Getting Students to and Through Advanced Math
Which Students Have Access and How State and District Leaders Can Help Address Challenges
Precalculus. Calculus. Advanced Placement (AP) math classes. These courses are the mainstay of advanced math programs in most U.S. high schools. Students who take advanced courses get a leg up when it comes to securing college admission and scholarships. These students are also more likely to major in science, technology, engineering, and mathematics (STEM) fields. Thus, success in advanced math courses in high school can set students up to enter high-demand STEM careers that pay well and offer opportunities for advancement in the modern workforce.

Despite these benefits, a large portion of U.S. students do not take advanced math in high school. Although there are many reasons why some students opt out of advanced math, structural inequalities create barriers to participation for others. Previous studies have found that high schools that serve large proportions of students of color or students living in poverty are less likely to offer advanced math courses. Additionally, differential access to early algebra I may limit some students’ options for advanced math courses before they even enter high school.

How can the nation support postsecondary participation in STEM fields and careers among all students? There are no easy answers. However, equitable preparation for and opportunities to take advanced math in high school are a critical part of the equation. Preparation for advanced math starts in kindergarten and accumulates over time. Systematic differences in students’ preparation for and access to advanced math courses could signal major inequities in how schools are preparing students for postsecondary academic success.

To explore and identify gaps in students’ opportunities to take and prepare for advanced math since the coronavirus disease 2019 (COVID-19) pandemic, RAND Corporation researchers conducted a nationally representative survey of teachers and principals in spring 2022. The researchers focused on two key ingredients that enable equitable student access to advanced math: access to advanced math courses and early algebra I and exposure to grade-level math content. The survey asked educators about their schools’ advanced math offerings, how frequently they skipped standards-aligned math content, and the challenges they faced in providing high-quality standards-aligned math instruction after the disruptions to schooling during the COVID-19 pandemic.

Together, educators’ responses highlight ways that school-, district-, and state-level education leaders can improve student access to and preparation for advanced mathematics for all student groups. Educators’ responses also reinforce the need to provide teachers with additional supports.

**Access to Advanced Math Courses and Early Algebra Differs by School Context**

Principals across the United States reported on the advanced math courses available to students in their high schools, which the researchers defined as courses traditionally taken after algebra II, and on course offerings in earlier grades, such as prealgebra and algebra I. Overall, the research team noted significant disparities across course offerings in both middle and high schools associated with school location, student body characteristics, and school size (see Figure 1).
High Schools That Are Small, That Are in Rural Communities, or That Serve Students from Historically Marginalized Communities Offer Fewer advanced Math Courses

Principals from large high schools (more than 450 students) reported offering more advanced math courses on average than principals from small high schools. They were also more likely to report offering any of the advanced math courses that the research team asked about, including precalculus, calculus, probability and statistics, and AP math courses. This finding was true no matter where the school was located (city, suburb, or rural area) or the demographics of the student body.

However, school size was not the only factor that mattered. In rural areas, principals reported fewer advanced course offerings overall and were less likely to report offering courses in probability and statistics, AP Calculus, or AP Statistics, even after the researchers controlled for school size. Principals in schools that predominantly serve students in poverty reported offering fewer advanced courses overall and were less likely to offer AP math courses. Schools that mostly serve students of color were less likely to offer calculus.

Uneven Access to Advanced Math Courses Starts Before High School with Uneven Access to Algebra I

Before students can take advanced math courses in high school, they typically complete a series of traditional core math classes that includes algebra I, geometry, and algebra II (or a series of equivalent-level courses). In most cases, for students to take calculus before they graduate, they need to complete algebra I before grade 9.

Only 65 percent of principals in urban schools with middle grades said they offered algebra I compared with 86 percent of such principals in suburban...
schools. Urban schools are disproportionately more likely to serve students in poverty and students of color. Likewise, only 68 percent of principals in schools that predominantly serve students of color said their schools offered algebra I, while 81 percent of principals in schools that predominantly serve white students did.

