This RAND Perspective lays out a research agenda for the American Mathematics Educator Study by synthesizing what we know from mathematics education research—including findings from RAND’s American Educator Panel surveys — regarding key factors that shape equitable, high-quality mathematics teaching and learning.

Results from assessments are clear: U.S. students have lost more learning in mathematics and other subjects since the beginning of the coronavirus disease 2019 (COVID-19) pandemic in 2020 than has ever been measured through the National Assessment of Educational Progress (NAEP), which began monitoring students’ mathematics achievement in 1990 (Nation’s Report Card, undated). According to the Education Recovery Scorecard, which drew on NAEP and spring 2022 assessment data, the average U.S. public school student lost a half year of mathematics learning since the COVID-19 pandemic took hold. To make matters worse, achievement gaps in mathematics and reading widened during the pandemic, which means
Public schools can take many steps to improve mathematics achievement. But those steps must keep equity front and center.

that many students experiencing poverty and students of color will have to rebound even more quickly than their more-advantaged counterparts to recover the learning missed during the pandemic (Fahle et al., 2023; Lewis and Kuhfeld, 2022).

The COVID-19 pandemic is just the most recent force widening gaps in mathematics outcomes, such as achievement. U.S. K–12 students have long had uneven access to high-quality mathematics learning opportunities that leads to those widening gaps. Some public middle and high schools do not even offer the rigorous mathematics courses that would put students on a pathway to college and career readiness, such as 8th grade Algebra I or advanced mathematics courses in high school (Wolfe, Steiner, and Schweig, 2023; Walston and Carlivati McCarroll, 2010; Gamoran and Hannigan, 2000). Even when schools offer those rigorous courses, students are often grouped by achievement level into classes (a practice typically called tracking). Researchers who study tracking have observed that students placed on tracks with lower-achieving students receive less grade-level content and more teacher lecturing (Gamoran et al., 1997; Kaufman et al., 2013; Oakes et al., 1990; Schmidt, 2009). In addition, many students who struggle in mathematics do not get the interventions they need, and some interventions are more effective than others (Berkeley et al., 2020; Schumacher, Zumeta Edmonds, and Arden, 2017).

Other sources of inequity are differences in the supports that teachers have to help students learn math. Specifically, some teachers get higher-quality mathematics instructional materials and more professional development to teach math compared with other teachers (Cogan, Schmidt, and Wiley, 2001; Doan, Kaufman, et al., 2022; Short and Hirsh, 2020). In addition, many teachers do not get much, if any, guidance on how to help the students who are struggling with mathematics in their classrooms, especially if those students have disabilities or are English learners (ELs) (Doan, Eagan, et al., 2022; Wang et al., 2023).

As the nation recovers from the pandemic, public schools can take many steps to improve mathematics achievement. But those steps must keep equity front and center by focusing particularly on mathematics learning

<table>
<thead>
<tr>
<th>Abbreviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEP</td>
</tr>
<tr>
<td>AMES</td>
</tr>
<tr>
<td>COVID-19</td>
</tr>
<tr>
<td>EL</td>
</tr>
<tr>
<td>IMPD</td>
</tr>
<tr>
<td>NCES</td>
</tr>
<tr>
<td>SWD</td>
</tr>
</tbody>
</table>
recovery for students who are Black, Hispanic, or experiencing poverty—students whose performance fell precipitously over the past few years. At the same time, we know that teachers and principals have multiple competing priorities, and student and teacher mental health is fragile (Steiner et al., 2022; Viner et al., 2022). Thus, education leaders and policymakers must chart a path that incorporates educator voices, is attentive to equity, and prioritizes student and teacher well-being alongside academic learning.

In 2022, the RAND Corporation launched the American Mathematics Educator Study (AMES), a five-year effort to investigate students’ access to high-quality mathematics learning opportunities and the availability of resources that teachers need to provide those opportunities to students in elementary school all the way through preparation for college and career pathways in high school. AMES will collect, analyze, and report on data from K–12 public school leaders and educators across the United States to

1. provide the field with data from teachers and principals on equity of access to high-quality mathematics instruction and college/career readiness supports
2. partner with organizations to improve dissemination and use of AMES data and findings
3. share data broadly to encourage research and inform decisionmaking.

AMES will field nationally representative surveys to K–12 principals and math teachers each spring from 2023 through 2027 using RAND’s American Educator Panels (AEP); the spring 2023 surveys have already been completed. The study will also collect state-representative teacher and principal survey data in the states of California, Florida, New York, and Texas and will oversample high school principals in Texas and the state of Washington. AMES will supplement the surveys with in-depth interviews with teachers and principals and detailed surveys about instructional practices. AMES will particularly focus on experiences of principals and teachers serving high proportions of Black, Hispanic, and low-income students. We refer to these groups of students as historically disadvantaged or minoritized students throughout this Perspective.

Beyond AMES, RAND researchers have been documenting educator perspectives on math instruction through numerous teacher, principal, and district surveys fielded through the AEP. These surveys have produced insights about students’ opportunities to access math courses and the resources teachers need to teach grade-level math equitably and effectively.

In this Perspective, we

- provide a conceptual framework for understanding how opportunities for students and resources for teachers are connected with equitable, high-quality mathematics instruction for historically disadvantaged students
- synthesize what we know from AEP surveys and extant research about these opportunities and resources
- offer near-term recommendations for mathematics education policies and practices based on the research
- lay out a research agenda for AMES that draws on what we know and what we need to know.

We also discuss how our research could be useful to many different groups who have a stake in ensuring that all U.S. students have equitable, high-quality learning
opportunities in mathematics—not only researchers, but also state policymakers, district and school administrators, teachers, parents, and students themselves.

Our Conceptual Framework

Figure 1 provides a conceptual framework describing research-based factors that have been linked to equitable, high-quality mathematics teaching and learning. This framework highlights the importance of (1) mathematics learning opportunities all students need to succeed in school, college, and/or career along with (2) resources that will help teachers deliver instruction within classrooms at the level of rigor and quality students need.

