Research Report

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How Are District Leaders Thinking About Mathematics?

Selected Findings from the American School District Panel

For more information on this publication, visit **www.rand.org/t/RRA956-18.**

Published by the RAND Corporation, Santa Monica, Calif.

About This Report

To obtain a national picture of how school districts across the country were approaching mathematics during and after the coronavirus disease 2019 (COVID-19) pandemic, we surveyed district and charter network leaders in the American School District Panel (ASDP) four times between fall 2021 and spring 2023 and conducted interviews with district leaders.

The American Educator Panels (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. The ASDP is a research partnership between the RAND Corporation and the Center on Reinventing Public Education. The panel also collaborates with several other education organizations—including the Council of the Great City Schools, Kitamba, and The School Superintendents Association—to help ensure that we produce actionable results. For more information, visit the ASDP website at www.americanschooldistrictpanel.org.

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 study 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 Bill & Melinda Gates Foundation. For more information and research on these and other related topics, please visit gatesfoundation.org.

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Acknowledgments

We are extremely grateful to the educators who agreed to participate in the panels. Their time and willingness to share their experiences are invaluable for this effort and for helping us understand how to better support their hard work in schools. We thank Brian Kim and Daniel Ibarrola for helping manage the survey; Casey Hunter for serving as the data manager for this survey; and Tim Colvin, Roberto Guevara, and Julie Newell for programming the survey. Thanks to Claude Messan Setodji for producing the sampling and weighting for these analyses. We greatly appreciate the administrative support provided by Tina Petrossian and ASDP management provided by Samantha DiNicola. We also thank Elaine Wang, Elizabeth Steiner, and Morgan Polikoff for helpful feedback that greatly improved this report. We also thank Blair Smith for her editorial expertise and Monette Velasco for overseeing the publication process for this report.

Summary

To obtain a national picture of how school districts across the country were approaching mathematics during and after the coronavirus disease 2019 (COVID-19) pandemic, we surveyed district and charter network leaders in the American School District Panel (ASDP) four times between fall 2021 and spring 2023 and conducted interviews with district leaders.

Key Findings

We found the following:

- About four of ten districts reported not having set any specific goals for middle and high school mathematics. We interpret a lack of specific goals as a signal that these districts may be lacking a specific, measurable vision for academic improvement. Of those districts that did report specific goals, their goals varied in topic, specificity, and ambition.
- District leaders most commonly identified a lack of qualified mathematics teachers as a main barrier to reaching their mathematics goals (four in ten identified this factor as a barrier). Two-thirds of district leaders said that they anticipate shortages of secondary mathematics teachers in the 2023–2024 school year. Similarly, two-thirds of leaders said that their districts or their states have enacted a wide variety of policies in an effort to boost the supply of math teachers.
- No more than 20 percent of districts had purchased any single mathematics curriculum for use at any grade band. District leaders reported the adoption of standards-aligned curriculum materials to a greater degree at the elementary level than at the secondary level.
- District leaders' responses indicate that they may be considering instructional system coherence in their decisionmaking to some degree. For example, 59 percent of district leaders said that the alignment of (middle school) mathematics curriculum with state standards was very important to their decision to adopt it—their top consideration followed closely by student engagement. Similarly, district leaders most commonly identified alignment with curriculum as a major consideration when selecting professional learning opportunities (84 percent said that this factor was a major consideration).

Recommendations

We offer the following recommendations to district leaders:

- **Districts should set specific goals that help unite school system leaders and teachers around a shared purpose and that articulate a clear vision for academic improvement.** As they navigate goals with a student body that is in the midst of pandemic recovery, district leaders will need to think strategically about the goals they set. "Good" goals have enough specificity to capture the student population of interest, articulate how to measure success and monitor progress toward the goal, and are appropriately achievable under a documented timeline given the district's current status. Goals should also have a clear focus on equity. Such goals can help district leaders unify their staff around a vision and put in place curriculum, assessments, and teachers that are appropriately aligned to help districts achieve these goals. To inform their goal-setting, districts would do well to backward map and identify interim goals, starting with expectations of what students should be able to do upon graduation from high school,

to assess whether students—and schools—are on track to achieve these goals. Coursetaking is a good example of how districts might backward map their goals. These goals likely would include not only pass rates tied to algebra I but also targets for increased enrollment in other mathematics courses, such as algebra II and higher-level mathematics courses (such as precalculus, statistics, and trigonometry) that are gateways to higher education. While acknowledging that a single mathematics pathway likely is not appropriate for all students, districts should monitor which students are in these courses with an eye toward increasing equity in enrollments in higher-level mathematics courses.

