering data for use in the AMES from nationally representative principal and teacher surveys administered through the RAND American Educator Panels and numerous other data sources, including educator and student interviews and teacher instructional logs. The conceptual framework underpinning the AMES, and more-detailed descriptions of the factors we hypothesize lead to differing mathematics learning opportunities, are discussed in Kaufman, Steiner, and Woo (2023).

This report specifically focuses on schools serving students in **kindergarten through 8th grade**; a companion report (Steiner, Morales, and Mulhern, forthcoming) investigates school structures supporting mathematics learning opportunities at the high school level. We specifically use the spring 2023 AMES survey data—with a focus on principal survey data—to explore the following three structures that may encourage or inhibit students' mathematics learning, which we refer to as *school opportunity structures* throughout this report:

- **School Opportunity Structure 1: tracking and access to rigorous mathematics courses.** We explore the extent of *tracking*, or grouping by perceived achievement level into and within mathematics classes, along with courses offered in middle school and students' access to those courses to better understand students' access to rigorous mathematics courses.

KEY FINDINGS

- Tracking in mathematics classes starts early in many schools. According to principals' self-reports, a greater proportion of Florida schools group students by achievement level than schools in other states. Furthermore, up to 20 percent more principals in large and low-poverty middle schools reported grouping students by achievement level into mathematics classes than those in smaller and high-poverty middle schools.
- Among K–8 principals who reported grouping students by achievement level into math classes, a majority report using grade-level accountability assessments, interim assessments, or teacher recommendations to group students. Parent requests are also used to group students in 50 percent of low-poverty schools (versus 30 percent of high-poverty schools).
- Middle school mathematics teachers are far more likely to have deep knowledge of mathematics pedagogy and content in the eyes of principals compared with elementary teachers who teach mathematics.
- Students who struggle in mathematics classes typically do not get the most experienced and knowledgeable teachers, although state context matters.
- Compared with the rest of the country, Texas principals are more likely to report that major obstacles may overburden mathematics teachers at their schools; principals in high-poverty schools were similarly more likely than those in low-poverty schools to report such major obstacles.
- A large majority of elementary and middle school principals reported providing many different types of supports for students who are struggling in mathematics; tiered intervention programming was reported as the most common. However, principals also reported that most students who struggle do not participate in these interventions.

- **School Opportunity Structure 2: teacher qualifications and assignment.** We consider whether students—and particularly those who are struggling in mathematics—have access to certified, knowledgeable mathematics teachers and principals.
- **School Opportunity Structure 3: supports for struggling students.** We examine the availability of supports for students who are struggling in mathematics and principals' estimates of the proportion of struggling students who are getting those supports.

This report focuses on questions of access to school opportunity structures more than on questions of whether students opt into specific classes or programs. That is, we are most interested in the presence or availability of opportunity structures, regardless of whether students may opt into or out of them, although we also look briefly at proportions of struggling students who are participating in available mathematics supports. Our policy recommendations are focused more on ensuring that students have access to and are aware of of available mathematics learning opportunities and supports rather than on increasing participation in such supports.

Given our focus on school opportunity structures, this report draws mostly on the reports of *principals* serving students in kindergarten through 8th grade, with a few data points based on teachers' self-reports about their certification. Importantly, this report uses one of very few datasets that examines mathematics teaching and learning in schools across the United States, and the dataset also includes representative reports from principals in the four largest U.S. states: California, Florida, New York, and Texas. This report does not explore the quality of mathematics instruction students receive in their classes; we will explore teachers' mathematics instruction in other reports over the course of the AMES. Instead, in this report, we consider the ways that schools set up mathematics learning opportunities and the implications that these school structures have for teaching and learning.

Motivation for This Report

U.S. K–12 public schools have long wrestled with the dilemma of ensuring that all children have equitable learning opportunities in mathematics while also attending to diverse needs that often require different instructional strategies and approaches. Providing all children the same rigorous learning opportunities through mathematics curriculum materials and instruction that are aligned with rigorous academic standards is an approach that many states and school systems have embraced, with the rationale that educators should have high expectations for all children (e.g., Doan et al., 2022). However, even if all students have equal exposure to challenging content, they may need different supports to access that content. In particular, we know that many U.S. students at the same grade level are performing at dramatically different achievement levels, especially in the wake of the coronavirus disease 2019 (COVID-19) pandemic, which led to widening achievement gaps in mathematics (Fahle et al., 2023; Kuhfield and Lewis, 2022). Thus, some students in the same schools and even in the same classrooms may need different supports to master mathematics content. At the same time, if teachers spend considerable time adjusting their instruction to address the needs of students who need particular supports or review, they may not be able to provide any enrichment to students who are performing above their grade level and could benefit from more-challenging work.

One potential solution to the dilemma of helping students master grade-level standards while attending to diverse student needs is *tracking*, or grouping students within or into classes by perceived achievement level. Tracking has long been embraced by many U.S. schools. Yet, tracking has some significant drawbacks: Black, Hispanic, and low-income children are disproportionately placed in lower-level tracks (McEachin, Domina, and Penner, 2020; Walston and McCarroll, 2010), and students placed in lower tracks typically receive less grade-level content, fewer opportunities to share their thinking in class, and more teacher lecturing (Gamoran and Mare, 1989; Kaufman et al., 2012; Oakes et al., 1990; Schmidt, 2009).

Tracking can also exacerbate an issue unique to mathematics education in the United States: It can limit students' access to algebra or a higher-level integrated mathematics class in 8th grade.

Algebra in 8th grade is linked with a wide variety of positive impacts, from more advanced mathematics coursetaking (Spielhagen, 2006; Sorensen et al., 2018) to higher mathematics achievement in high school and beyond (Gamoran and Hannigan, 2000; Kurlaender, Reardon, and Jackson, 2008). Yet, national data indicate that White and higher-income students are more likely to take Algebra I in 8th grade than students of color and lower-income students (McEachin, Domina, and Penner, 2020; Walston and McCarroll, 2010). Some likely reasons for these inequities are that (1) schools with more lower-income students and students of color are less likely to provide Algebra I in 8th grade, so those students do not have the opportunity to take it, and (2) even when such courses are offered, schools provide access to those courses only to students who are deemed able to handle that content: specifically, students in higher-tracked classes. Thus, tracking likely limits mathematics learning opportunities for many students who might want to take higher-level courses but are not able to enroll in those courses.

Some U.S. schools have opted to provide the same mathematics course content to all students, ostensibly to avoid some of the biases built into tracking systems. Universal algebra in 8th or 9th grade is one example of such an approach. However, schools that have offered universal algebra have seen increased numbers of students failing algebra and mixed evidence of increased achievement among all students (Clotfelter, Ladd, and Vigdor, 2015; Domina et al., 2015; Stein et al., 2011; Williams et al., 2011). Some research suggests that certain strategies could reduce inequities in access to and performance in Algebra I, such as using better data to inform achievement-level grouping starting early in middle school (Dougherty et al., 2015) or assigning struggling students to a "double dose" of algebra (i.e., twice as much instructional time focused on algebra than what is typically offered) (Nomi and Allensworth, 2009).

However, beyond achievement-level grouping, there are other potential solutions to the problem of inequitable mathematics learning opportunities for students. One solution is to ensure that schools have enough highly qualified teachers who can attend to students' needs. According to the National Council

on Teacher Quality (undated-a), teacher preparation programs vary considerably in how they prepare elementary mathematics teachers, in particular, and the Council's database of state policies (National Council on Teacher Quality, undated-b) also indicates wide variation in requirements for mathematics teacher licensure. That said, U.S. schools have long faced teacher shortages, especially in mathematics (Sutcher, Darling-Hammond, and Carver-Thomas, 2019), which may lead school systems to hire teachers who hold emergency or provisional certifications.

Another solution to ensuring equitable mathematics learning opportunities is to provide students who are taking rigorous courses with additional mathematics supports to help them access grade-level content, which is a particular need now, given missed learning because of the COVID-19 pandemic. Schools typically provide a plethora of programming to help students who are struggling with mathematics, from high-dosage tutoring to summer learning opportunities and extra mathematics classes (often called "double dose" classes). Yet, many students who are struggling in their mathematics courses do not access those supports, even when they are offered (Hendricks and Fuchs, 2020; Nelson et al., 2022; Nelson and Powell, 2018).

RAND American Educator Panels research through surveys fielded prior to the AMES surveys suggests that schools offer mathematics interventions at roughly the same levels regardless of the poverty level of students (Stelitano et al., 2020), even though high-poverty students are more likely than others to struggle in mathematics. Even in the years following the COVID-19 outbreak in 2020, teachers in higher-poverty schools with more students of color—those same students whose performance was affected most detrimentally by the COVID-19 pandemic—reported about the same amount of student access to a mathematics specialist compared with teachers in schools with more low-poverty and White students (Kaufman and Diliberti, 2021).

Our research questions for this report specifically focus on these school opportunity structures that may lead to differing opportunities: achievement-level grouping, or tracking, into and within mathematics classes; teachers' qualifications and expertise to teach mathematics; and intervention offerings along with student participation in interventions. Subsequent reports will focus on other areas of our conceptual framework, including such teacher resources as instructional materials, professional learning, and supports for diverse learners. These reports will be based on data from the AMES surveys, which will be administered annually from 2023 through 2027, and other qualitative and quantitative data collected through the AMES.

Methods

This report draws on data from the first administration of the AMES surveys. These surveys were administered to nationally representative samples of teachers and principals from the American Teacher Panel (ATP) and American School Leader Panel (ASLP) in spring 2023. In total, the 2023 AMES data include responses from 2,934 teachers of mathematics (including elementary teachers of all subjects) and 3,174 principals across all grades K–12 (a response rate of 49.8 percent of teachers and 32.5 percent of principals overall, and 45.6 percent of K–8 teachers and 32.7 percent of K–8 principals). Survey responses are weighted to be representative of the national population of K–12 teachers and school leaders (whom we refer to as *principals* throughout this report). Additionally, we gathered survey data from oversamples of teachers and principals in the four largest states—California, Florida, New York, and Texas—which allows us to report state-representative averages across those four states as compared with the rest of the country. More details on sampling, survey response rates, and survey weighting are available in *American Mathematics Educator Survey: 2023 Technical Documentation and Survey Results* (Schweig et al., 2023).

The 2023 AMES surveys were developed with input from the Bill & Melinda Gates Foundation, experts in mathematics education policy and practice, and high school students. These experts gave input at a few points of time as we were developing our surveys. Any new items developed for this survey (i.e., not borrowed from other surveys) were pilot tested by a small number of teachers ($N = 3$) and principals ($N = 4$). Pilot testing entailed the teachers and principals taking the survey and then participat-

ing in an interview in which we asked them questions about the extent to which items made sense to them and whether they had revision suggestions. We also conducted focus groups with high school students to get input on critical aspects of their mathematics learning experiences that could be worth exploring via our surveys.