Mathematics Learning Opportunities for Students

By opportunities for students, we mean the mathematics courses and pathways to which students have access and interventions to help students who may be struggling with mathematics. As we will discuss, whether students have access to advanced mathematics courses can depend on where they go to school. Even when schools do offer advanced mathematics courses, certain students may be more likely to have access to those courses than other students. Beyond just being able to enroll in an advanced course, some students who are struggling with mathematics across grade levels do not get the interventions they need to ensure their success. All these barriers translate to big differences in which students are likely to enroll and succeed in advanced mathematics courses, depending on where they live and the school they attend.

Resources for Teachers

By resources for teachers, we mean the array of tools teachers need to deliver high-quality, equitable mathematics instruction. First, teachers need high-quality instructional materials, which we define as materials that are aligned with grade-level standards and provide opportunities for all
students to learn mathematics. At the same time, we know from abundant research—which we summarize in more detail below—that simply providing teachers with those materials does not guarantee better, more standards-aligned instruction for all students. In addition to good instructional materials, teachers need curriculum-aligned supports to use those materials thoughtfully and well. Those kinds of supports can come in various forms, from teacher professional learning communities to guidance from principals to curriculum-aligned assessments, among other resources. Lastly, teachers need lots of guidance for serving the diverse needs of students within their classrooms. That guidance could come in the form of instructional materials, as well as professional learning and other types of resources.

What Do We Know About Student Opportunities for Mathematics Learning?

Taking Advanced Mathematics Courses Is a Key Predictor of Students’ Success, yet Many Historically Disadvantaged Students Do Not Have Access to Those Courses

What We Know from Extant Research

We defined advanced mathematics courses as math classes that high school students can take after completing Algebra II (Byun, Irvin, and Bell, 2015); examples include pre-calculus, calculus, courses in probability and statistics, and Advanced Placement math courses. Figure 2 represents a notional, but typical, set of math course pathways students typically follow from middle school through high school.

In general, a student who takes Algebra I in 8th grade could take advanced math courses in 11th grade and 12th grade rather than only in 12th grade. Of course, students who take Algebra I in 9th grade and who also take accelerated math courses, or take math courses in summer school, could access advanced math courses in 11th grade. However, they would need to put in some extra work to get to those courses relative to their peers who take Algebra I in 8th grade. Math pathways in some schools start with an integrated math course in 8th grade (labeled Math 1 in the figure), followed by two additional integrated math courses that typically intend to address the content across Algebra I, geometry, and Algebra II in a more integrated way. That pathway also sets up students for advanced math courses by 11th grade.

Algebra I has been called a “gatekeeper to higher mathematics,” and when to offer or allow students to access Algebra I is the subject of ongoing debate (Schwartz, 2023; Stein et al., 2011). Taking Algebra I in 8th grade paves the way for students to take at least two years of advanced math courses in high school (e.g., Irizarry, 2021). Yet, nationally, Black and low-income students are less likely to take Algebra I in 8th grade than White and higher-income students, despite some evidence that it can help raise math achievement and participation in advanced math courses in high school (McEachin, Domina, and Penner, 2020; Walston and Carlivati McCarroll, 2010).

One reason students do not take advanced mathematics courses is that they may not be offered by their school. For example, many schools do not offer algebra in 8th grade, which limits how many advanced math courses students in those schools can pursue down the line (Coburn et al., 2012; National Center for Education Statistics, 2019b; Schmidt, 2009). High schools with higher-
poverty students are up to 40 percentage points less likely to offer calculus than lower-poverty high schools (Leung-Gagné et al., 2021; U.S. Government Accountability Office, 2018). Large high schools and noncharter schools are also more likely to offer calculus and AP courses than smaller schools (U.S. Government Accountability Office, 2018).

But just offering advanced courses to all students is not a clear-cut solution. For example, although giving all students access to Algebra I in 8th grade can increase enrollment in Algebra I among prepared students, it can also increase enrollment among students who are underprepared, reinforcing the need for interventions or supports to boost student math achievement (McEachin, Domina, and Penner, 2020; Stein et al., 2011). Offering Algebra I in 9th grade can increase the number of students who are prepared for the course, but it can also limit students’ opportunities to take more advanced math in high school and preserve—or exacerbate—ethnoracial gaps in advanced coursetaking (Huffaker, Novicoff, and Dee, 2023).

Another issue keeps some students who might otherwise succeed in advanced math courses from taking them: tracking of students into different classes by their achievement level. Students placed in higher-achieving classes from as early as elementary school are more likely to have access to Algebra I in 8th grade and advanced math courses in high school (Stein et al., 2011). Furthermore, students tracked into higher-achieving classrooms typically receive more opportunities to ask questions, engage in mathemat-
ics reasoning, and have access to more grade-level content than their peers in lower-achieving classes (Domina et al., 2019; Donaldson, LeChasseur, and Mayer, 2017; Gamoran and Mare, 1989; Oakes et al., 1990).

Subjective factors in how students are identified to take one course versus another—such as teacher nomination, interaction with guidance counselors, or parental involvement—can lead to deep inequities in which students get placed on higher versus lower tracks (Hallinan, 1994; Schmidt et al., 2015; Stone, 1998; Wronowski et al., 2022). At the same time, students who are identified to receive remedial coursework based on test-based measures—which are often deemed less subjective—may potentially be placed in lower-track classes that inhibit their future success (Figlio and Özek, 2023).

What We Know from the AEP

Our AEP surveys fielded to teachers and school leaders over the past few years have tracked students’ access to and participation in math courses, from Algebra I in 8th grade to advanced mathematics courses in high school. Much of these data have been gathered more recently than the research we have summarized above.

According to principal reports, schools serving mostly students of color were 14 percentage points less likely to report offering Algebra I in middle school than schools serving mostly White students during the 2021–2022 school year. Furthermore, only 25 percent of principals in schools with middle grades that offered Algebra I reported that this course was open to any student who wanted to take it (Wolfe, Steiner, and Schweig, 2023). Principals in higher-poverty schools and those serving more Black or Hispanic students also reported offering fewer advanced math courses in high school and seeing less participation in those courses among students intending to go to college (Wolfe, Steiner, and Schweig, 2023).