- **Districts (and their state partners) need to further explore policy changes to recruit, develop, and retain high-quality mathematics teachers in the current labor market.** District leaders identified a lack of high-quality mathematics teachers as the number-one barrier to achieving mathematics goals, and teachers are critical to supporting the development of coherent instructional systems. Many leaders expected shortages of secondary teachers in the 2023–2024 school year. State leaders can assist their district partners in recruitment efforts by expanding alternative certification routes that allow districts to recruit promising candidates from other careers and build their workforces internally by empowering paraprofessionals. They can also explore policy mechanisms (such as boosting teacher pay) to make the teaching profession a more attractive career to both enter and stay in.
- **Although some degree of flexibility is important to meet student needs, districts should encourage their schools and staff to adopt mathematics curricula, assessments, and professional learning opportunities that are intentionally aligned with one another and that meet state standards.** State standards should be the backbone of a coherent instructional system. As a first step in moving toward coherence, district leaders should further encourage their staff to adopt standards-aligned curriculum materials and, perhaps, curriculum materials that have built-in assessments. These leaders might encourage their classroom teachers to adopt standards-aligned materials by purchasing materials that are aligned with standards and by strongly recommending or requiring their schools to use these materials. To guide decisions about what to purchase, district leaders might look to such sources as EdReports or their state departments of education. Too few district leaders who took our survey indicated using such tools as EdReports to make informed decisions when adopting curricula. From there, district leaders can work toward further instructional system coherence. For example, districts might provide their teachers and principals with professional development opportunities that focus on the use of these standards-aligned curriculum materials and how to use assessment data to inform their instructional practices.

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CHAPTER 1

Introduction

Numerous studies have documented a large decline in students' mathematics achievement during and after the coronavirus disease 2019 (COVID-19) pandemic (e.g., Kane and Reardon, 2023; Lewis and Kuhfeld, 2023; National Center for Education Statistics [NCES], undated-a; Wakelyn, 2022). For example, reports from a fall 2022 nationwide mathematics assessment showed that students' mathematics performance was not only lower during the COVID-19 pandemic but remained lower in the year following the pandemic, after schools returned to in-person instruction (NCES, undated-a). The question facing school districts now is how to help students recover.

Since fall 2020, we have repeatedly surveyed and interviewed district leaders who are members of the American School District Panel (ASDP). The ASDP is a research partnership between the RAND Corporation and the Center on Reinventing Public Education. The panel also collaborates with several other education organizations, including the Council of the Great City Schools, Kitamba, and The School Superintendents Association.

Previous ASDP data collection efforts have primarily focused on how districts were responding to COVID-19–era challenges, such as shifts to new instructional modes, staffing shortages, and community disagreements over safety practices. However, a small portion of our previous data collections have focused on mathematics. For example, four of the seven ASDP surveys we have conducted thus far each included a handful of questions about how districts are approaching mathematics. Similarly, some of the district leaders we have interviewed since fall 2021 have spoken specifically about mathematics in the context of discussing their broad academic recovery efforts and associated challenges.

As of spring 2023, we reached a critical mass of ASDP data—21 survey items and four rounds of interviews—that broadly touch on mathematics instruction. Because we believe that the findings from these survey items can contribute to the national conversation about how best to help students recover unfinished mathematics learning, we compiled these data to consider four research questions:

1. What are districts' goals for mathematics?
2. What do leaders perceive to be the main barriers in meeting these goals?
3. What actions are districts taking to ensure that there is an adequate supply of mathematics teachers?
4. What do district leaders take into consideration when making decisions about components of their instructional systems, such as curriculum materials, assessments, and professional learning?