For the purposes of this report, we limit the analytic sample to teachers and principals serving students in grades K–8, omitting those teachers and principals who serve only students in grades 9–12 (for reporting on grades 9–12 see Steiner, Morales, and Mulhern, forthcoming). This limits the sample to 2,505 teachers and 2,293 principals. Table 1 shows the weighted composition for key school-level subgroups of teachers and principals included in our analysis. These school-level demographic variables come from linking survey data files to 2021 Common Core of Data (CCD) files from the National Center for Education Statistics. As indicated in the table note, we relied on CCD definitions to categorize schools by poverty level and size. Specifically, *high-poverty schools* are defined as those with a majority of students qualifying for free or reduced-price lunch, *large schools* are those with at least 450 students, and *small schools* enroll fewer than 450 students. Full descriptive data, including weighted nationally representative summary statistics across all survey questions and population estimates for the descriptive data shown in Table 1, are available in *American Mathematics Educator Survey: 2023 Technical Documentation and Survey Results* (Schweig et al., 2023).

Throughout this report, we frequently differentiate results by school level (elementary or middle school, or schools serving K–5th versus 6th–8th grade students). When our figures indicate that the data are comparing K–5th and 6th–8th grade students, we have explicitly asked principals to respond to a given survey item for those grade bands; principals get questions about students in those grade bands only if they have reported leading a school that includes grades within that band. So, for example, we asked principals how they grouped their K–5 students and/or their 6–8 students. For that question, principals who serve students in the grades within only one grade band are asked about that band, and principals who serve students in grades across bands are asked about both of those bands separately.

TABLE 1

Percentage Distribution of Descriptive Characteristics of K–8 Teacher and Principal Analytic Samples

	K–8 Teachers (%)	K–8 Principals (%)
Urban	30	27
Suburban	39	32
Rural	31	41
Low poverty	52	50
High poverty	48	50
Majority White students	49	53
Majority students of color	51	47
Small school	41	39
Large school	59	61
N	2,505	2,293

NOTE: Descriptive variables included in this table are merged into teacher and principal survey data from the 2021 CCD files using National Center for Education Statistics codes. Each cell reports the nationally representative weighted percentage of teachers or principals in the sample that fall into a given subgroup. *Low poverty* is defined as less than 50 percent of students in a school qualifying for free or reduced-price lunch (FRPL). *High poverty* is defined as 50 percent or more (a majority) of students in a school qualifying for FRPL, which splits our sample approximately in half. *Small schools* are defined as those with fewer than 450 students, and *large schools* are defined as those with 450 students or more. These are the National Center for Education Statistics definitions of large and small schools in the CCD. *N*-sizes report the total number of K–8 teachers and principals, respectively, included in the analytic sample.

When we report results for elementary versus middle school principals or teachers, our classifications come from the CCD. Specifically, in the CCD, an *elementary school* is defined as a school that offers more of grades K–4 than 5–8 and no 9–12, and a *middle school* is defined as a school that offers more of grades 5–8 than higher or lower grades (National Center for Education Statistics, undated).

For all our research questions, we present nationally representative responses of principals and teachers in public schools serving K–8 grade students (typically elementary and middle schools). We also consider whether principals in schools serving students with different demographics (e.g., high- and low-poverty schools, schools with more Black or Hispanic students) report different practices and processes, in terms of achievement grouping, access to teachers with expertise in mathematics pedagogy and content, and interventions. Throughout this report, we note where differences between state, school level, and demographic subgroups are statistically significant. Because this report is purely descriptive, we conducted significance testing using two-sided pairwise *t*-tests at the critical value of $p < 0.05$, and all reported differences are unadjusted for other statistical controls. In some cases, we clarify that we are reporting notable differences that are large but not statistically significant ($p > 0.05$) or are marginally significant ($p < 0.10$).

Opportunity Structure 1: Tracking and Access to Rigorous Mathematics Courses

In this section, we share data on *tracking*, or whether and how students are grouped by achievement level within and into their mathematics classes, based on reports from school principals. Principals were asked

- whether students were grouped by achievement level at all and, when they were grouped, whether they were grouped by achievement level *within* their mathematics classes (e.g., the teacher breaks students into small groups of similar achievement levels in the course of classroom instruction) or *into* their mathematics classes (e.g., students of different achievement levels are in different classrooms)
- whether students tended to be grouped on a course-by-course basis versus grouped into a specific achievement-level grouping pathway across the courses that they took
- which mathematics courses were available at their schools and whether all students had access to available mathematics courses
- what criteria they used to group students by achievement level.

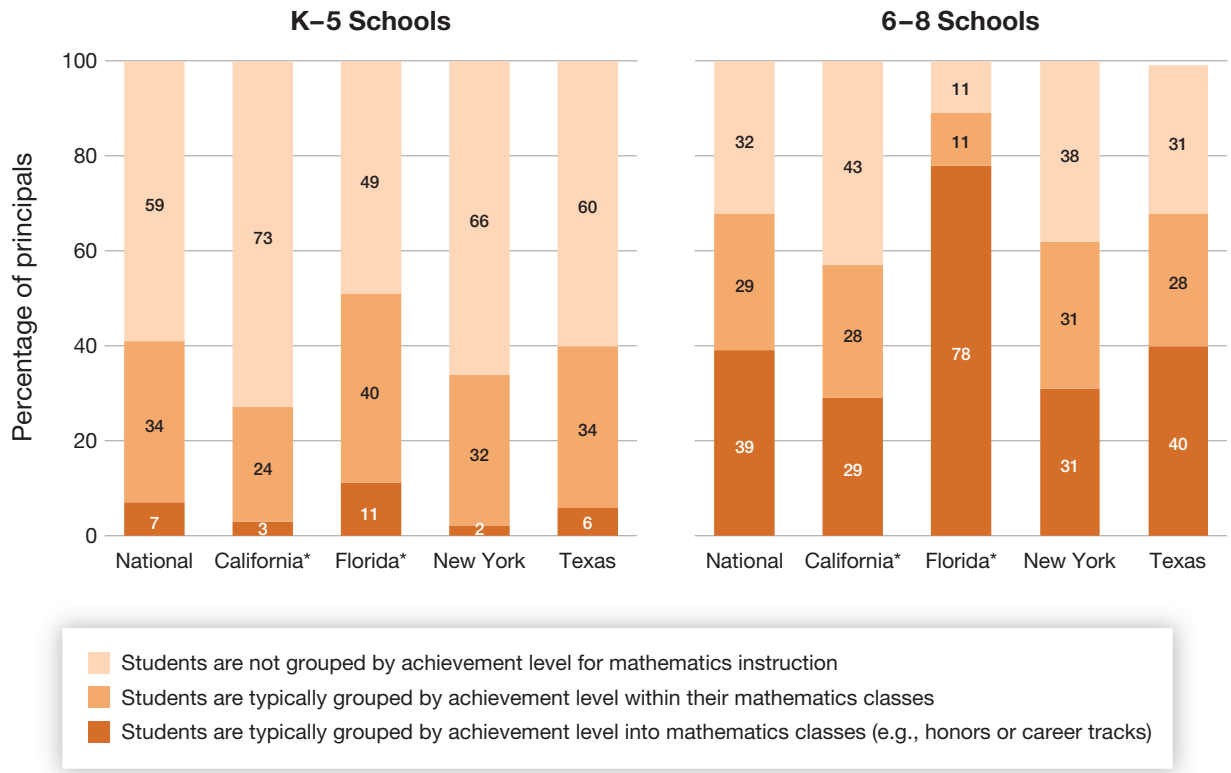
Throughout this section, we often break out these data by state for our state oversamples, because we observed a fair amount of variation in achievement grouping according to the state in which a school is located. We examine both achievement grouping overall and across mathematics classes, along with course offerings in middle school and, particularly, for 8th grade algebra, which can be a gateway into more-advanced coursetaking in the senior year of high school. Although we use the term *achievement grouping* throughout this section, we acknowledge that students may often be grouped by perceived achievement level, not their objective achievement level.

Grouping Students by Achievement Level Starts Early in Many Schools; Florida Schools Group by Achievement Level More Often Than Schools in Other States

As shown in Figure 1, grouping students by achievement level *into* mathematics classes—as opposed to grouping them *within* their classes—is much less common in elementary school than middle school. Nationally, 41 percent of elementary school principals reported that students are grouped by achievement level. However, of that 41 percent, 34 percent report grouping students by achievement level within their math classes, whereas only 7 percent report grouping students by achievement level into their math classes. In contrast, of the 68 percent of middle school principals who report grouping students by achievement level, only 29 percent report grouping students within their classes and 39 percent report grouping students into different math classes. California principals reported the lowest levels of grouping by achievement

FIGURE 1

Percentage of Principals in Schools Serving Grades K–5 and 6–8 Reporting Whether, and How, Students Are Typically Grouped by Achievement Level



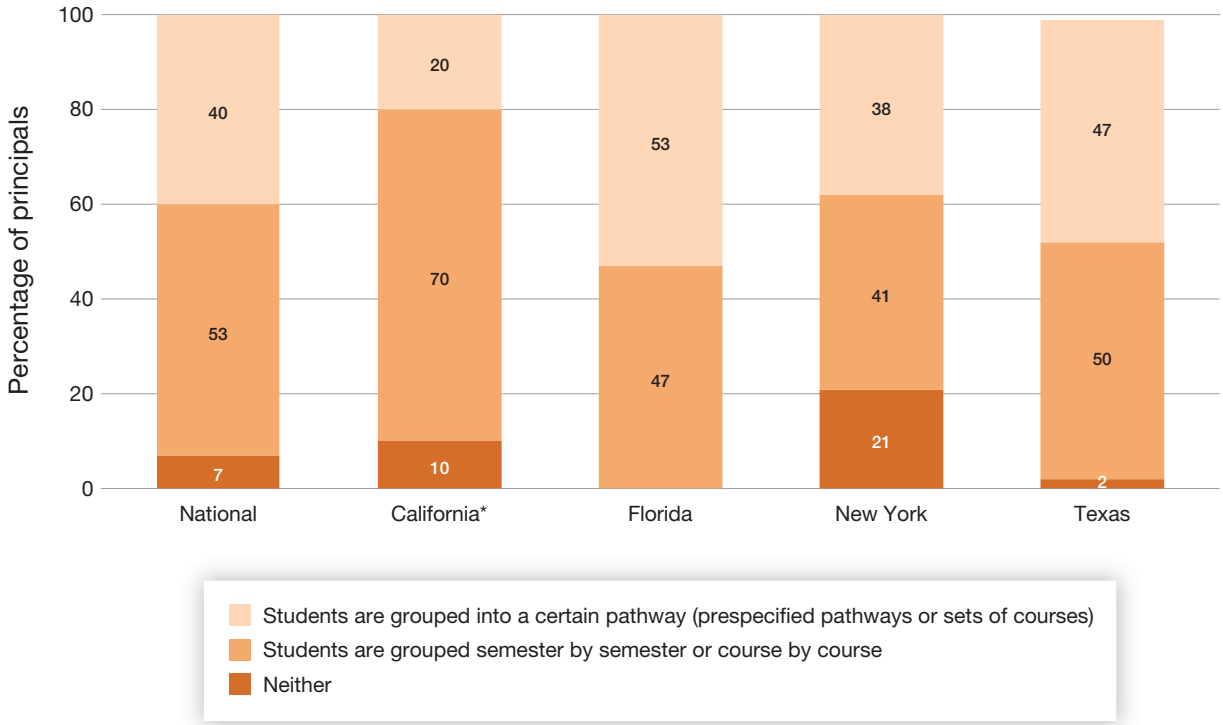
NOTE: This figure uses principal survey response data for the following question (K–5, n = 1,715; 6–8, n = 1,143): "Some schools organize mathematics instruction differently for students with different achievement levels. What is your school's policy about how students are grouped in the following grade bands?" Principals could choose only one response; response options are mutually exclusive. Asterisks (*) indicate that the percentage of principals in a given state who reported grouping by achievement level either within or into mathematics classes is significantly different from percentages of principals in the rest of the country ($p < 0.05$). This figure includes only principals of elementary and middle school grades. Some bars do not sum to 100 percent because of rounding.