Implications for Policy and Practice Right Now

Education leaders and policymakers could consider the following strategies to support more advanced math coursetaking:
One key barrier to expanding mathematics course offerings in some schools is a dearth of highly qualified mathematics teachers.

- **Schools could educate parents early and often about the importance of advanced math coursetaking.** School districts should consider a systematic approach to educating parents about the importance of advanced math, starting in middle school. For example, middle schools could provide parents with transparent information about where math courses lead and offer families resources that they can use at home to support their children’s interest and learning in math.

- **Schools that do not have the capacity to offer advanced math courses could get incentives and support to offer them.** Students should not be shortchanged just because their school does not (or is not able to) offer early algebra or more-advanced mathematics courses. Policymakers should provide incentives for those schools to provide such courses through dual enrollment or online learning. Such opportunities could be particularly powerful for students who attend small high schools or high schools in geographically isolated or historically under-resourced communities.

- **Schools should identify and work to eliminate barriers that keep students from enrolling and succeeding in advanced math courses.** By examining who enrolls in advanced courses, districts and schools could reflect on all the biases that hinder enrollment for traditionally disadvantaged students. These barriers might include subjective determinants of who gets in advanced courses and advanced coursetaking tracks; inadequate early support that prepares students to enroll in those courses; and lack of intervention or support for students who are struggling in more advanced courses. We discuss these latter two barriers in more detail in the upcoming sections of this report.

- **States could provide more pathways for training and hiring more math teachers who are highly qualified.** One key barrier to expanding mathematics course offerings in some schools is a dearth of highly qualified mathematics teachers. Financial incentives—such as higher starting salaries or loan forgiveness—could improve hiring and retention. School leaders could also consider collaboration with local teacher training programs to find the teachers they need.

**Implications for AMES and Additional Research**

These data make clear that providing students with multiple opportunities to take advanced mathematics courses in high school hinges on access to Algebra I in 8th grade and
depends, in part, on school context. Future research could particularly explore (1) disparities in advanced mathematics course offerings in secondary schools and their causes; (2) disparities in the criteria schools use to assign students to mathematics courses (e.g., test scores, parent or teacher recommendations) and their impacts on coursetaking and student learning; (3) how opportunities to take advanced mathematics courses are communicated to students and parents and how communication ameliorates or exacerbates disparities in math coursetaking; and (4) which math coursetaking policies and practices support more-equitable, high-quality mathematics learning opportunities.

Many Struggling Students Likely Do Not Have Access to the Math Interventions They Need, Particularly in the Early Grades

What We Know from Extant Research

Simply giving all students access to advanced mathematics courses is not going to be an effective solution to providing equitable mathematics learning opportunities for all. For example, in schools that have offered universal Algebra I as early as 8th grade, studies have documented increases in numbers of students failing algebra and mixed evidence of increased achievement (Stein et al., 2011). These patterns make logical sense. A push to enroll more students in challenging courses means that at least some of those students may not be ready to take those courses. Thus, any serious efforts to expand access to advanced courses for all students would ideally offer interventions beyond what is available within the courses themselves, as well as guidance to help teachers meet the diverse needs of students enrolled in those courses. In this section, we focus on mathematics interventions. Later, when we discuss resources, we consider the resources teachers need to offer effective differentiated instruction.

Studies have documented several potential Tier 2 interventions that can help students access grade-level mathematics content in their courses. For example, teachers’ just-in-time approaches within whole-class instruction could have a positive impact if the teacher can closely monitor and diagnose when students are having trouble themselves or through adaptive courseware (Pane et al., 2013; TNTP, 2021). Well-designed Tier 2 mathematics interventions that focus on explicit modeling, underlying problem structure, use of visual and thoughtfully sequenced models, and providing corrective feedback can improve mathematics performance among students with mathematics difficulties (Jitendra, et al., 2021). High-dosage tutoring, adaptive software, and summer learning programs are all interventions that have also yielded positive effects on student learning (Bettinger et al., 2023; McCombs et al., 2020; Pane et al., 2014; Robinson et al., 2021). In addition, increased instructional time—in the form of an extra mathematics class for students who struggle in their core academic class—has been connected to greater success among students in universal 9th grade algebra in Chicago (Nomi and Allensworth, 2009). Yet, many students who are struggling in their math courses do not always get the interventions they need—such as tutoring—to help boost their achievement and enable them to access higher-level math courses (Hendricks and Fuchs, 2020; Nelson et al., 2022; Nelson and Powell, 2018).

1 Tier 2 interventions are intended to provide additional support beyond core mathematics instruction for students who demonstrate some academic risk or mathematics difficulties but do not demonstrate multiple or persistent learning needs.
Students in low-income schools struggling with math content likely receive less access to math specialists than their higher-income counterparts.

What We Know from the AEP

Prior to the COVID-19 pandemic, our AEP research suggested that early intervention for English language arts (ELA) was much more prevalent than early intervention for mathematics. Although more than 70 percent of elementary teachers reported that they used interventions for ELA during the 2018–2019 school year, only a little more than half of elementary teachers said the same for mathematics interventions (Stelitano et al., 2020). Furthermore, although teachers in lower-income schools were slightly more likely to report ELA interventions than those in higher-income schools, prevalence of math intervention did not vary by school poverty (Stelitano et al., 2020), even though we know that students in higher-poverty schools have a greater likelihood of struggling in mathematics. These data imply that students in high-poverty settings may not be getting the interventions they need.

The widened achievement gaps because of COVID-19 mean that historically disadvantaged students will need more mathematics intervention to recover than ever before. According to our AEP research, schools that were fully remote for a majority of the 2020–2021 school year in an attempt to mitigate the health impacts of the COVID-19 pandemic were also schools that disproportionately served more students of color and more low-income students. Teachers and principals in schools that were fully remote were much more likely to report less instructional time and less curriculum coverage in mathematics than their counterparts in fully in-person schools (Diliberti and Kaufman, 2020; Kaufman and Diliberti, 2021). Estimates of incomplete student assignments and absenteeism were almost twice as high among teachers who were remote compared with teachers in fully in-person settings (Kaufman and Diliberti, 2021).