Data Collection Overview

We conducted analyses to answer these research questions using survey and interview data collected over multiple time points between fall 2021 and spring 2023. We drew from four surveys that were administered during the fall and spring of the 2021–2022 and 2022–2023 school years. These four ASDP surveys were administered to nationally representative samples of district leaders representing traditional public school districts and charter management organizations (CMOs) across the United States. Between 220 and 360

district leaders completed each of the four surveys. We independently weighted each survey to make district leaders' responses representative of school districts nationally at the time the survey was administered. (For more information about each survey sample, see Tables A.1 and A.2 in the appendix.) We complemented our survey data with qualitative data from four rounds of interviews with school leaders and district leaders in five case study school districts conducted between September 2021 and May 2023. In total, the survey and interview data presented in this report represent the perspectives of hundreds of district leaders. We use the term *district leaders* throughout this report to refer to leaders of both traditional public school districts and CMOs.

Using data from multiple ASDP surveys and interviews allowed us to build a more comprehensive picture of how districts are approaching math. However, using data from multiple data collections occurring over a two-year period also means that the timing of each data collection likely affected district leaders' responses—especially responses from fall 2021, when the delta variant of COVID-19 caused cases to surge, and responses from spring 2022 in the wake of the omicron variant. During the 2021–2022 school year, many districts—but especially urban districts, high-poverty districts, and districts serving mostly students of color—were still dealing with regular disruptions to learning because of heightened staffing shortages and ongoing COVID-19 quarantine policies (Schwartz and Diliberti, 2022). By the 2022–2023 school year, schooling conditions had mostly stabilized and were more similar to a typical prepandemic school year, but by then, districts had focused more heavily on pandemic recovery efforts. In sum, district leaders' responses to our survey items likely were shaped by their specific pandemic context at the exact time the survey was administered. However, because we do not know the degree to which this pandemic context shaped district leaders' responses (and how this might have differed across districts), we cannot determine the extent to which the findings we identify in this report generalize to time points outside the specific survey administration date. To help readers understand the context of each finding, we include the administration date of each survey question throughout the report.