(either within or into mathematics classes) compared with principals in the other large states in our sample, a difference that is statistically significant. Specifically, 27 percent and 57 percent of elementary and middle school principals, respectively, reported that students in their schools are grouped by achievement level for mathematics instruction in California. However, achievement grouping is very common in Florida, where 51 percent and 89 percent of elementary and middle school principals, respectively, reported grouping students by achievement level either within or into mathematics classes, which is statistically significantly higher than the national average. Among all Florida middle school principals, 78 percent reported grouping by achievement level *into* mathematics classes, compared with just under 40 percent of principals nationally. Thus, grouping students into mathematics classes by achievement level appears much more common in Florida middle schools than in middle schools in the rest of the country.

In cases where middle school principals across the United States did report grouping by achievement level, most reported that students are grouped semester by semester or course by course (53 percent), rather than grouped into a prespecified pathway (40 percent) (see Figure 2). Compared with the rest of the country, significantly more California principals reported that students are grouped on a semester-by-semester or course-by-course basis than reported that students are grouped into a prespecified pathway. California principals reported significantly less grouping into a pathway and more semester-by-semester or course-

FIGURE 2

Percentage of Principals in Schools Serving Grades 6–8 Reporting Grouping Students by Achievement Level into a Pathway Versus Semester by Semester or Course by Course



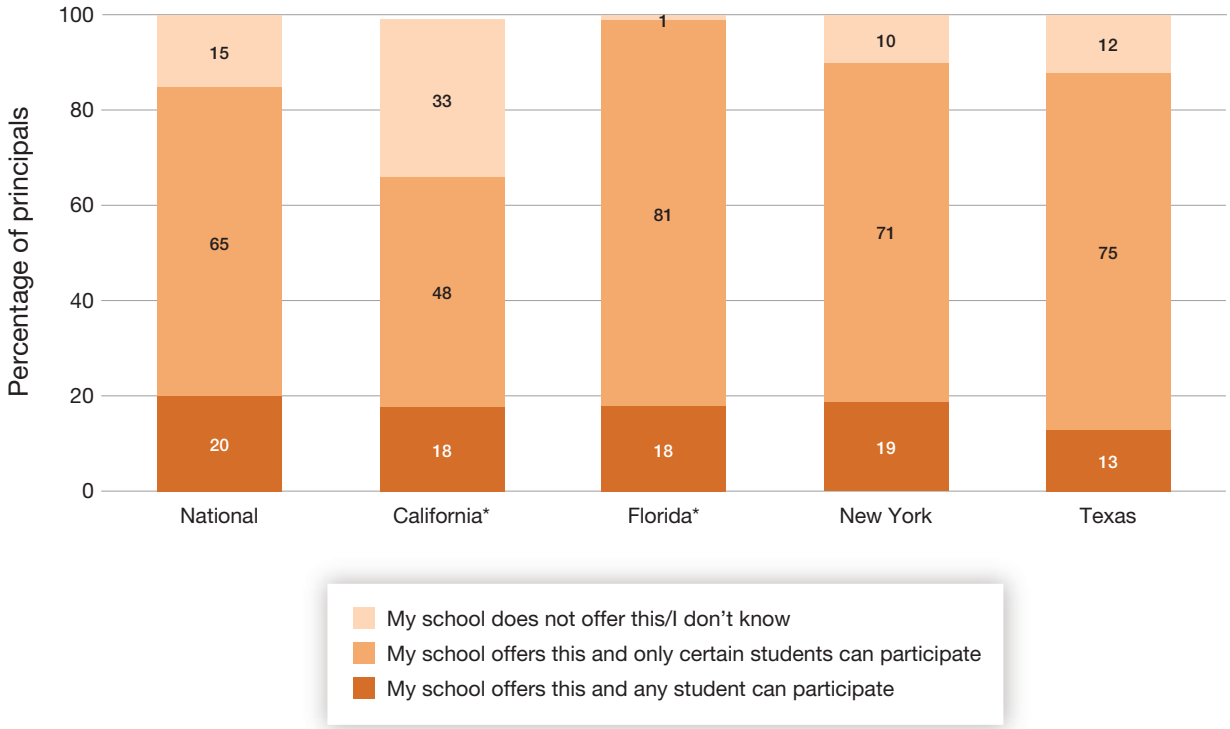
NOTE: This figure uses principal survey response data for the following question (n = 430): "How are students grouped by achievement level into mathematics classes at your school?" Principals could choose only one response among the three listed in the legend. Asterisks (*) indicate that the percentage of principals in a given state who reported grouping students into a certain pathway is significantly different from the percentage in other states ($p < 0.05$). This figure includes only principals of middle school grades who reported that their schools group students by achievement level into classes. Some bars do not sum to 100 percent because of rounding.

by-course grouping practices than principals in other states; about half of both Florida and Texas middle school principals reported grouping students into a set pathway. Interestingly, roughly one in five New York principals reported that they implement a different achievement grouping practice than the two practices we asked about (i.e., semester by semester/course by course or a set pathway). However, we did not observe any patterns in the open-ended responses provided by these principals on how they group students, in part because of the small sample size (n = 7). Though local policies on coursetaking vary, and principals may have interpreted our survey items in different ways, we assume that grouping semester by semester or course by course likely offers more flexibility for students to change their mathematics course trajectories than when placed in a prespecified pathway.

We also asked principals which of their students were able to take Algebra I in 8th grade, given that schools that group by achievement level may be more likely to channel only some students into 8th grade algebra than those that do not group students by achievement level. Nationally, nearly two-thirds of principals reported that only some of their students can participate in 8th grade algebra. Just as lower proportions of California principals reported grouping students by achievement level, lower proportions of California middle school principals reported offering Algebra I in 8th grade. In contrast, significantly more principals in Florida reported offering Algebra I in 8th grade compared with principals in other states (see Figure 3). In fact, Algebra I in 8th grade is nearly universal in Florida middle schools; 99 percent of principals reported that it is offered in their

FIGURE 3

Percentage of Principals Reporting That Algebra I in 8th Grade Is Offered at Their School, and If so, Who Can Participate



NOTE: This figure uses principal survey response data for the following question (n = 875): "Indicate if your school offers any of the following opportunities, and which students can participate." Asterisks (*) indicate that the percentage of principals in a given state who reported offering Algebra I in 8th grade is significantly different from the percentage of principals in other states ($p < 0.05$). This figure includes only principals in schools that serve 8th grade. Some bars do not sum to 100 percent because of rounding.

schools. Importantly, when Algebra I is offered in 8th grade in Florida (and in other states), it is most often offered to only some students.

As of 2023, as noted in the introduction to this report, California's new mathematics framework encourages students to take algebra in 9th grade as opposed to 8th grade because of some evidence that many students are not prepared for 8th grade algebra (Schwartz, 2023; Woo and Steiner, 2023). The framework encourages those California schools that offer algebra in 8th grade to take additional steps to ensure that students are prepared for that accelerated option. In contrast, New York State Education Department policy requires that high school–level mathematics courses are made available to 8th grade students who want to take them (New York State Education Department, undated). In Florida, schools receive points toward accountability grades if students who are enrolled in algebra pass an end of course algebra test (Florida Department of Education, 2023). These differential state policies likely contribute to lower percentages of California schools offering Algebra I in 8th grade relative to New York and Florida schools.

In addition to looking specifically at access to algebra in 8th grade, we asked middle school principals about all mathematics course offerings available in their school. The most commonly reported mathematics course offerings in middle school grades (6–8) are reported in Table 2. General Mathematics is the most-offered course among middle schools nationally and in all sampled states except Florida, where principals reported their schools offering Algebra I about as commonly as general mathematics. Integrated Mathematics I appears somewhat more common in California and Florida. California specifically names Integrated Mathematics I through III as a specific

TABLE 2

Percentage of Principals in Schools Serving Grades 6–8 Reporting That Each Course Is Offered in Their School

Course	National	California	Florida	New York	Texas
General Mathematics	91	95	89	91	86
Algebra I	54	22*	90*	74*	75*
Prealgebra	42	19*	82*	22*	34
Review or remedial mathematics	37	38	47	36	51
Geometry	24	11*	69*	6*	14*
Integrated Mathematics I	13	20	19	5*	4*
Computer Science	13	3*	15	7*	11
Algebra II	12	2*	10	5*	14

NOTE: This table uses principal survey response data for the following question (n = 1,191): "This school year (2022–2023), which of the following mathematics and computer science courses are offered onsite at your school?" In total, we inquired about 25 different courses, but for parsimony, we report only the eight most commonly offered courses in this table. Asterisks (*) indicate that the percentage of principals in a given state who reported that each course is offered is significantly different from the percentage of principals in other states ($p < 0.05$). This table includes only principals in schools serving grades 6–8.

pathway available to students, according to the state's framework for mathematics instruction (California Department of Education, 2023). Geometry and prealgebra are also significantly more available in Florida middle schools, while the integrated mathematics approach is significantly less common in New York and Texas. Overall, principals in Florida appear to report a wider variety of course offerings than principals in other states.

Large and Low-Poverty Middle Schools Are 10 to 20 Percentage Points More Likely to Group Students by Achievement Level into Mathematics Classes Than Smaller and High-Poverty Middle Schools

There are multiple noteworthy trends in achievement grouping by school demographic composition (see Table 3). As noted previously, about 39 percent of middle school principals across the United States reported grouping students by achievement level into mathematics classes. Significantly more principals (45 percent) in low-poverty 6–8 schools reported grouping by achievement level into classes than principals (33 percent) of high-poverty schools. Although the K–5 data show no difference in achievement-level grouping reports by principals in schools of different sizes, significantly more large middle schools group students by achievement level into mathematics classes than smaller middle schools, whereas smaller middle schools are more likely to group within classes and not into classes.

A Majority of Principals of Schools Serving Grades K–8 Reported Using Grade-Level Accountability Assessments, Interim Assessments, or Teacher Recommendations to Place Students into Achievement Level Groupings

Table 4 shows which data principals reported being used for achievement-level grouping, when grouping into mathematics classes is practiced. These data reflect mostly middle school principals who reported such grouping practices, although they also reflect a small proportion of elementary principals who also reported grouping students into mathematics classes.