Opportunities to take algebra I before high school tended to be selective. Only 25 percent of principals in schools with middle grades who reported offering algebra I said the course was open to any student who wanted to take it. Instead, most principals said enrollment was based on eligibility criteria, such as grade point average, grades in math, and the completion of prerequisite courses. Nearly one-quarter of principals said teacher nominations were included as part of the selection process; 11 percent only referenced teacher nominations. This last finding could be concerning. Previous research demonstrates that use of subjective measures—especially teacher nominations—during the enrollment process is a known contributor to persistent disparities in representation in advanced courses.

Exposure to K–12 Math Content Is Also Uneven

Students’ access to advanced courses and equitable opportunities to prepare for such courses are critical to succeed in advanced math. In the study, the research team examined how preparation for advanced math may differ during their K–12 academic careers, using two simple measures of content exposure: (1) how frequently K–12 math teachers reported skipping standards-aligned content at grade level and (2) what content they said they taught in place of grade-level content.

Teachers who worked in schools that predominantly served students in poverty were significantly more likely to report skipping content occasionally or frequently than teachers in schools who served more affluent student groups (25 percent versus 32 percent—a 7-percentage point difference). When the research team looked only at middle and high school teachers, it found a 17-percentage point difference between the proportion of secondary teachers in high-poverty schools and low-poverty schools who said they skipped content. Teachers in high-poverty schools across all grade levels were more likely
to report replacing most of the standards-aligned content they skipped with content below grade level.

There are many reasons why a teacher may skip grade-level content, such as a need to fill in student knowledge or skill gaps. Although this study provides simple measures of relative content exposure that have implications for students’ readiness for advanced math, the authors caution against ascribing fault or blame to either teachers or students. This is because higher levels of skipping, coupled with more time spent on below-grade-level concepts, also reveals where students may benefit from additional supports, including those offered beyond the classroom. It also reveals that teachers might benefit from additional resources and guidance.

From the lack of equitable access to technology to its disparate social and economic effects on families, the COVID-19 pandemic disproportionately disrupted the learning of students from economically disadvantaged backgrounds and students of color. Many math teachers who support students from these groups have been working to help their students catch up on higher levels of unfinished learning and may be facing a critical dilemma of how much time they should devote to foundational content before moving into grade-level content.

To illustrate this point, Figure 2 shows how the skipping patterns reported by middle and high school teachers have differed over time. The higher rates of frequent and occasional skipping by teachers in high-poverty schools and schools that predominantly serve students of color support the conclusion that learning recovery has been uneven.

FIGURE 2


(a) student body racial/ethnic composition?

(b) student poverty levels?

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NOTE: This figure shows the proportion of middle and high school math teachers (i.e., secondary teachers) who reported skipping content occasionally or frequently by (a) student poverty levels and (b) student body racial/ethnic composition in spring 2020 (n = 790), spring 2021 (n = 593), and spring 2022 (n = 438) based on the survey item: “Do you ever skip standards-aligned math content in your instruction?” We distributed our spring 2020 surveys just as schools began closing in response to the COVID-19 pandemic. We interpret these results as reflective of a prepandemic context. The displayed percentages were produced using separate weights specific to each survey. Although the cross-sectional comparisons we make between years are useful for describing trends, the weights we employed do not properly account for changes across years or overlap among the sampling pools. Because of rounding, the difference between the proportion of secondary teachers in high- and low-poverty schools during the 2021–2022 school year who reported skipping frequently or occasionally (17.4 percentage points) appears slightly exaggerated by this graph.
During the 2021–2022 School Year, Math Teachers Faced Multiple Challenges to Their Instruction of Standards-Aligned Content

The research team sought to understand some of the challenges faced by teachers in their delivery of standards-aligned content during the 2021–2022 school year that may elucidate ways education leaders can better support math teachers. The team asked teachers about their expectations for students, their perceptions of student readiness, and whether they had the time and resources they needed to provide high-quality math instruction.