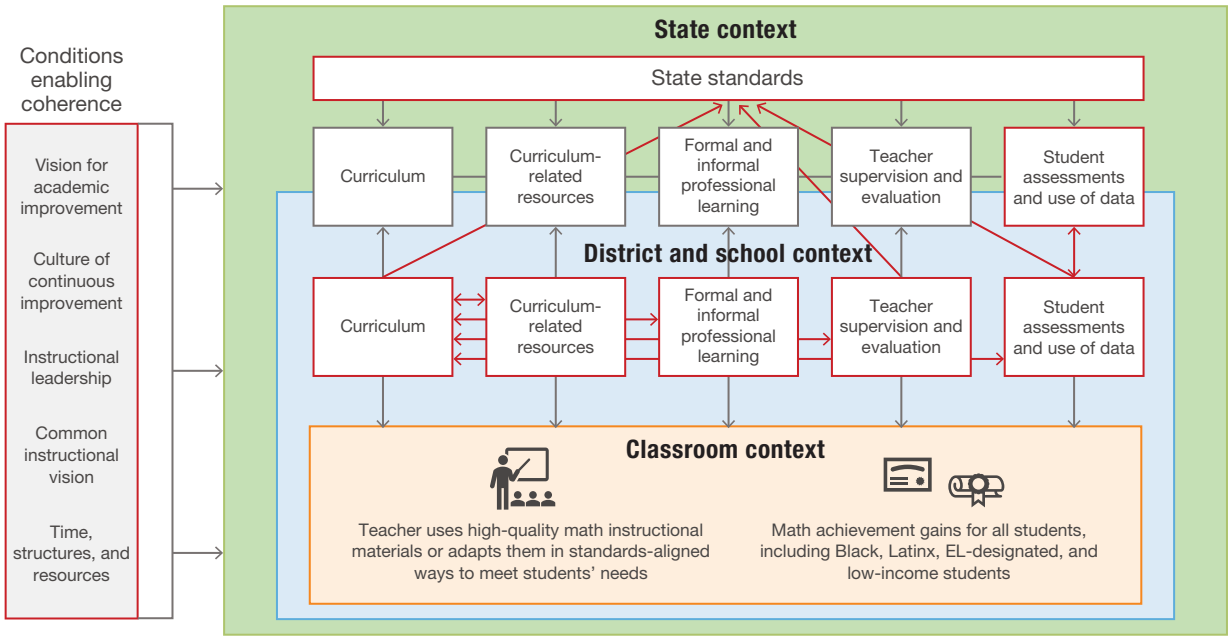
Conceptual Framework

We draw on a framework describing coherent instructional systems (CIS) to motivate and organize this report. This framework is grounded in a body of literature related to school system coherence (e.g., Fullan and Quinn, 2016; Honig and Hatch, 2004; Newmann et al., 2001; Smith and O'Day, 1991) and has been developed through extensive research (Pauketat et al., 2023; Polikoff et al., 2020; Wang et al., 2022; Wang et al., 2023). As shown in Figure 1.1, in a CIS framework, components of the instructional system—including state standards, curriculum materials, formal and informal professional learning opportunities, teacher evaluation, and benchmark and summative assessments—are aligned to convey consistent messages to teachers about instructional priorities with the aim of meeting students' academic learning needs and, therefore, these messages can lead to achievement gains for all students (Polikoff et al., 2020; Wang et al., 2022). Previous work has hypothesized that there are five key drivers, or conditions, that enable the development of system coherence. These conditions are a vision for academic improvement; a culture of continuous improvement; instructional leadership; common instructional vision; and consideration of time, structures, and resources (Polikoff et al., 2020; Wang et al., 2022).

Previous RAND work on coherent instructional systems has used survey and interview data collected from teachers to focus primarily on how teachers perceive the coherence of the instructional systems in their schools. This report is our first look at district leaders' perspectives on parts of coherent instructional systems. Because we can ask only a limited number of questions to district leaders on any one survey or interview, we have not yet asked about all the components of a coherent instructional system in our ASDP data collections. Therefore, this report focuses on some, but not all, of the enabling conditions and components

FIGURE 1.1

Components of a Standards-Aligned Coherent Instructional System and Theory of Action Leading to Student Learning



SOURCE: Adapted from Polikoff et al., 2020, p. 7.
NOTE: EL = English learner. Arrows indicate theoretical relationships between components.

that make up a coherent mathematics instructional system. We generally discuss the pieces of the framework that we deem to be most policy-relevant in the current pandemic recovery context, pieces over which districts have the most control, and pieces for which we have data available. In future ASDP surveys and interviews, we will continue to explore those elements of the CIS framework in which districts are the lead actors (e.g., selection of curriculum, teacher evaluation).

Organization of the Report

This report is organized as follows: In Chapter 2, we focus on two of the *conditions* listed in Figure 1.1—vision for academic improvement and time, structures, and resources—that enable coherence. In Chapter 3, we focus on three of the *components* of a coherent instructional system: curriculum materials, assessments, and professional learning. In Chapter 4, we conclude the report with suggested recommendations for how district leaders can work toward building more-coherent instructional systems.

Terms Used in This Report

Throughout our analyses, we considered how leaders' perceptions might vary by district subgroup. In this report, we describe only those differences among district subgroups that are statistically significant at the 5-percent level. We briefly define some of the terms we use to describe these district subgroups below.

- *Majority White districts* are districts in which more than half of students are White
- *Majority student-of-color districts* are districts in which more than half of students are Black, Hispanic, Asian, Pacific Islander, American Indian or Alaska Native, or of two or more races
- *Low-poverty districts* are districts in which fewer than half of students qualify for a free or reduced-price meal
- *High-poverty districts* are districts in which half or more than half of students qualify for a free or reduced-price meal
- *Historically disadvantaged districts* include urban districts, high-poverty districts, and districts serving mostly students of color
- *Historically advantaged districts* include suburban districts, low-poverty districts, and districts serving mostly White students.

CHAPTER 2

Enabling Conditions to Support the Development of Coherent Mathematics Instructional Systems

Enabling Condition 1: A Vision for Academic Improvement

A vision for academic improvement is critical; it sets a direction for how to align the various components of instructional systems. Deliberate and open discussion about what the shared purpose is helps bring everyone onto the same page and align their work toward system goals (Srinivasan and Archer, 2018). Or, as summed up by Polikoff et al., 2020, "If there is not a clear shared purpose—an anchor or vision for how to improve students' learning and academic achievement, for all students, especially those at risk or traditionally underserved—then all other efforts will likely be aimless and point in different directions" (p. 11).

Understanding Our Data on Districts' Goals

In this chapter, we draw on survey data collected at two different time points. In both our fall 2021 and spring 2023 surveys of district leaders, we posed the following open-ended question: "What are your district's specific goals for middle school and high school mathematics? For example, a specific goal would be for X% of students to pass Algebra I by the end of 9th grade." In fall 2021, we asked 359 district leaders this question, and 222 district leaders were asked this question in spring 2023, including 98 district leaders who participated in both surveys and were thus asked this question twice. We pooled these two sets of responses to increase our sample for this analysis. For those district leaders who answered our question at both time points, we used their more-recent answers, except for a handful of cases in which leaders provided substantive information only in fall 2021.