Nationally, diagnostic assessments and teacher recommendations are reported most by principals (85 percent and 83 percent, respectively) as measures

TABLE 3

Percentage of Principals Reporting That They Group Students by Achievement Level Within Classes Versus into Classes

	Percentage of Principals Who Group Students Within Classes		Percentage of Principals Who Group Students into Classes	
	K–5	6–8	K–5	6–8
National	34	29	7	39
California	24*	28	3*	29*
Florida	40	11*	11	78*
New York	32	31	2*	31
Texas	34	28	6	40
Low poverty	33	27	7	45*
High poverty	34	31	6	33*
Majority White	34	30	7	40
Majority students of color	34	28	7	39
Small school	37	35*	4*	24*
Large school	32	27*	9*	47*

NOTE: This table uses principal survey response data for the following question (K–5, n = 1,715; 6–8, n = 1,143): "Some schools organize mathematics instruction differently for students with different achievement levels. What is your school's policy about how students are grouped in the following grade bands?" Asterisks (*) indicate that the percentage of principals within that subgroup grouping by achievement either within classes or into classes is significantly different from the rest of the sample ($p < 0.05$). This table includes only principals who serve elementary grades in the K–5 columns and middle school grades in the 6–8 columns.

TABLE 4

Among K-8 Principals Who Report Grouping Students by Achievement Level into Math Classes, Percentage Reporting Use of Each Type of Data for Grouping Students

	National	California	Florida	New York	Texas
Required grade-level tests administered for accountability purposes	59	48	71	78*	70
Diagnostic, benchmark, or interim assessments that measure students' achievement	85	83	78	77	66*
Tests or quizzes created by teachers or provided in curriculum materials	46	50	29*	44	53
Classroom tasks, assignments, or projects created by teachers or provided in curriculum materials	34	48	30	60	37
Students' Individualized Education Programs (IEPs)	49	36	42	43	29*
Parent, guardian, or family member requests	42	28	42	48	50
My own knowledge of the student	15	5*	8*	27	14
Teacher recommendations	83	84	67*	94*	75
Counselor recommendations	24	11*	19	40	14

NOTE: This table uses principal survey response data for the following question (n = 543): "What data do you use to group students by achievement level into different mathematics classes?" Asterisks (*) indicate that the percentage of principals in a given state who reported using that type of data is significantly different from the percentage of principals in other states ($p < 0.05$). This table includes only principals who serve elementary and middle school grades who indicated that they group students by achievement level into mathematics courses.

used to group students. The state in which a school is located appears to be a key factor that determines which measures are used to group students. In California, for example, significantly lower proportions of principals reported using grade-level accountability tests to group students compared with principals in Florida and New York, respectively. Additionally, lower proportions of Florida elementary and middle school principals reported using teacher-created tests, classroom tasks, or teacher recommendations to place students compared with those in California and New York.

More principals in large schools and urban schools reported using multiple measures to group students by achievement level, including grade-level tests or classroom tests or tasks, compared with principals in smaller and rural schools. At the same time, principals in large and urban schools reported grouping based on their knowledge of students less than their counterparts, possibly because principals have less knowledge of individual students when serving larger or more diverse populations.

Parent and guardian requests are much more common modes of grouping students in low- versus high-poverty schools (50 versus 30 percent), according to principal self-reports. These data suggest that parents in low-poverty schools may be more likely to advocate for their children than parents in high-poverty schools, and/or that principals of low-poverty schools may be more likely to respond to parent requests. Grouping based on knowledge of students is reported nearly twice as often in schools with mostly White students than in schools serving a majority of students of color (18 versus 10 percent) and in smaller versus larger schools (23 versus 12 percent).

Taken together, these data suggest that there is more use of recommendations for grouping students in low-poverty schools and schools with more White students, potentially alongside or in place of assessments. These findings potentially suggest that more diverse types of data are taken into account in low-poverty schools but could also indicate that teachers and parents are better able to advocate for different student placements in those settings.

Opportunity Structure 2: Teacher Qualifications and Assignment

In this section, we explore K–8th grade students' access to expert teachers who can support their mathematics learning. We specifically examine proportions of mathematics teachers who possess mathematics teaching credentials. We also examine principals' reports regarding teachers' content and pedagogical knowledge for mathematics instruction, along with principals' reports of how teachers are assigned to mathematics classes.

Middle School Mathematics Teachers Likely Have More Deep Knowledge of Mathematics Pedagogy and Content Than Elementary Teachers

Certification requirements for mathematics teachers vary by state. However, typically, teachers of grades K–5 or K–6 are certified to teach elementary mathematics via an elementary teacher certificate, whereas secondary teachers of grades 6–12 or 7–12 are typically required to have a secondary mathematics teaching certificate. According to the National Council on Teacher Quality, 28 states also require that candidates licensed to teach elementary mathematics pass a mathematics subtest that is part of their educator licensure exam (National Council on Teacher Quality, 2020b). The states for which we have state-representative samples—California, Florida, New York, and Texas—also vary considerably in their licensure requirements, particularly at the elementary level. The box provides more detail on those requirements.

We have information on certification rates through a question we asked teachers about the areas where they are certified, including elementary education and mathematics. Nationally, 96 percent of elementary teachers reported having an elementary certification, although 10 percent also reported holding a mathematics certification, as noted in Figure 4, which displays mathematics certification rates. Nationally, 66 percent of middle school mathematics teachers reported being certified to teach math-

Elementary and Middle School Mathematics Teacher Licensure Requirements in California, Florida, New York, and Texas

California elementary school teachers are required to obtain a K–12 Multiple Subject Teaching Credential and pass three subtests that are part of the California Subject Examination for Teachers: a reading, language, literature, history, and social studies subtest; a science and mathematics subtest; and a physical education, human development, and visual and performing arts subtest. California teachers can be exempt from the testing requirements if they complete an elementary subject matter preparation program. In addition, teachers only need to pass a subtest with a composite score. **California middle school teachers** may have either a K–12 Multiple Subject Teaching Credential or a K–12 Single Subject Teaching Credential to teach mathematics; middle school teachers can add a math single-subject credential to a certificate either by completing a single-subject program or passing a math content-area test.

Florida elementary school teachers are required to obtain a pre-K–3 or K–6 elementary license and pass a certification exam subtest in mathematics, in addition to subtests in other subject areas. **Florida middle school teachers** are required to obtain a middle grades certificate (grades 5–9) or a grades 6–12 math-specific teaching credential and pass a subject-specific test to teach mathematics.

New York elementary teachers are required to obtain a grades 1–6 or K–2 elementary certification and pass three subtests that are part of New York's State Teacher Certification Examinations Multi-Subject: a literacy and English language arts subtest; a mathematics subtest; and a science, social science, and arts/health/fitness/family and consumer science/career development subtest. **New York teachers of grades 5–9** are required to obtain a Generalist in Middle School Childhood Education (grades 5–9) certificate and pass the three subtests that are part of the New York State Teacher Certification Examination Multi-Subject (grades 5–9), which includes a math subtest. New York teachers of grades 7–8 have the option of obtaining either the Generalist in Middle School Childhood Education certificate or a single-subject certification in mathematics and a content test focused on mathematics.

Texas elementary teachers are required to obtain either a pre-K–6 generalist or pre-K–3 certificate. Those obtaining a pre-K–6 generalist certification must earn a satisfactory level of performance in each of the following subtests: English language arts, mathematics, science, and social studies. Pre-K–3 certificates do not require teachers to pass a content-area test. **Texas middle school teachers** are required to obtain (1) a core subjects grades 4–8 certification; (2) a grades 4–8 combination English language arts and reading and social studies, or combination mathematics and science certification; or (3) a single-subject certification. Single-subject or core subjects licenses are provided only if the candidate passes a single-subject test. Teachers obtaining a combination English language arts and reading and social studies or combination mathematics and science certification need to pass the combined test with a composite score.

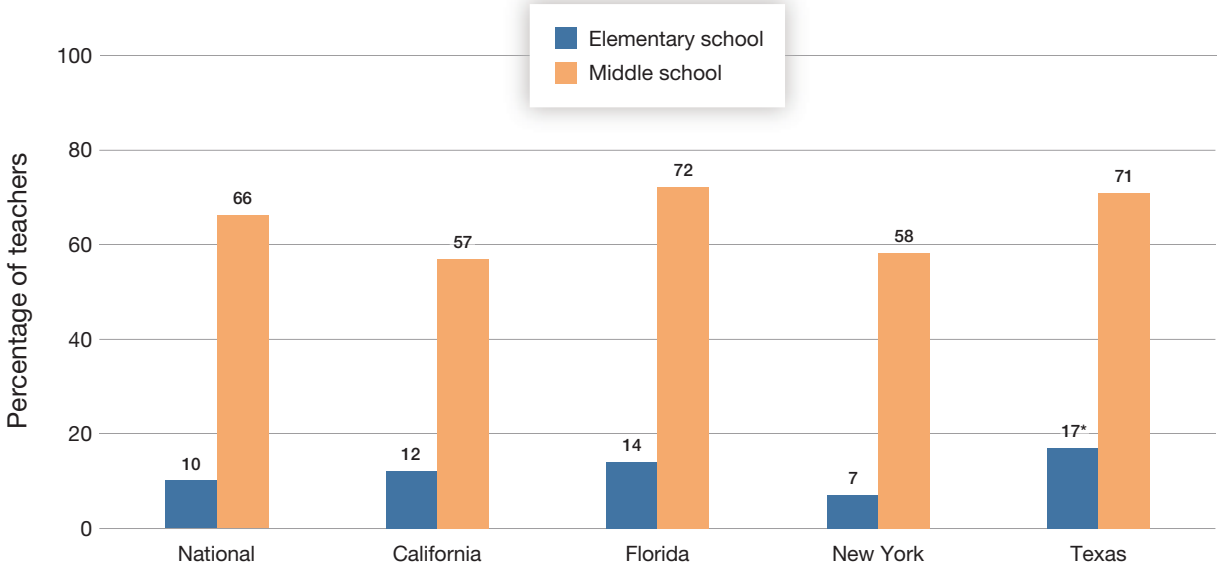
NOTE: These details on state licensure requirements are drawn from the National Council on Teacher Quality State Teacher Policy Database (National Council on Teacher Quality, undated-b), which was updated in February 2020. Some of these details may have changed between 2020 and when we surveyed teachers for this report in spring 2023.

ematics in their state. Lastly, more Texas elementary teachers indicated that they are certified to teach mathematics (17 percent) compared with elementary teachers in the rest of the country. Readers should keep in mind that 6th-grade mathematics teachers are also included in the middle school sample and may not be required by their state to have a mathematics certification.

Principals reporting on middle school teachers typically rated them as having more deep knowledge of mathematics content and pedagogy than principals reporting on elementary school teachers (Figure 5). Specifically, 55 percent of middle school principals reported that their mathematics teachers demonstrate deep knowledge of mathematics pedagogy, compared with 28 percent of elementary school principals. Similarly, 64 percent of middle school

FIGURE 4

Percentage of Teachers Reporting That They Are Certified in Mathematics



NOTE: Figure shows teacher survey response data to the following question (elementary school, n = 1,401; middle school, n = 253): "In what areas are you certified to teach in your state?" Figure shows the percentage of teachers selecting the response "mathematics." Asterisks (*) indicate that the percentage of teachers certified in mathematics in a given state is significantly different from the percentage of teachers in other states ($p < 0.05$).

principals reported that their mathematics teachers demonstrate deep knowledge of mathematics content, as compared with 33 percent of elementary school principals. When examining these percentages, readers should keep in mind that these responses represent principals' perceptions (i.e., they might not be based on any objective data). Thus, principals' biases about who is knowledgeable in mathematics content and pedagogy, and the demographic composition of teachers across the United States, may come into play in their responses. For example, elementary school teachers are mostly White women, whereas secondary mathematics teachers are about equally likely to be male or female. Any biases principals may have related to gender (as well as ethnicity) and mathematics knowledge could, thus, influence how they rate teachers.