In the survey, nearly all teachers reported that they expected their students to work hard at math during the 2021–2022 school year. Most teachers also believed that their students could master key mathematical concepts. However, very few teachers said that all their students started the year with the necessary foundational skills to succeed in their math courses (Figure 3).

A Large Proportion of Teachers Said They Were Unable to Devote Sufficient Time for Math Instruction and Needed Additional Support

Forty percent of K–12 math teachers did not agree that they were able to devote as much time to math instruction as they would have liked during the 2021–2022 school year. Additionally, one-half of teachers said they needed more support for delivering high-quality instruction. Although the researchers did not ask teachers specifically how these factors affected their instruction, survey responses suggest that a large portion of teachers may have felt crunched for time or that they were unable to provide high-quality instruction to the extent they would have preferred.

Teachers in high-poverty schools were more likely to indicate that they needed additional support for delivering high-quality math instruction than their counterparts in low-poverty schools (54 percent compared with 44 percent). These findings, together with the others mentioned in this research brief, demonstrate that many teachers—especially those in high-poverty schools—need more resources and support to deliver high-quality math instruction than they are currently receiving to prepare and support students in their math courses.

FIGURE 3

What Were Math Teachers’ Expectations for Student Learning and Their Perceptions of Students’ Preparedness and Math Identity During the 2021–2022 School Year?

NOTE: This figure is based on math teachers’ responses to the following survey item: “Please indicate your level of agreement or disagreement with the following statements.” Respondents could select strongly disagree, somewhat disagree, somewhat agree, or strongly agree. The bars show the proportion of teachers who somewhat or strongly agreed with the statements shown (response options in this figure are based on weighted percentages of teachers, n = 1,576). Double asterisks (**) indicate that the responses of teachers in a subgroup were significantly different (p < 0.05) from teachers in the counterpart subgroup, before and after controlling for school- and teacher-level characteristics. The vertical lines (whiskers) indicate standard error.
School districts should invest federal and state funding into high-dosage tutoring programs for middle schoolers who attend high-poverty schools.

Prior research suggests that high-dosage tutoring is one of the only proven interventions with the potential to help accelerate the learning of students whose instruction was disproportionately affected by online and hybrid learning. Such programs should support 8th graders already enrolled in algebra I and promote algebra I readiness among middle school students who are not yet enrolled in algebra I.

District leaders should partner with regional postsecondary institutions to identify and implement creative solutions to making high-quality advanced math courses accessible for all high school students.

Students who have the potential to succeed in advanced math courses should have access to them, and access is needed especially for students who attend schools in small, geographically isolated, or underresourced communities. Universities and colleges could assist in developing dual-enrollment or online learning opportunities for students, or they could help create specialized training opportunities for math teachers to increase schools’ capacities to offer advanced math courses on site.

State education leaders and school districts should provide teachers with high-quality, standards-aligned curriculum materials and training to support teachers’ use of these materials.

This is the first critical step toward helping teachers align their instruction with the intended curriculum. This support should provide teachers with guidance on how to bridge grade-level content for students who lack foundational knowledge and increase student engagement overall.

Districts, school leaders, and teachers should develop transparent messaging around the importance of advanced math courses for students and their families.

Many parents may lack information about the long-term benefits of taking advanced math courses and the importance of beginning to prepare for advanced courses in middle school. Therefore, it is essential that school districts adopt a systematic approach to providing families with information they can use to help their children determine which math courses are best suited to their goals and to advocate for additional opportunities for their children to take and prepare for advanced math.

Recommendations

Four recommendations emerged from this study.

1. School districts should invest federal and state funding into high-dosage tutoring programs for middle schoolers who attend high-poverty schools.

2. State education leaders and school districts should provide teachers with high-quality, standards-aligned curriculum materials and training to support teachers’ use of these materials.

3. District leaders should partner with regional postsecondary institutions to identify and implement creative solutions to making high-quality advanced math courses accessible for all high school students.

4. Districts, school leaders, and teachers should develop transparent messaging around the importance of advanced math courses for students and their families.