Our final analytic sample for the analysis of districts' mathematics goals includes unique, substantive responses from 411 district leaders. Because we pooled responses from two time points and excluded district leaders who left the question blank, we deem our sample to be a convenience sample of district leaders. Therefore, we have not weighted their responses to be representative of the national population of K–12 public school districts.

There are three reasons readers should interpret these results with caution. First, results are not necessarily representative of the national population of public school districts because we pooled data from two surveys of district leaders. Second, district leaders may not have written down their full set of goals or provided the full details, so we may be undercounting the percentage of districts with goals, or we may be characterizing their goals as less detailed than they actually are. Third, our example goal referencing algebra I pass rates might have influenced what district leaders chose to write about in their comments. This example might have biased leaders to write about algebra I in their responses or to write "no specific goals" if their district's goal looked very different from the example given. For these reasons, we urge readers to avoid overinterpreting the results.

We asked district leaders about their mathematics goals for student learning as a way to understand their vision for academic improvement. Although districts might set a vision for academic improvement without setting specific math goals for student learning, we deem goal-setting to be one concrete and common (if not sufficient) indicator of a clear vision for academic improvement. In this chapter, we explore districts' goals for secondary math and what factors district leaders perceive to be barriers to meeting these goals.

Four in Ten Districts Had Not Set Any Specific, Measurable Goals for Secondary Mathematics

About four of every ten district leaders (41 percent) in our analytic sample indicated that their district had "no specific goals" for middle or high school mathematics (see the box titled "Understanding Our Data on Districts' Goals"). Because having a goal can help unite teachers in what to aim for in their instruction, we interpret this finding as an indication that a large share of districts lacks an explicit, measurable vision for academic improvement—which is one of the key conditions hypothesized to enable system coherence (Polikoff et al., 2020).

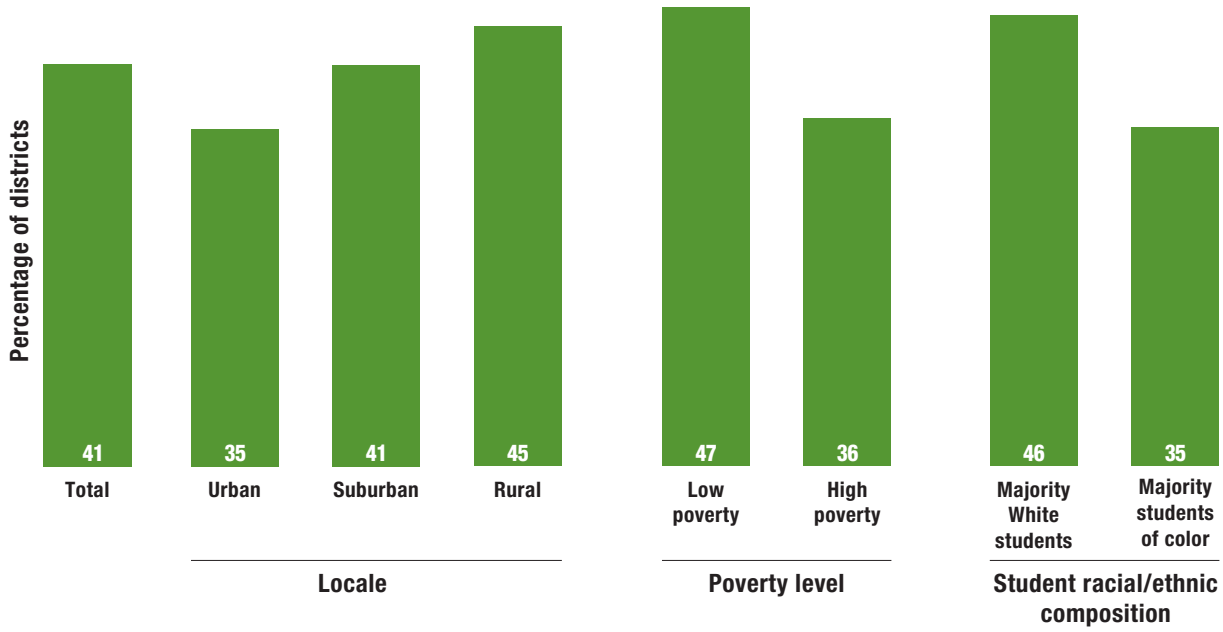
A greater percentage of *historically disadvantaged districts*—by which we mean urban districts, high-poverty districts, and districts serving a majority of students of color—had set specific goals for secondary math than had historically advantaged districts (see Figure 2.1). Our main hypothesis for this goal-setting is that urban districts and districts serving mostly students of color are larger, on average, than their suburban and especially rural counterparts. We suspect that this larger enrollment size translates to a greater number of central office staff, which in turn allows for more-specialized roles, such as academic chief officer or mathematics specialists who have more capacity for math goal-setting. A second hypothesis is that state and local accountability requirements may put more pressure on these types of districts—which have historically served large numbers of low-achieving students (NCES, undated-b)—to improve achievement.