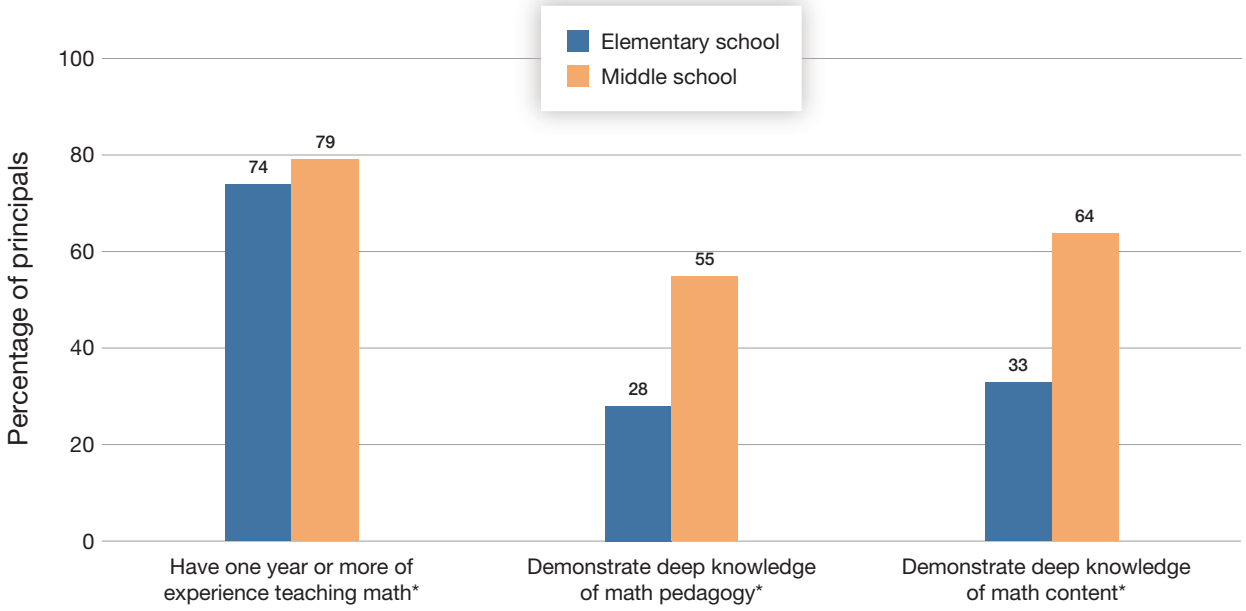
We also compared principals' perceptions about their teachers' knowledge for different types of schools and schools in different states. As seen in Figure 6, fewer principals in urban and high-poverty schools reported that their teachers have deep knowledge in mathematics pedagogy and content. California principals also regarded their teachers as less knowledgeable compared with principals in other states, which could be connected to the less-rigorous mathematics certification requirements for K–8 teachers in California. Specifically, California teachers can be exempt from the requirement to pass a math content test to teach mathematics.

Most Principals Agreed That They Have Enough Knowledge of Mathematics Content and Strategies to Provide Teachers with Feedback, Although Fewer Strongly Agreed

When asked whether they believe that they have enough knowledge of mathematics content and strategies to support teachers, large majorities of principals (upward of 90 percent) at least somewhat agreed that they do. However, only a little over one-third of principals of K–8 grades *strongly agreed* that they do (see Figure 7). Principals in Texas reported significantly higher rates of strong agreement about their knowledge than principals in other states. Although

FIGURE 5

Percentage of Principals Reporting That All or Almost All Teachers Have Certain Characteristics, with Elementary Versus Middle School Comparisons



NOTE: This figure uses principal survey response data for the following multipart question (elementary school, n = 1,502; middle school, n = 568): "What proportion of the mathematics teachers in your school have more than one year of experience teaching mathematics/demonstrate deep knowledge of mathematics pedagogy/demonstrate deep knowledge of mathematics content?" Responses indicate the percentage of principals who selected that "all or almost all" teachers have a given characteristic. Asterisks (*) indicate that the difference between elementary school and middle school is statistically significant ($p < 0.05$).

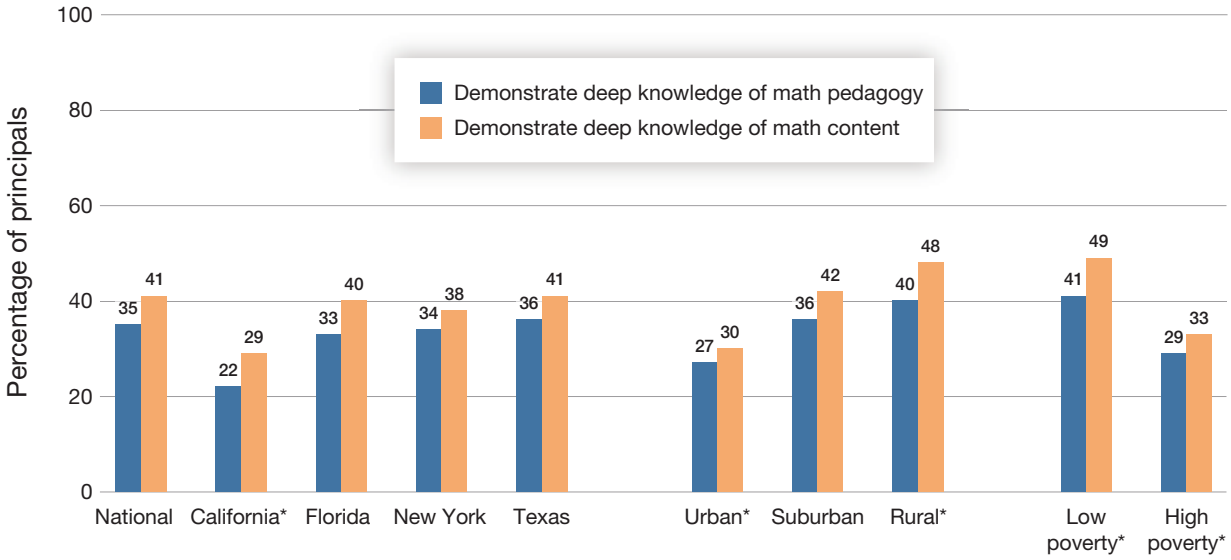
principals in California strongly agreed that they have enough knowledge of mathematics *instructional strategies* at a rate comparable with the national average, a lower percentage of California principals strongly agreed that they have enough knowledge of mathematics *content*. When principals reported having primary responsibility of observing and coaching mathematics teachers, they were about nine percentage points more likely to strongly agree that they have enough knowledge of mathematics instructional strategies than principals in schools where someone else is primarily responsible for observing and coaching mathematics teachers.

Students Who Struggle in Mathematics Classes Typically Do Not Get the Most Experienced and Knowledgeable Teachers, Although State Context Matters for Teacher Assignments

About one in three U.S. principals, on average, reported assigning students who are struggling to teachers with the most knowledge of mathematics pedagogy and content, although we observed significant variation in teacher assignment across states (Figure 8). For example, significantly more principals in New York reported assigning teachers with the most knowledge to their struggling students (40 percent) than in other states. In contrast, California has the lowest percentage of principals reporting that struggling students get the most-knowledgeable teachers (19 percent) and the highest percentage of principals reporting no flexibility in assigning teachers to students (40 percent). Florida has the second-highest percentage of principals who reported that

FIGURE 6

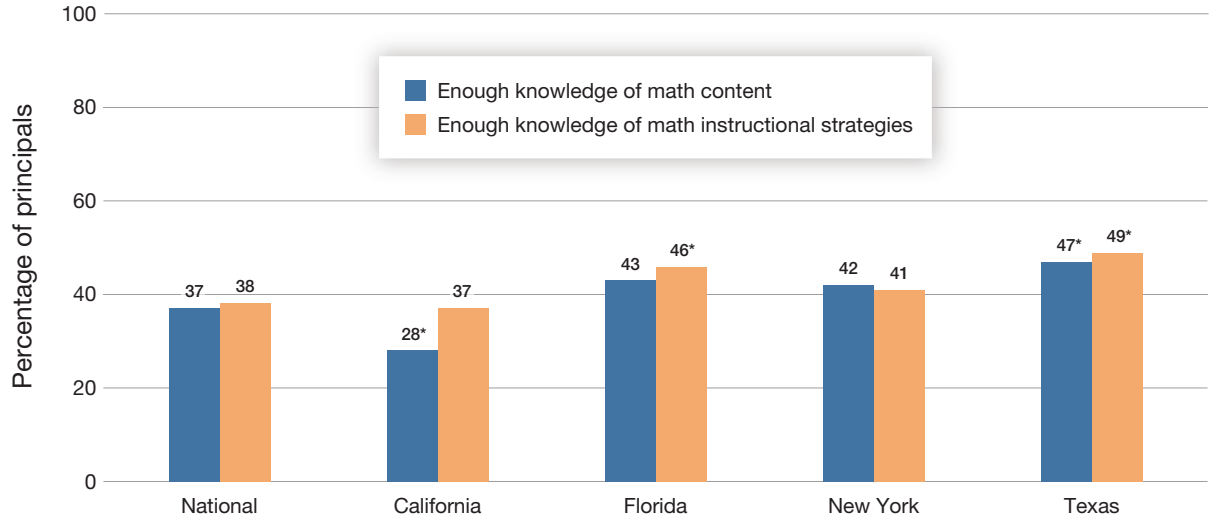
Percentage of Principals Reporting That All or Almost All Teachers Demonstrate Deep Knowledge of Mathematics Pedagogy or Content



NOTE: This figure uses principal survey response data for the following multipart question (n = 2,203): "What proportion of the mathematics teachers in your school have more than one year of experience teaching mathematics/demonstrate deep knowledge of mathematics pedagogy/demonstrate deep knowledge of mathematics content?" Responses indicate the percentage of principals selecting "all or almost all" teachers have a given characteristic. Asterisks (*) indicate that a given subgroup is significantly different from the others in that category ($p < 0.05$).