As schools returned to in-person learning during the 2021–2022 school year, about 60 percent of all K–12 math teachers said that their struggling learners were able to obtain access to tutoring or other supports to help them succeed in their math courses. However, Kaufman and Diliberti (2021) found that teachers in higher-poverty schools with more students of color reported about the same amount of student access to a math specialist—if not slightly less access—compared with their peers in mostly White and higher-income schools. Given that we know that students in lower-income schools and schools with more students of color are more likely to struggle in mathematics, students in low-income schools struggling with math content likely receive less access to math specialists than their higher-income counterparts.
Implications for Policy and Practice Right Now

Education leaders and policymakers could consider investing federal and state funding in the following strategies:

- **Ensure that students who struggle are identified for additional support.** Students cannot get access to intervention if they are not identified and encouraged to access such supports. Schools that adopt systematic, evidence-based means of identifying struggling students (e.g., through development of criteria and assessments to diagnose students’ progress in mathematics and their needs) are better equipped to keep students from falling through the cracks.

- **Ensure access to effective interventions for struggling students.** Such interventions could occur within or outside the classroom. Some research suggests that additional instructional time via such methods as high-dosage tutoring or a “double dose” of mathematics (via students’ regular academic class and an additional support class) could boost students’ math performance. Adaptive software, if carefully implemented, also has the potential to boost mathematics achievement. Other potential interventions include those that provide mathematics instruction through summer programming.

Implications for AMES and Additional Research

We need to learn more about how schools support struggling students in mathematics. AMES and additional research should explore (1) the extent to which students across grade levels struggle in their mathematics classes, how schools identify such students, the support to which those students have access and the extent to which they participate; (2) the perceived efficacy of those supports for helping students access grade-level and more rigorous mathematics course-taking; and (3) what additional policies and supports students need to boost their mathematics instruction, especially in high-poverty schools and schools with more students of color.

What Do We Know About Resources That Support Mathematics Learning?

High-Quality Instructional Materials Can Support Teachers to Provide Standards-Aligned, Culturally Relevant Mathematics Instruction; States Can Make a Difference in Adoption and Use of Those Materials

What We Know from Extant Research

The instructional materials teachers use influence the mathematics topics they cover and how they teach those topics (Stein and Kaufman, 2010; Tarr et al., 2008) as well as play a role in boosting student achievement (Steiner, 2017). It thus stands to reason that when teachers use curriculum materials that are closely aligned to state academic standards, they should then use more standards-aligned instructional practices. However, many widely used math instructional materials are not well-aligned with state standards, according to independent curriculum reviews from organizations such as EdReports (2022). Furthermore, the adoption of standards-aligned materials does not automatically guarantee better mathematics teaching and learning. A recent study across several states...
to assess the efficacy of standards-aligned elementary mathematics textbooks found no differences in achievement among students who did or did not use those materials (Blazar et al., 2019). One likely explanation for these mixed effects of curriculum materials is that teachers do not always receive the help they need to use those materials well. (We consider all the curriculum-aligned supports necessary to help teachers use their materials well in the next section.)

Other dimensions of quality for instructional materials—beyond alignment to state standards—likely matter when it comes to boosting student achievement. For example, materials that embed guidance and support for teachers can help teachers use those materials thoughtfully (Davis and Krajcik, 2005; Stein and Kim, 2011). In addition, materials that connect mathematics instruction to students’ lived experiences and cultural background can help promote student engagement, confidence, and math achievement (Aronson and Laughter, 2016; Hubert, 2014).

What We Know from the AEP

The AEP American Instructional Resources Survey has monitored adoption and use of standards-aligned materials in a network of states that have implemented reforms to improve use and supports for such materials: the Council of Chief State School Officers (CCSSO) High-Quality Instructional Materials and Professional Development (IMPD) Network. States in the IMPD Network believe that high-quality instructional materials and connected professional learning can ensure that students have access to high-quality, standards-aligned instruction (CCSSO, 2022). We define high-quality instructional materials and standards-aligned curriculum materials in the text box. The

High-Quality Instructional Materials and Standards-Aligned Curriculum Materials

In this report, we refer to high-quality instructional materials as materials that U.S. states explicitly encourage K–12 school systems to adopt and teachers to use. These materials include both standards-aligned materials and those materials that meet other criteria for quality on the basis of state priorities and focuses. For instance, states may have their own curriculum review processes that incorporate elements like cultural relevance.

In our AEP research, we refer to standards-aligned curriculum materials as any materials that have been rated as fully meeting expectations of college- and career-ready standards. We draw on the ratings of EdReports, a nonprofit organization that conducts reviews of commonly used curriculum materials.

IMPD Network provides states with a policy roadmap of strategies that might encourage more use of high-quality materials, including

- enhancing transparency around the quality of curriculum materials by conducting curriculum reviews and making them publicly available
- providing schools and districts with guidance on curriculum selection through guidance documents or district cohorts
- tying eligibility for funding, grants, or supports to high-quality instructional material adoption
- reducing the administrative burden or cost to districts of adopting high-quality instructional materials through the use of statewide contracts (Doan et al., 2022b).
Figure 3 provides an illustration of the theory of action for the IMPD Network and specifically offers the hypothesis that when states provide strategies encouraging adoption of standards-aligned materials, those strategies can translate to higher adoption and use of such materials. Our research to date indicates these state strategies are, indeed, making a difference in the percentage of teachers actually using high-quality materials. Teachers within IMPD Network states report higher district adoption of standards-aligned mathematics materials than teachers in states outside the IMPD Network (Doan, Kaufman, et al., 2022). At the same time, such organizations as EdReports—which provide independent information about the quality of instructional materials—and IMPD Network states themselves may be influencing other states and school systems to adopt standards-aligned materials. In the 2018–2019 school year, only 34 percent of teachers reported using standards-aligned math curricula. By the 2021–2022 school year, this percentage rose to 49 percent (Kaufman, Doan and Fernandez, 2021; Woo and Steiner, 2023).