The percentage of districts that did not report any specific goals for mathematics might be different from past school years given that we asked district leaders about their goals either during the COVID-19 pandemic in fall 2021 or in the postpandemic period of recovery in spring 2023. District leaders in our interviews cited two pandemic-related reasons for *not* setting specific mathematics goals. Several leaders expressed a reluctance to put more pressure on teachers during COVID-19 pandemic recovery. One leader echoed this theme: "There's been a lot of protectivist [attitudes], like we can't ask teachers to do anything else." This leader further described a serious tension between knowing how much student learning had suffered in the wake of the pandemic and feeling limited in their ability to raise expectations amid other challenges. Similarly, a leader of a historically high-performing district explained that they had turned away from end-of-year goals temporarily and focused instead on shorter-term "cycles of improvement" to maintain momentum. As the leader said, "We've been pretty one-dimensional in our thinking about success being an A-rated district but [we] do have to recognize that we're in a really tough jam."

Another reason leaders cited in interviews for not setting specific goals was a lack of clear data on how their students were going to perform coming out of the pandemic. End-of-year state summative assessments were canceled in spring 2020 and severely modified in spring 2021 because of COVID-19–related disruptions to schooling, which curbed one of districts' main data sources for understanding how their students are performing. District leaders we interviewed questioned the validity of spring 2021 scores given high rates of absenteeism and the fact that some students had taken their high-stakes assessments at home. As a result of missing and potentially invalid pandemic-era data, many district leaders found it hard to predict how students would do when testing eventually returned to normal in spring 2022. In a typical comment, one leader explained, "Our mathematics scores in primary were lower than what we anticipated . . . which was kind of a shocker because all the indications through the year [were] that it was gonna be the other way around."

FIGURE 2.1

Percentage of Districts Who Indicated That Their District Had *Not* Set Specific Goals for Secondary Mathematics



NOTE: This figure depicts response data from the following survey question administered to district leaders in fall 2021 or spring 2023: "What are your district's specific goals for middle school and high school math? For example, a specific goal would be for X% of students to pass Algebra I by the end of 9th grade. If you do not have specific goals, please write 'No specific goals.'" (n = 411). As described in the box titled "Understanding Our Data on Districts' Goals," we pooled district leaders' responses to both surveys and defined a set of exclusion criteria to create an analytic sample. This figure was created using this subset of district leaders and was not weighted to be representative of the national population of K–12 public school districts.

Districts with Mathematics Goals Most Commonly Described Goals for Student Performance on State Assessments and Completion of Algebra I

We asked district leaders who reported having goals for middle or high school mathematics in fall 2021 or spring 2023 what those goals were. We posed an open-ended question to district leaders: "What are your district's specific goals for middle school and high school mathematics?" We expected that leaders would write in either a goal related to student learning or performance (e.g., "increase the percentage of students reaching proficiency on state summative assessments") or one related to shifting resources as a means of theoretically shifting student learning (e.g., "hire more high-qualified math teachers to teach advanced mathematics courses"). District leaders could also list multiple specific goals. Our example included with the first survey question prompt (see the box titled "Understanding Our Data on Districts' Goals" for survey question wording) may have increased district leaders' propensity to write in student performance goals related to algebra I.