FIGURE 7

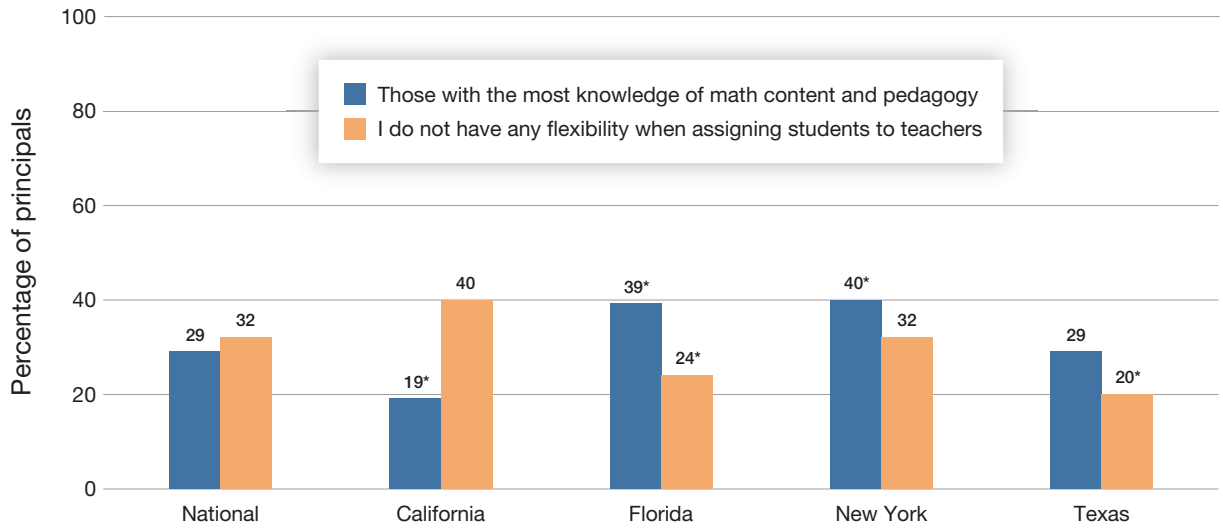
Percentage of Principals Who Strongly Agreed That They Have Enough Knowledge of Mathematics Content and Instructional Strategies to Provide Teachers with Actionable Feedback on Their Mathematics Instruction



NOTE: This figure uses principal survey response data for the following survey item (n = 2,259): "Indicate your level of disagreement or agreement with the following statements . . ." The statements were "I have enough knowledge of mathematics content to provide teachers with actionable feedback on their mathematics instruction" and "I have enough knowledge of mathematics instructional strategies to provide teachers with actionable feedback on their mathematics instruction." Response choices were as follows: "strongly agree," "somewhat agree," "somewhat disagree," and "strongly disagree." Asterisks (*) indicate that the percentage of principals in a given state who strongly agree with each statement is significantly different from the percentage of principals in other states ($p < 0.05$).

FIGURE 8

Percentage of Principals Reporting That Struggling Students Are Taught by the Most Knowledgeable Teachers or That They Do Not Have Flexibility in Assignment



NOTE: This figure uses principal survey response data for the following question (n = 2,208): "In my school, students who need the most help with mathematics are generally taught by . . ." Asterisks (*) indicate that the percentage of principals in a given state selecting that response is significantly different from the percentage of principals in other states ($p < 0.05$).

struggling students get the most-knowledgeable teachers (39 percent) and that they have no control in assigning teachers (24 percent).

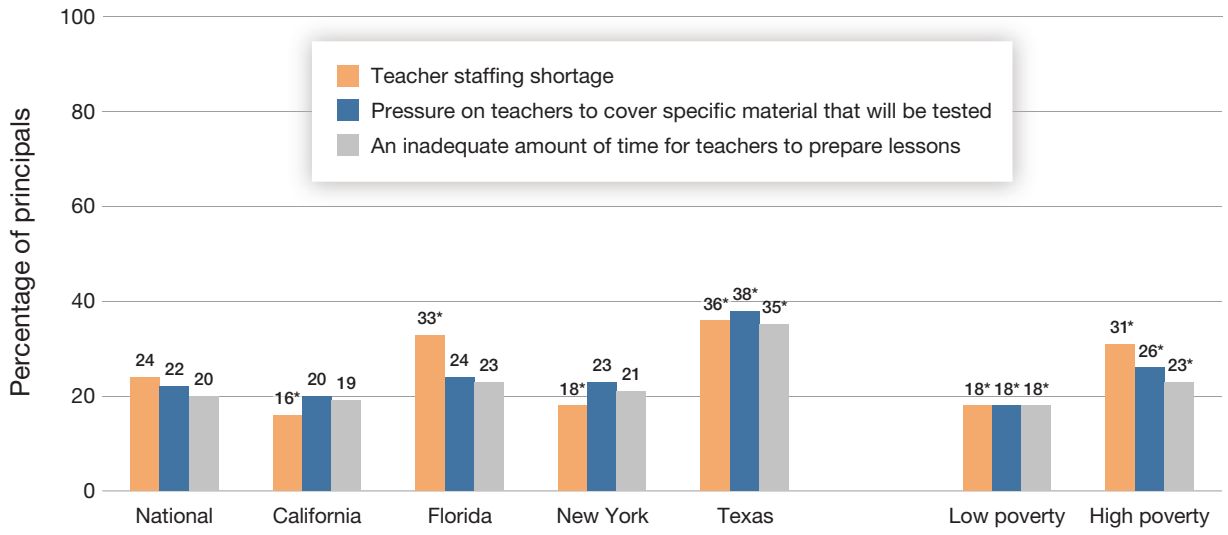
In Florida, New York, and Texas, the percentages of principals who reported not having flexibility in how they assign teachers are generally lower than the percentages who indicated assigning their most knowledgeable teachers to their struggling students. In contrast, in California, the percentages of principals who reported no flexibility are 20 percentage points higher relative to the proportion who indicated being able to assign their most-knowledgeable teachers to struggling students.

Compared with Principals in the Rest of the Country, Texas Principals Were More Likely to Report That Major Obstacles May Overburden Mathematics Teachers at Their Schools; Principals in High-Poverty Schools Were Also More Likely to Report Those Major Obstacles Than Those in Low-Poverty Schools

To better understand students' access to strong teachers, we asked principals about the obstacles that might hinder teachers' efforts to promote students' mathematics learning, including staffing shortages, testing pressures, and inadequate lesson planning time. Nationally, 24 percent of principals reported staffing shortages, 22 percent reported testing pressure, and 20 percent reported inadequate lesson planning time (see Figure 9). A significant number of principals from high-poverty schools noted that each of these obstacles exists at their schools and is a major obstacle. The major obstacle most frequently reported by principals of high-poverty schools was teacher staffing shortages (31 percent), whereas only 18 percent of principals in

FIGURE 9

Percentage of Principals Reporting That Staffing Shortages and Limited Teacher Time Are Major Obstacles to Student Learning in Mathematics



NOTE: This figure uses principal survey response data for the following question (n = 2,243): "Indicate whether the following conditions exist at your school and the degree to which each is an obstacle to you and/or your teachers' efforts to promote student learning in mathematics." Asterisks (*) indicate that the proportion of principals from a given subgroup reporting a major obstacle is significantly different from other subgroups in that category ($p < 0.05$)

low-poverty schools reported staffing shortages as an obstacle. The higher staffing shortages at high-poverty schools reflect an exacerbation of the struggle that these schools have in retaining teachers independent of a national shortage (Edwards et al., 2022). A significantly lower percentage of principals from low-poverty schools mentioned testing pressure and inadequate planning time as obstacles in their schools (18 percent each) compared with high-poverty schools.

We also observed some differences in obstacles that principals reported by state. Compared with other states, California and New York are home to significantly lower proportions of principals who reported teacher staffing shortages as a major obstacle (16 percent and 18 percent, respectively). Texas principals reported significantly higher incidence of every major obstacle we asked about that could signal overburdened teaching staff; we have no obvious explanation for that trend. Only Florida is closest to Texas in terms of the percentage of principals reporting the teacher shortage as a major obstacle (33 percent to Texas's 36 percent). The most commonly reported obstacle for Texas principals was the pressure on teachers to cover the specific material that will be tested, which could reflect a more rigid adherence to standardized tests relative to other states.

Opportunity Structure 3: Supports for Struggling Students

In this section, we consider what interventions principals in schools serving grades K–8 reported offering to students who are struggling in mathematics, along with the principals' reports of student participation in those interventions. We asked principals of elementary school grades about a slightly different set of interventions than those leading middle-grade schools based on feedback we received from experts during survey development.

We asked principals of both elementary and middle school grades whether they offered "tiered programming/intervention for math," as well as multiple methods of intervention that could occur within or apart from tiered intervention programming (e.g., tutoring, help after school, summer programming). Tiered intervention programming is

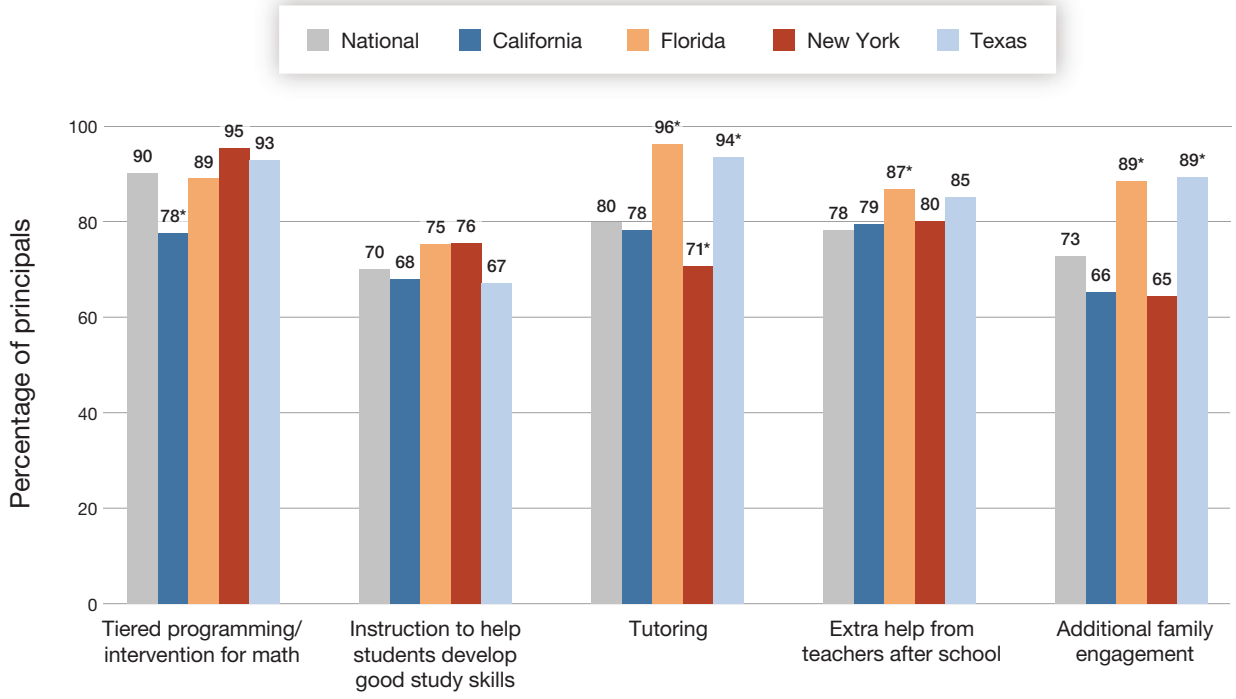
also sometimes referred to as *response to intervention* (RTI) or *multitiered systems of supports* (MTSS). Both are widely used across U.S. schools to identify and support struggling learners. That support can take place within the classroom by their teachers (often described as "Tier 1" instruction); through short-term, targeted intervention in addition to their regular classroom instruction (often described as "Tier 2" instruction, provided through small groups or other methods, often not to exceed a grading period); or through more-intensive interventions (described as "Tier 3" intervention, which typically involves considering eligibility for special education services) (RTI Action Network, undated). State requirements for RTI and MTSS vary (Zirkel, undated). Some states mandate that districts use RTI to identify students with learning disabilities, and others leave it up to the district itself. A smaller number of states also require RTI for general education intervention beyond special education identification. State guidelines for RTI planning, frequency, and duration also vary widely.