Of course, adoption of standards-aligned materials is but one necessary step. Teachers must also use the materials. Yet, we have found that teachers who use standards-aligned materials tend to modify them (Kaufman et al., 2020). One way teachers modify their materials is by skipping content that they think students may not be able to handle. Nearly one-third of math teachers nationally reported skipping standards-aligned content occasionally or frequently during the 2021–2022 school year. Since pandemic-related school closures began, the skipping of standards-aligned content has become more prevalent (Wolfe, Steiner, and Schweig, 2023). One reason teachers might skip standards-aligned content is that they perceive it to be too challenging for their students. In one AEP study, teachers who used standards-aligned materials were more likely to perceive their materials as too challenging compared with teachers not using standards-aligned materials—a challenge that is even more acute for teachers serving many struggling learners (Wang et al., 2021). Regardless of the reasons why teachers are skipping standards-aligned content, these results point to widening inequities in students’ access to standards-aligned, grade-level content. Lack of access to grade-level content compounds over time, with the result that students are unlikely to be prepared for advanced math courses in high school. Yet, when math teachers reported using least one standards-aligned material regularly, they were more likely
FIGURE 3
IMPD Network Theory of Action

Focus on HQIM as defined by individual states

State actions

A. State signals and incentives, and/or mandates for adoption of HQIM

School or district actions

B. School or district adopts standards-aligned curriculum materials

C. School or district provides standards-aligned supports:
   - Principal encourages use of standards-aligned curriculum
   - School/principal incorporates curriculum use into observations
   - School or district provides curriculum-specific professional learning, such as collaborative learning, coaching, and workshops

Focus on standards-aligned curriculum materials, as rated by EdReports

Teacher perceptions and actions

D. Teacher buy-in for standards-aligned curriculum materials

E. Teachers' regular use of standards-aligned curriculum materials

Teacher and student or student actions

F. Teacher engages students in standards-aligned classroom practices

G. Student learning

Focus of IMPD Network states

SOURCE: Adapted from Doan, Kaufman, et al., 2022.
NOTE: HQIM = high-quality instructional materials.
to report that their students engaged in standards-aligned practices, such as explaining and justifying their work, applying math to solve real-world problems, and critiquing the reasoning of others, than teachers not using any standards-aligned materials (Opfer et al., 2018).

Implications for Policy and Practice Right Now

Education leaders and policymakers could consider the following strategies to support adoption and use of high-quality instructional materials:

- **States can make the adoption of high-quality curriculum materials easy and attractive for schools and districts.** IMPD Network states have adopted a variety of strategies that are likely encouraging more adoption and use of materials, from making that adoption mandatory in some or all school systems to making adoption of those materials more affordable and easier for school systems. Other states that adopt such strategies could see similar effects.

- **Greater school leader and educator understanding about the quality of instructional materials could make a difference for what materials are adopted in school systems and the quality of instruction.** When states—and such organizations as EdReports—provide information about quality of instructional materials, that information can translate to more adoption and use of those materials.

- **Education leaders and state policymakers must keep in mind that adoption of high-quality materials does not equate with use of those materials in classrooms.** In the next section of this Perspective, we discuss the system of supports that likely leads to teachers’ more-intensive use of adopted curriculum materials.

When math teachers reported using least one standards-aligned material regularly, they were more likely to report that their students engaged in standards-aligned practices.

Implications for AMES and Additional Research

The field would benefit from a closer examination of the specific state policies and strategies that might be driving higher district adoption and teacher use of high-quality mathematics materials, as well as the within-school factors that encourage intensive use of such materials. AMES and additional research could specifically explore (1) how state policies that encourage more adoption and use of high-quality mathematics materials are associated with more use of high-quality mathematics materials; (2) how use of high-quality mathematics materials is related to improved teaching and learning; and (3) the extent to which state and
Curriculum materials alone are unlikely to have substantive impacts on instruction unless they are accompanied by an architecture of supports that help teachers use those materials. District limitations on the discussion of race- and gender-related topics are connected to the provision and use of culturally relevant instructional materials.


What We Know from Extant Research

As discussed above, adoption of standards-aligned materials without other supports is no guarantee that teachers will use them, and even teachers who use those materials regularly modify them considerably in many ways. Thus, curriculum materials alone are unlikely to have substantive impacts on instruction unless they are accompanied by an architecture of supports that help teachers use those materials. For example, several studies have linked students’ mathematics achievement gains to the provision of curriculum-aligned professional development for teachers (Hill et al., 2020; Jackson and Makarin, 2018). Similarly, Coburn et al. (2012) found that teachers who had frequent opportunities to have substantive conversations about mathematics instruction with other expert teachers were less likely to lower the cognitive demand of mathematics tasks they drew from their curricula and more likely to encourage high-quality student discussions about mathematics. Likewise, Jackson, Webster, and Wilson (2018) found that both pull-out professional development and collaborative conversations with other teachers during within-school, grade-level meetings were important for improving teachers’ instruction.

What We Know from the AEP

Teachers likely need an array of curriculum-connected resources and supports—including curriculum-aligned professional development, teacher preparation, and assessments—to use their adopted curriculum materials regularly and productively. We refer to this array of supports as a coherent instructional system (Polikoff et al., 2020). For example, teachers who reported receiving more curriculum-based professional learning and evaluative feedback from their school principal on their use of their curriculum materials also reported more intensive use of their mathematics curriculum (Kaufman et al., 2020). Our work in the IMPD Network states suggests that a strong system of support for use of materials includes both state systems and school district systems (Doan, Eagan, et al., 2022). Teacher preparation is another avenue to support
Teachers who perceived their systems to be more coherent were less likely to modify their curriculum materials and more likely to say that they experienced strong instructional leadership, a clear vision for instruction, and a culture of continuous improvement.