In total, 59 percent of district leaders wrote in a goal for secondary math. As shown in Table 2.1, district leaders most commonly wrote goals relating to improving student performance, such as increasing course-passage rates and improving student proficiency on summative or benchmark assessments. Fifty-seven percent of district leaders wrote in a goal related to improving student performance. We interpret this as an indication that a small majority of districts have an explicit, measurable vision for academic improvement—one of the key conditions hypothesized to enable system coherence (Polikoff et al., 2020).

Meanwhile, few districts (only 6 percent) described resource-related goals, such as increasing course access, improving teacher quality, or increasing student supports. A few of those who wrote in resource goals

TABLE 2.1

Percentage of Districts Who Indicated Having Various Goals for Secondary Mathematics

Goal	Number of Districts	Percentage of Districts
Student performance goals	**233**	**57**
Increase course enrollment and/or passage rates	70	17
Algebra I	64	16
Geometry	5	1
Algebra II	7	2
Calculus	2	0
Improve student performance on state summative assessments	70	17
Improve student performance/passage on end-of-course exams	24	6
Algebra I	23	6
Algebra II	1	0
Improve performance on benchmark assessments	16	4
Improve performance on college entrance exams (e.g., SAT, ACT)	15	4
Increase typical years of math taken	8	2
Increase number of students who are “algebra I ready” in middle school	8	2
Close achievement gaps	6	1
Increase graduation rates	4	1
Keep students “on track” for graduation	2	0
Increase number of students who are “college ready”	1	0
Improve course grades	1	0
Resource goals	**24**	**6**
Increase students’ access to more and/or more-rigorous courses	11	3
Increase instructional system coherence	4	1
Improve curriculum	3	1
Improve teacher quality	3	1
Increase student supports	3	1
Unable to determine	**33**	**8**
No specific goals	**170**	**41**

NOTE: This table depicts response data from the following survey question administered to district leaders in fall 2021 or spring 2023: “What are your district’s specific goals for middle school and high school math? For example, a specific goal would be for X% of students to pass Algebra I by the end of 9th grade. If you do not have specific goals, please write ‘No specific goals.’” (n = 411). The unable to determine category includes instances in which districts did not give enough context for us to understand what their goals were (e.g., “growth,” “be proficient in them,” “99%”). As described in the box titled “Understanding Our Data on Districts’ Goals,” we pooled district leaders’ responses to both surveys and defined a set of exclusion criteria to create an analytic sample. This table was created using this subset of district leaders and was not weighted to be representative of the national population of K–12 public school districts. Indented items are subsets of the above category. Districts were allowed to write in more than one mathematics goal. Therefore, columns will not sum to totals.

explicitly touched on the idea of coherence. For example, one district leader wrote in "meet as grade/subject level teams to review curriculum alignment to [state] standards, and lessons aligned to the curriculum," while another leader wrote in "provide high-quality, standards-based mathematics instruction that focuses on fluency, student discourse, and conceptual understanding. Design and facilitate school-based support for implementation of the [state] standards for mathematics. . . . Partner with outside entities to provide additional professional learning in mathematics content."

Examining in more detail the student performance goals that district leaders wrote in the survey, we found that 17 percent of district leaders who responded to this question wrote in a mathematics goal that was broadly related to improving student performance on annual statewide summative assessments. Beyond raising student performance on statewide summative assessments, a sizable share of districts' goals related to algebra I. Sixteen percent of district leaders said that they had a goal related to increasing enrollment and/or passage rates in algebra I. Among the 64 districts who wrote in a goal related to algebra I coursetaking, 60 were focused on increasing algebra I course passage rates, while the remaining four districts were focused on simply increasing algebra I enrollment. Meanwhile, 6 percent of all districts' mathematics goals related to improving student performance on algebra I end-of-course exams, and 2 percent of district leaders mentioned goals related to improving algebra I "readiness" in middle school.

Although our inclusion of an example about algebra I in our survey question may have increased the rate at which district leaders wrote down algebra I–related goals, we also believe that it is plausible that algebra I is the dominant goal area for districts. First, states have increasingly moved to include completion of algebra I as a requirement for high school graduation (Achieve, undated; Dounay Zinth, 2012). Roughly one-third of states require students to pass an algebra I end-of-course exam to graduate high school (Achieve, undated; Zinth, 2016), and states may administer other assessments in high school that include algebra concepts (Education Commission of the States, 2018; NCES, undated-d). Secondly—and likely relatedly—algebra I is a frequent gatekeeper to other, higher-level mathematics coursetaking. As we discuss in more detail below, algebra I is often the first mathematics course students take before progressing to other courses, such as geometry and algebra II or even such higher-level courses as trigonometry, precalculus, statistics, or calculus (Brown et al., 2018; Wolfe, Steiner, and Schweig, 2023b). Twenty-nine states require students to complete coursework more advanced than algebra I to graduate (usually through geometry or algebra II), meaning that getting students through algebra I is a key hurdle to getting students to access more-advanced coursework (Achieve, undated).