Elementary School Principals Reported a Variety of Supports for Struggling Students, Although They Also Reported Minorities of Their Struggling Students Participating in Any of Those Supports

Nationally, tiered intervention programming is the most common support for elementary students who are struggling with mathematics (reportedly offered by 90 percent of schools, according to principals; see Figure 10), although significantly lower propor-

FIGURE 10

Percentage of K–5 Principals Reporting That Each Type of Support Is Offered for Struggling Students in Their Schools



NOTE: This figure uses principal survey responses for the following question (n = 1,712): "This school year, what proportion of students who are struggling academically in mathematics have participated in the following programs?" The response choices were "My school does not offer this," "No students," "Less than half," "More than half but not all," "All or almost all," and "I don't know." The figure shows the percentage of principals who reported that the intervention was offered, regardless of how many students participated. Asterisks (*) indicate that the percentage of principals in a given state reporting that an intervention is offered is significantly different from the percentage of principals in other states ($p < 0.05$). This figure includes only principals of grades K–5.

tions of California principals reported offering tiered intervention programming compared with principals in the rest of the United States. We did not observe other significant differences in offers of tiered intervention programs across elementary schools by demographic characteristics.

Four out of five U.S. elementary principals also reported offering tutoring. Additionally, such supports as instruction in good study skills, after-school help from teachers, and additional family engagement are also prevalent across U.S. elementary schools. More Florida and Texas principals reported offering such interventions as tutoring and after-school support than in other states.

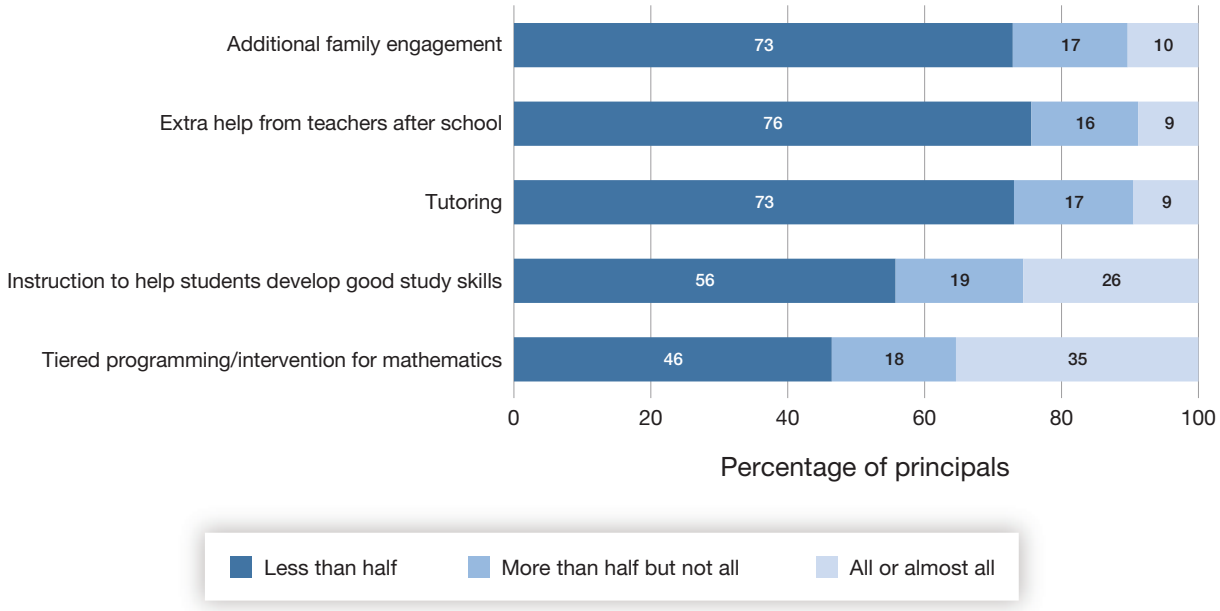
We also asked about the rough proportion of students participating in any support that is offered. Thirty-five percent of principals who reported offering tiered instruction as an intervention indicated that all or almost all of their students who struggle in mathematics get that intervention (Figure 11). Yet, 46 percent of principals indicated that less than half of their struggling students participate in a tiered intervention. Principals reported that even fewer struggling students participate in other offered programs intended to support those students. For example, about three-quarters of principals indicated that less than half of struggling students typically participate in tutoring, receive after-school help, or get extra family engagement if those supports are offered.

Tiered Intervention Programming and Tutoring Are the Most Common Supports for Middle School Students Struggling with Mathematics, yet—as at the Elementary Level—Many Students Who Are Struggling in Mathematics Are Not Participating in Supports That Are Offered

Similar to the elementary level, tiered intervention programming is a common mathematics support at the middle school level, along with tutoring. We asked middle school principals about a small number

FIGURE 11

Elementary School Principals' Reports of the Proportion of Struggling Students Participating in Offered Supports



NOTE: Figure shows principal survey responses for the following question: "This school year, what proportion of students who are struggling academically in mathematics have participated in the following programs?" This figure includes only principals of grades K–5 who reported that each type of program was offered at their school. Sample size varies based on the number of principals who reported offering each type of program. Totals might not sum to 100 because of rounding.

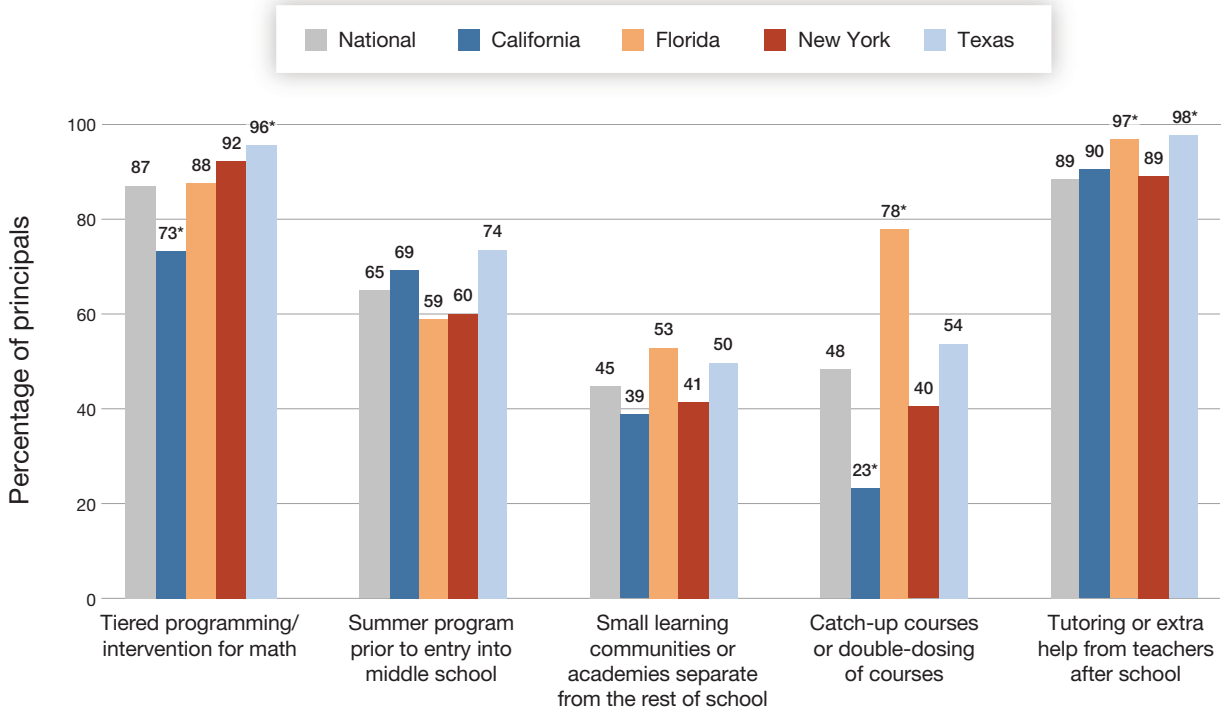
of other types of supports, including summer programming prior to middle school entry, small learning communities, and double-dose courses. Nearly two-thirds of U.S. principals and majorities of principals across our oversampled states reported offering summer programming (see Figure 12). Small learning communities are less common than summer programming but are still offered in about 30 to 50 percent of middle schools, depending on the state. Interestingly, catch-up or double-dose courses are far more prevalent in Florida than in other states, especially California.

As we observed in elementary schools, most middle school students who struggle with mathematics may not be getting the supports they need. For example, only around one-quarter of principals indicated that all or almost all of their students struggling with mathematics participate in a tiered intervention when tiered intervention programming is available. Much smaller percentages of principals respond that all struggling students participated in any other type of offered support (Figure 13). In another example, even when principals indicated that their school offers catch-up or double-dose courses, most principals responded that majorities of their struggling students do not participate.

We do not observe many significant differences in offering of tiered intervention programming in middle schools with different demographics, although principals in larger middle schools are slightly more likely to report offering tiered intervention programming than those in smaller schools. Tutoring and summer programming are somewhat

FIGURE 12

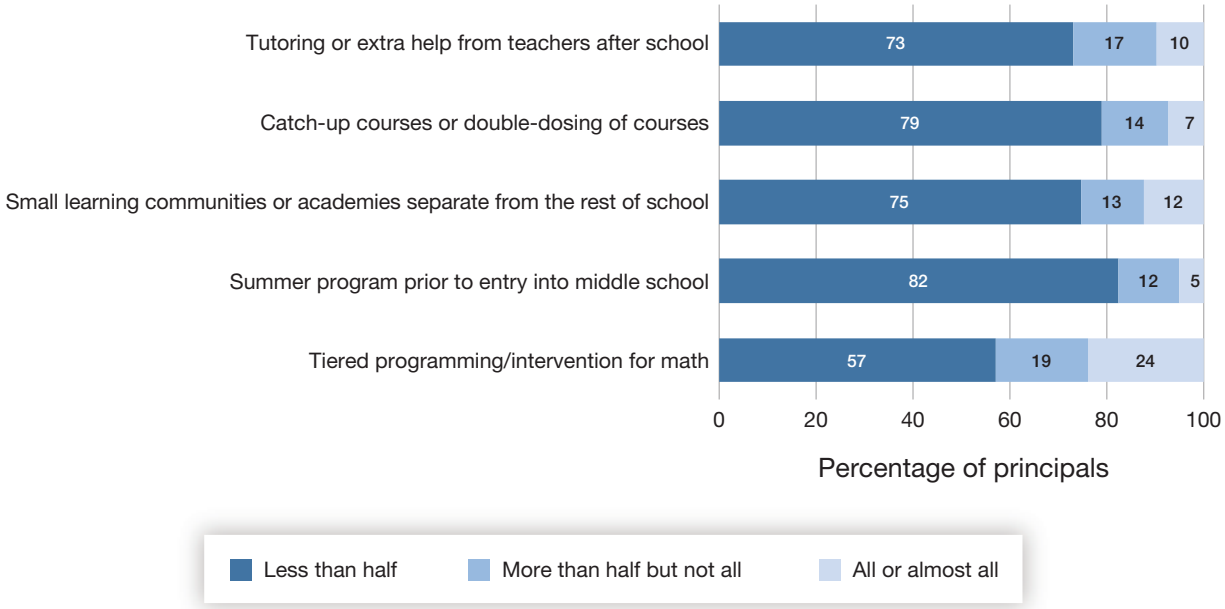
Percentage of 6–8 Principals Reporting That Each Type of Support Is Offered for Struggling Students in Their Schools



NOTE: Figure shows principal survey responses for the following question (n = 1,144): "This school year, what proportion of students who are struggling academically in mathematics have participated in the following programs?" The response choices were "My school does not offer this," "No students," "Less than half," "More than half but not all," "All or almost all," and "I don't know." This figure shows the percentage of principals who reported that the intervention was offered, regardless of how many students participated. Asterisks (*) indicate that the percentage of principals in a given state reporting that an intervention is offered is significantly different from the percentage of principals in other states ($p < 0.05$). This figure includes only principals of grades 6–8.