Implications for Policy and Practice Right Now
Education leaders and policymakers could consider the following strategies to support use of high-quality instructional materials:

- Provide teachers with curriculum-aligned professional development that supports teachers in the use
of high-quality curriculum materials and scaffolding of standards-aligned content. Much research from the AEP underscores the importance of curriculum-based professional learning for improving use of that curriculum and its potential efficacy.

- **Support alignment between teachers’ curricula and other resources intended to support their instruction.** Beyond curriculum-based professional learning, numerous other aspects of instruction can support teachers to use their curriculum thoughtfully and productively to help students learn. Curriculum-aligned benchmark assessments, for example, likely help teachers to meet students’ needs by helping them use their curricula in a more data-driven way, and aspects of evaluation that integrate and encourage use of curriculum send teachers a clear message on what instructional materials they should be using and how they should be using those materials.

**Implications for AMES and Additional Research**

While we know that curriculum-based professional learning can support both teachers’ use of curriculum and students’ math learning, we know less about the ways in which a system of standards-aligned, curriculum-based supports can achieve those outcomes. Through AMES, we intend to examine that system of supports systematically, both through surveys and qualitative research, to understand what resources are most useful to teachers and students.

**Teachers Report They Are Not Getting Adequate Resources to Support Diverse Student Needs**

**What We Know from Extant Research**

U.S. public school students are becoming more racially diverse. In 2021, more than half of public school students were people of color (National Center for Education Statistics [NCES], 2023c). ELs and students with disabilities (SWD), too, are a growing portion of the total student population, accounting for 10 and 15 percent of public school students, respectively (NCES, 2023b; NCES 2023d). Additionally, nearly 20 percent of children live in poverty (NCES, 2023a). Students in these groups come to school with a wide variety of needs.

Often, teachers are serving many of these vulnerable student groups together in the same classroom, in part because many of these student groups overlap. For instance, Black, Hispanic, and American Indian or Alaska Native students are overrepresented among students experiencing poverty (NCES, 2019a), nearly all ELs are students of color (NCES, 2023b), and students of color are also over-
represented among SWD (National Center for Learning Disabilities, 2020). Moreover, consistent with the principle of educating SWD in the least restrictive environment, as established in the Individuals with Disabilities Education Act (U.S. Code, Title 20, Section 1412), more than 90 percent of SWD are enrolled in traditional schools. Two-thirds of SWD in traditional schools spend 80 percent or more of their time in general education classes (NCES, 2023d). The diversity of public school students underscores the importance of ensuring that teachers are well equipped to meet the varied needs of the students in front of them.

Many teachers face challenges when trying to tailor their instruction to meet the diverse needs of the students they teach. When presenting challenging mathematics tasks to students, teachers often reduce the cognitive demand of those tasks by doing “too much” for students instead of allowing them to struggle (Stein, Grover, and Henningsen, 1996). In classrooms with mixed needs and abilities, teachers may particularly struggle with adapting their lessons to meet each student at their own level without lowering the rigor of their instruction (Tomlinson et al., 2003).

Moreover, while the U.S. student population grows more racially and ethnically diverse, White teachers make up most of the teacher workforce, even though research has shown that students of color especially benefit from having teachers of color (Gershenson et al., 2022). This may be because, as one experimental study found, teachers of color are more likely to engage in culturally responsive practices, which includes differentiating their instruction to meet students’ varied needs (Blazar, 2021). Teachers’ expectations can also influence student achievement, which is concerning because some White teachers have lower expectations of their Black students than they have of their White students (Papageorge, Gershenson, and Kang, 2018).

Researchers have identified a few ways to support teachers to meet students’ varied needs and help them maintain the rigor of their instruction. For example, teachers who had the opportunity to engage in conversation with expert teachers about their math instruction were more likely to maintain the cognitive demand of the math tasks they presented to students (Coburn et al., 2012). Curricula that contain supports within the materials—such as clear objectives and focuses and explicit information to help teachers understand the mathematical ideas in the lessons—can also help teachers implement their challenging curricula while maintaining the intended level of cognitive demand (Davis and Krajcik, 2005; Stein and Kaufman, 2010). In addition, research has emphasized the importance of differentiated instruction, or instruction that is tailored to the needs of individual students within a classroom. Differentiated instruction is most effective when it is carefully planned and paced and allows for small-group settings (Tomlinson et al., 2003), and profes-

Teachers often reduce the cognitive demand of those tasks by doing “too much” for students instead of allowing them to struggle.
sional learning focused on differentiation can support teachers’ self-efficacy around differentiating instruction in their classrooms (Dixon et al., 2014).

**What We Know from the AEP**

Our AEP surveys consistently indicate that teachers do not feel they are getting adequate support to meet diverse students’ needs. As recently as the 2021–2022 school year, most teachers reported that they do not get sufficient guidance about how to support the needs of traditionally underserved students (e.g., students performing below grade level, ELs), SWD, or Black or Hispanic students (Wang et al., 2022; Wang et al., 2023). Furthermore, most teachers reported getting little to no guidance to address equity and diversity in their mathematics instruction (Wang et al., 2023). Perhaps because teachers lack sufficient supports to meet the diverse needs of their students, more than three-quarters of math teachers nationally reported that they skipped standards-aligned content during the 2021–2022 school year, and, of these teachers, about half said that they replaced that content with content from prior grade levels. Teachers serving high-poverty schools were even more likely than their counterparts to say that they skipped standards-aligned content occasionally or frequently and were more likely to say that they replaced their skipped content with review from prior grades (Wolfe, Steiner, and Schweig, 2023).

Provision of better materials could help teachers differentiate their instruction. In spring 2022, more than half of math teachers said they needed math materials that provided more scaffolds or supports to help students master grade-level content, and about half of math teachers said they needed more or better materials to provide options for ELs and SWD (Doan, Eagan, et al., 2022). And most teachers reported that the math curriculum materials required or recommended by their schools or districts were not adequate for helping them provide culturally relevant instruction, reflecting students’ interests or experiences, or reflecting the diversity of identities within their classrooms (Doan, Eagan, et al., 2022). Furthermore, about four in ten math teachers also reported that they had a need for more or better math materials for activating students’ diverse cultural background knowledge (Doan, Kaufman, et al., 2022).

Professional learning is another lever for improving teachers’ ability to meet the needs of their diverse learners. Before the pandemic, math teachers identified differentiation of instruction and cognitively demanding, standards-aligned practices as the areas where they most needed professional learning (Hamilton et al., 2016). In 2022, more than half of teachers said that their professional learning opportunities did not provide much information about supporting ELs and students with individualized educational plans or 504 plans, and using required curriculum materials (Zuo, Doan, and Kaufman, 2023). Professional learning about culturally relevant approaches is also relatively uncommon. About two-thirds of math
teachers nationally reported that their professional learning placed no emphasis or only a little emphasis on the tenets of culturally relevant pedagogy, such as selecting and using culturally responsive instructional materials, reflecting on their cultural lenses and personal biases, and implementing culturally relevant pedagogy (Doan, Zuo, et al., 2022).

Implications for Policy and Practice Right Now

Education leaders and policymakers could consider the following strategies to give teachers the support they need to meet diverse student needs within their classrooms:

- *Help general education teachers partner better with special educators and English language specialists to provide a system of supports for students.* English language and special education specialists have expertise that could potentially better support general education teachers who serve ELs and SWD. Opportunities for common planning might be one way to support collaboration between lead teachers and specialists serving ELs and SWD who may pull students out of their regular classes regularly to provide additional support or provide support alongside teachers of record within classrooms.

- *Provide teachers with standards-aligned tools that help them differentiate effectively.* According to our AEP data, teachers reported that curriculum materials with built-in scaffolds can help ensure that the instructional materials they use are appropriately challenging. For example, teachers told us that materials that moved from procedural or concrete to conceptual and those that progressed gradually in difficulty allow students the opportunity to practice and build their confidence. Math teachers also felt it was helpful when problems or tasks were “chunked” into digestible parts and when materials helped students build their academic math vocabulary so that reading comprehension did not act as a barrier to the development of students’ math skills (Wang et al., 2021). Policymakers should consider these curriculum characteristics or strategies when reviewing curricula for adoption or considering professional development topics.

- *States and school systems could include the principles of culturally relevant pedagogy in curriculum review processes and provide professional learning on culturally relevant teaching practices.* Many states already
have their own curriculum review processes or rely on information provided by such organizations as EdReports. However, many of these processes do not include the cultural relevance of curriculum materials as a criterion in their review. The Massachusetts Department of Elementary and Secondary Education (MA DESE) provides one example of how cultural relevance can be woven into the curriculum review process: They review the extent to which curriculum materials ask students to “engage with meaningful, culturally and historically relevant, real-world problems” (MA DESE, 2023). Other states could consider weaving such criteria into their own rubrics. However, as we have discussed previously, teachers often need such supports as professional learning to effectively implement curricula, so efforts to implement the use of culturally relevant curricula should be paired with professional learning on culturally relevant tenets.

Implications for AMES and Additional Research

Teachers we survey regularly report that they do not receive adequate guidance to support the diverse needs in their classrooms. Yet, we do not know enough about what supports might be most effective for different students in different contexts. Through AMES, we will continue to ask mathematics teachers what guidance and support they receive to serve traditionally disadvantaged students and those who struggle within their classes, and we will also ask them what types of supports could be particularly helpful, especially when teachers are using standards-aligned curriculum materials.

Our Next Steps

Figure 4 summarizes the proposed AMES research agenda we outlined throughout this Perspective. For this research agenda to improve mathematics teaching and learning, we know that it must:

1. Focus on research questions that address the needs of specific audiences that have a material stake in K–12 mathematics teaching and learning: state and district policymakers, school leaders, teachers, parents, and students.

2. Identify critical findings and solutions arising from those questions through reflection and partnership with those groups and ensure those solutions are actionable, practical, and concrete.

Because of the importance of partnering with these groups, we have begun to sketch out how our proposed research agenda provides supports and could speak to the needs of those groups. Preliminarily, we believe our research could support

- **state policymakers**—by identifying models for state policies and state-provided resources that are associated with improved and more equitable mathematics coursetaking and achievement

- **district and school administrators**—by bringing the needs of teachers, parents, and students for improvements to mathematics education to administrators’ attention and working with them to identify what those needs imply for critical changes to education systems

- **teachers**—by bringing the needs of parents and students for improvement to mathematics instruction to teachers’ attention and providing concrete
FIGURE 4
Research Agenda for Investigating Opportunities for Students and Resources for Teachers to Support Equitable Mathematics Instruction

Research questions related to rigorous mathematics coursetaking for all students:
- What are the disparities in advanced mathematics course offerings and criteria used to place students into mathematics courses?
- What are the potential impacts of these disparities?
- How are opportunities to take advanced mathematics courses communicated to families?
- How are mathematics coursetaking policies connected with equitable, high-quality mathematics learning opportunities?

Research questions related to coherent systems of supports aligned with instructional materials:
- What disparities exist in access to instructional resources that align with both mathematics standards and curriculum materials?
- How do coherent systems of curriculum-based supports improve math teaching and learning?

Research questions related to adoption and use of high-quality instructional materials:
- How are state policies related to greater use of high-quality mathematics instructional materials?
- How is use of high-quality mathematics materials associated with improved math teaching and learning?
- How are state and district limitations on race- and gender-related topics connected to the provision and use of culturally relevant instructional materials?

Research questions related to interventions to help students master grade-level content:
- To what extent do students struggle in their mathematics classes?
- What are the disparities in mathematics intervention options that struggling students receive?
- To what extent do interventions help students master grade-level content and pass more-rigorous mathematics courses?

Research questions related to supports to help teachers meet students’ diverse math learning needs:
- What are the disparities in the resources and guidance that teachers receive to meet students’ diverse needs in math?
- What resources and guidance would be most useful to teachers for serving diverse populations, especially when they use standards-aligned mathematics instructional materials?
suggestions for what they could do to support their own professional learning and students’ mathematics learning without straining their capacity

• parents and students—by helping them better understand how education systems support or stand in the way of equitable, high-quality mathematics learning opportunities for all students and how they can advocate to increase chances that students will take and succeed at advanced mathematics courses in high school.