FIGURE 13

Middle School Principals' Reports of the Proportion of Struggling Students Participating in Offered Supports



NOTE: Figure shows principal survey responses for the following question: "This school year, what proportion of students who are struggling academically in mathematics have participated in the following programs?" This figure includes only principals of grades 6–8 who reported that each type of intervention was offered at their school. Sample size varies based on the number of principals who reported offering each type of intervention. Totals might not sum to 100 because of rounding.

more prevalent in larger middle schools and middle schools with more students of color.

Limitations

These analyses have several limitations. First, they rely entirely on self-reports from principals and teachers, which can be subject to self-report biases and may not reflect objective reality within schools and classrooms. Second, these survey items do not tell us anything about the quality of instruction within mathematics classrooms. For example, we cannot tell from these analyses whether schools that engage in more or less achievement-level grouping tend to provide better or worse instruction to different groups of students. Nor do we know whether teachers who are certified in mathematics—or who principals reported having deeper or less knowledge of mathematics content and pedagogy—provide lower- or higher-quality mathematics instruction. Third, readers should keep in mind that differences between states and between schools with different demographics in terms of mathematics learning opportunities could be present for myriad reasons that are beyond the bounds of this report to fully explore. For example, underlying the differences in our results could be different student populations in different states or different levels of resources provided in different types of schools, districts, and states.

Conclusions, Implications, and Recommendations

This report investigates access to school structures—which we refer to as *opportunity structures*—that may facilitate or limit K–8 students' rigorous mathematics classes, teaching, and supports. We specifically examined the following school opportunity structures:

- Tracking and rigorous mathematics courses: We explored the extent of achievement-level grouping within or into mathematics courses,

along with courses offered in middle school and students' access to those courses to better understand students' access to rigorous mathematics instruction.
- Teacher qualifications and assignment: We considered whether students—and particularly those who are struggling in mathematics—have access to certified, knowledgeable mathematics teachers.
- Supports for struggling students: We examined the availability of school offerings to support students who are struggling in mathematics and principals' estimates of the proportion of struggling students who are getting those supports.

We looked at these opportunity structures across the United States and in the four largest states: California, Florida, New York, and Texas.

We need to undertake more research to better understand the trends in tracking, teacher assignment, and intervention programming, as well as how those trends are connected with teaching and learning in schools. That said, we have identified several takeaways and corresponding recommendations based on these data.

First, these data imply that students in particular states and in particular types of schools have more-equitable access to mathematics learning opportunities relative to others. For example, we learned that achievement-level grouping within classes starts early and that—by middle school—many students are grouped by achievement level into classes, especially in Florida relative to the other large states where we have oversamples. The way this might afford opportunities to some students versus others is particularly stark in the case of Algebra I in 8th grade, which is offered to all 8th-grade students in less than 20 percent of schools that have an 8th grade and is much more often provided to only certain students—likely those who are in higher achievement-level groupings. These data thus suggest that some students who would like to take algebra in 8th grade are unable to do so.

Achievement-level grouping is most prevalent in large schools and low-poverty schools. That said, principals in larger schools reported that achievement grouping is more often made on the basis of several different types of measures, including various types of testing data, compared with principals of smaller schools. Parent or guardian request is a much more common mode of grouping in low-poverty schools. These data could reflect that parents or guardians make more such requests in low-poverty schools; that they are given more opportunity to make those requests; and/or that principals in low-poverty schools act on those requests more than in high-poverty schools.

Given these findings, we recommend that districts and schools investigate ways to reduce biases in how students are tracked by achievement level within and into mathematics classes. Given the pervasiveness of tracking in our data and potential inequities in who is placed in lower-tracked mathematics classes, schools that track should carefully consider whether they have enough data points on each student to track them into classes that give them what they need. For example, multiple data points may be better than just one, and some research suggests that use of a high-quality, rigorous assessment of mathematics knowledge to place students in more or less accelerated classes in early middle school may reduce inequities in who gets access to algebra in 8th grade and to more-advanced mathematics classes later (Dougherty et al., 2015). Furthermore, if districts find that use of an assessment to place students results in more-equitable outcomes, they may consider experimenting with the threshold by which to place students in more or less advanced courses to see what threshold leads to the greatest gains both in enrollment and pass rates for students of different ethnicities and income levels.

To further avoid biases in how students are tracked, schools could also work more closely with teachers, guidance counselors, parents, and students to make sure students are getting the challenge they want and need in their classes. For example, principals could ask teachers to report at various times during the year whether all their students are receiving the appropriate level of challenge and whether it might make sense to shift any students to a different track. School staff could also ask students themselves (and parents) whether they think they could handle more-challenging work in their classes.

More close communication with teachers, parents, and students about their mathematics placement is particularly imperative in early middle school grades, before students are placed in 8th grade algebra or another accelerated mathematics option. After that point, students may feel stuck on a particular track unless they double up on mathematics courses to catch up, an option that may be unappealing or even impossible in some schools.

A second implication of our research is that many teachers are likely lacking deep knowledge in mathematics pedagogy and content. Only about one-quarter of elementary principals indicated that all or nearly all of their teachers have deep knowledge of mathematics pedagogy and content. More principals reported that their teachers have deep knowledge of mathematics pedagogy and content at the middle school level. But, even then, only about one-half to two-thirds of principals reported that all or nearly all of their teachers have deep knowledge of mathematics pedagogy and content. These trends in principals' perceptions of teacher knowledge may be tied to state certification practices; although most teachers of mathematics in our sample hold either an elementary teaching certificate or a mathematics teaching certificate, state licensure is often based on different requirements. For example, Texas elementary teachers are required to pass a stand-alone mathematics assessment for elementary mathematics, whereas California elementary teachers can receive their elementary certification without taking a mathematics assessment. These requirements could have influenced the lower principal ratings of teachers' mathematics pedagogy and content knowledge in California relative to the rest of the country.

These findings imply that states and school systems should provide opportunities for teachers to build their knowledge of mathematics pedagogy and content, particularly at the elementary level. Our surveys indicate that elementary teachers in particular may lack deep knowledge of mathematics pedagogy and content. State teacher licensure requirements could help address this problem by requiring elementary preservice teachers to pass a mathematics teaching assessment to receive their elementary certification and setting a high bar for what teachers should master related to mathematics pedagogy and content through preservice teacher coursework. Elementary schools could work to prioritize professional learning focused on mathematics teaching as well. For example, schools could identify teachers with mathematics expertise to mentor other teachers or lead professional learning groups, and they could work to ascertain the areas of mathematics instruction where teachers need the most support.

Lastly, our findings suggest that students who struggle in mathematics likely do not get all the support they need. When students struggle with mathematics, they are typically not placed with teachers who have the most knowledge about mathematics content or pedagogy, when in fact these are exactly the teachers that struggling students could use most. Furthermore, most principals reported that less than half of their struggling students participate in the supports offered at their school. There could be a variety of reasons why students are not participating in these supports beyond just choosing not to participate. For one, schools may not use universal screeners to identify struggling students and then direct them into tiered interventions. In addition, students and parents may not be aware of supports that are available to them or even that they need help. These data illustrate that students who struggle to learn mathematics content may end up falling through the cracks and never get the help they need to access grade-level content.

These findings suggest that school systems should assess the array of supports they offer and why students are or are not taking advantage of those supports when they struggle. First, schools should consider whether they have adequately identified which students struggle in mathematics and the types of supports they need. When students are identified, schools should consider whether they provide clear messages to those students and their parents about their performance in mathematics and what additional supports are available to them. Lastly, schools might consider why students opt not to participate in supports and whether they could do anything to address those issues through revisions to their intervention programming. For example, transportation issues could keep students from taking advantage of after-school programming, which might

imply that schools should consider changes to that programming.

Another way to support students beyond intervention programming is to place them in classes taught by teachers with the most knowledge of mathematics pedagogy and content. Yet, most principals indicate that this is not a common practice. There could be myriad reasons for that, including that principals do not have any flexibility in how they place teachers, and that they do not know which of their teachers have the most knowledge of mathematics. Districts and schools might consider ways to determine which teachers have more mathematics expertise (e.g., a mathematics certification or clear success in improving students' mathematics performance) and whether it could be possible to develop incentives that encourage such teachers to move to positions where they are working primarily with students who are struggling in mathematics. Such incentives might include bonus pay or a co-teacher. States could provide structures that encourage these placements, such as providing additional funding to schools for that purpose or developing criteria to help schools determine which teachers have a high degree of knowledge in mathematics.

Lastly, these findings suggest that K–12 educators play critical roles in ensuring equitable mathematics opportunities. For example, our data indicate that teacher recommendation is a primary way that students are grouped by achievement level. Thus, when teachers have that authority, they could use it by ensuring that students are placed into more-challenging classes if they could handle that challenge. This is especially true for teachers of early middle school grades, when the stage is being set for decisions on whether students should be placed into an Algebra I or integrated mathematics class in 8th grade, a choice that could pave the way for more-advanced mathematics coursetaking in high school and beyond.

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About This Report

In this report, we use data from the American Mathematics Educator Study (AMES) fielded in spring 2023 to K–12 public school principals and mathematics teachers to describe K–8 students' access to rigorous mathematics classes, teaching, and interventions. A companion report will examine structures and processes that support students' access to rigorous mathematics courses and teaching in grades 9–12.

The AMES was fielded through the RAND American Educator Panels (AEP). The AEP are nationally representative samples of teachers, school leaders, and district leaders across the country. The panels are a proud member of the American Association for Public Opinion Research's Transparency Initiative.

If you would like to know more about the AMES dataset, please see *American Mathematics Educator Survey: 2023 Technical Documentation and Survey Results* (Schweig et al., 2023) for more information on survey recruitment, administration, and sample weighting. If you are interested in using AEP data for your own surveys or analysis or in reading other publications related to the AEP, please email aep@rand.org or visit www.rand.org/aep.

RAND Education and Labor

This study was undertaken by RAND Education and Labor, a division of the RAND Corporation that conducts research on early childhood through postsecondary education programs, workforce development, and programs and policies affecting workers, entrepreneurship, and financial literacy and decisionmaking. This report is based on research funded by the Bill & Melinda Gates Foundation. The findings and conclusions presented are those of the authors and do not necessarily reflect positions or policies of the foundation.

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