Our team fielded the first AMES surveys of teachers and principals in March and April of 2023. We will field AMES surveys yearly through spring 2027. We partnered with advisers in college and career pathways, mathematics instruction, mathematics curricula, and educational equity to develop the survey questions. These advisers include researchers, former teachers, and equity advocates, as well as high school students and recent high school graduates. We will also conduct in-depth interviews with teachers and principals about mathematics instruction and pathways to college and career readiness to understand the “why” behind the survey responses.

We plan to release several reports based on AMES data throughout the 2023–2024 school year, starting with two reports focused on students’ equity and access to mathematics learning opportunities that will focus, respectively, on (1) kindergarten through 8th grade mathematics learning opportunities and (2) mathematics learning opportunities in high school. We will continue partnering with these advisers to get input on our reports, which will aim to offer some of the supports to various groups we enumerated above. Avenues of dissemination will include public reports that are freely available on the RAND website, webinars, social media, and researcher and practitioner conferences. Lastly, we will make the AMES data available for the public benefit through the AEP data portal and through Bento, a customizable data visualization tool purpose-built for exploration of AEP data.
References


CCSSO—See Council of Chief State School Officers.


MA DESE—See Massachusetts Department of Elementary and Secondary Education.


NCES—See National Center for Education Statistics.


Steiner, David, *Curriculum Research: What We Know and Where We Need to Go*, Standards Work, March 2017.


U.S. Code, Title 20, Education; Chapter 33, Education of Individuals with Disabilities; Subchapter II, Assistance for Education of All Children with Disabilities; Section 1412, State Eligibility.


About the Authors

**Julia H. Kaufman** is a senior policy researcher and co-directs the American Educator Panels at the RAND Corporation. Her primary areas of interest are how policies and programs can best support teaching and learning, as well as how to measure teaching quality accurately. She holds a Ph.D. in international education.

**Elizabeth D. Steiner** is a full policy researcher at the RAND Corporation with expertise in education policy, policy analysis, program evaluation, and qualitative methods and analysis. Steiner’s research is focused on ways to improve public education in the United States, reduce racial and socioeconomic achievement gaps, and improve equity of educational and life outcomes. She holds an M.S. in public policy and management.

**Ashley Woo** is an assistant policy researcher at the RAND Corporation and a Ph.D. student at the Pardee RAND Graduate School. Her research interests include educational equity, supporting the learning experiences of students from historically minoritized groups, educator recruitment and retention, the diversity of the educator workforce, social and emotional learning, and instructional systems that support teaching and learning. Woo has a M.Phil. in policy analysis.

Acknowledgements

We thank Alvin Nugroho, Brian Kim, and Dan Ibarrola for serving as the survey managers for this survey. We thank Julie Newell and Tim Colvin for programming the surveys. We thank Ruolin Lu for serving as the data manager for this survey. And we thank Dorothy Seaman for producing the sampling and weighting for these analyses, as well as David Grant for AEP Panel management. We also greatly appreciate the administrative support provided by Tina Petrossian. We are grateful to Adam Goldfarb, Jacklyn Altuna Willard, and their colleagues at the Bill & Melinda Gates Foundation for their support and collaboration. We thank Benjamin Master for helpful feedback that greatly improved this report. We thank Anna Bloom for her editorial expertise and Monette Velasco for overseeing the publication process.
About This Perspective

In this Perspective, the authors synthesize research about affordances and barriers to equitable, high-quality mathematics instruction for Black, Hispanic, and low-income students. Specifically, the authors discuss opportunities for students and resources for teachers that are tied to improved mathematics learning and teaching. The authors discuss what findings from the RAND American Educator Panels (AEP) and other research indicate about these opportunities for students and resources for teachers. Then, the authors note near-term recommendations suggested by this research that might be applicable for education leaders and policymakers as the nation recovers from the coronavirus disease 2019 (COVID-19) pandemic. Lastly, they lay out a research agenda for an upcoming five-year study to understand these student opportunities and teacher resources more deeply in service of identifying more-equitable mathematics education policies and practices.

The AEP are nationally representative samples 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 are interested in using AEP data for your own surveys or analysis or reading 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 publication is based on research funded by the Bill & Melinda Gates Foundation. The findings and conclusions contained within are those of the authors and do not necessarily reflect positions or policies of the Bill & Melinda Gates Foundation.

More information about RAND can be found at www.rand.org. Questions about this report should be directed to jkaufman@rand.org, and questions about RAND Education and Labor should be directed to educationandlabor@rand.org.

The RAND Corporation is a research organization that develops solutions to public policy challenges to help make communities throughout the world safer and more secure, healthier and more prosperous. RAND is nonprofit, nonpartisan, and committed to the public interest.

Research Integrity

Our mission to help improve policy and decisionmaking through research and analysis is enabled through our core values of quality and objectivity and our unwavering commitment to the highest level of integrity and ethical behavior. To help ensure our research and analysis are rigorous, objective, and nonpartisan, we subject our research publications to a robust and exacting quality-assurance process; avoid both the appearance and reality of financial and other conflicts of interest through staff training, project screening, and a policy of mandatory disclosure; and pursue transparency in our research engagements through our commitment to the open publication of our research findings and recommendations, disclosure of the source of funding of published research, and policies to ensure intellectual independence. For more information, visit www.rand.org/about/research-integrity.

RAND’s publications do not necessarily reflect the opinions of its research clients and sponsors. RAND® is a registered trademark.

Print and Electronic Distribution Rights

This work is licensed under a Creative Commons Attribution 4.0 International License. All users of the publication are permitted to copy and redistribute the material in any medium or format and transform and build upon the material, including for any purpose (including commercial) without further permission or fees being required.

For more information on this publication, visit www.rand.org/t/PEA2836-1.

© 2023 RAND Corporation