Similarly, district officials we interviewed noted the fact that early algebra I completion is associated with greater postsecondary success—a position that is well supported by research evidence (e.g., Ogut et al., 2021). As one mathematics coordinator put it, "We've seen historically from our data, [that] our kids' persistence through college is quite a bit higher, in fact, over 20% higher [when they] take Algebra I by eighth grade, their ability to persist through college just remains high." In response to that finding, leaders in the district were working closely with the state to expand access to algebra in middle school.

In addition to graduation requirements and gatekeeping, algebra I might be a focus area for districts because algebra test scores took a particularly hard hit during the pandemic. One district leader echoed this sentiment:

> [We had a] huge dip . . . especially in Algebra I, [which] prompted us to put a plan in place. . . . It's even written inside of the strategic plan for algebra readiness and Algebra I to show improvement across all grade levels from kindergarten to Algebra I.

We consider a good goal or vision for academic improvement as meeting two criteria: (1) the goal must be specific enough to be actionable and (2) it must balance ambition with reasonable considerations of the district's starting point. In this section, we explore the extent to which our district leaders adequately defined

a vision for academic improvement based on these criteria. We also explore how districts' expectations for academic success might be related to district context.

Districts' Secondary Mathematics Goals Varied in Their Specificity and in Their Ambition

Specificity in goal-setting allows teachers and other school staff to get on the same page and allows educators to measure and monitor success toward meeting the goal. In the box titled "Examples of Districts' Goals Related to Improving Student Performance on Summative Assessments," we use districts' goals related to increasing performance on state assessments to illustrate differences in the specificity of districts' goals. Leaders in Districts A and B reported ambiguous goals in the sense that they did not clearly define the measure of success, what specific student populations or grade levels were of focus, or the timeline within which to accomplish the goal. At the other end of the spectrum, leaders in Districts H and I, for example, clearly defined the metrics for success, defined who the goals applied to, and identified a deadline to accomplish the goal. Although we acknowledge that the observed variation in the specificity of goals may be related to the open-ended nature of the survey item, the number of district representatives who wrote in ambiguous goals raises concerns that some districts' visions for academic improvement may not be specific enough to unite educators around a single objective.

In addition to being specific, a good goal must be ambitious enough to require improvement while also being attainable. We use districts' goals for algebra I to explore variation in the ambition of districts' goals. We focus on algebra I for this analysis for several reasons. First, our survey results suggest that algebra I is a focus area for districts, which we hypothesize is in part because this course has historically been used as a gateway to accessing more-rigorous math courses (American Institutes for Research, undated; Brown et al., 2018) that are strongly related to students' postsecondary success (e.g., Attewell and Domina, 2008; Long et al., 2012; Morgan et al., 2018). Second, federal data show that mathematics coursetaking combinations and sequences vary substantially by state, school context, and among individual students (Brown et al., 2018; Wolfe, Steiner, and Schweig, 2023b). The observed variation in mathematics coursetaking is probably driven

Examples of Districts' Goals Related to Improving Student Performance on Summative Assessments

- District A: "pass the state exams"
- District B: "outperform state averages"
- District C: "working towards 80% proficiency"
- District D: "84% advanced/proficient in math"
- District E: "3% yearly increase in student growth level on state test"
- District F: "100% students will show growth in math proficiency with 80% of students reaching proficiency"
- District G: "increase percentage from 43% in 2021 to 56% by 2026"
- District H: "increase the percentage of students in levels 3 and 4 from 19.1% to 50% on the math state assessment by May 2026"
- District I: "The percent of 4th–6th grade students that are on grade level or above on the state math test will increase from 22% in 2019 to 48% by 2024."

These examples are intended to illustrate the patterns we observed in the data and are not an exhaustive set of the mathematics goals that district leaders wrote in their open responses.

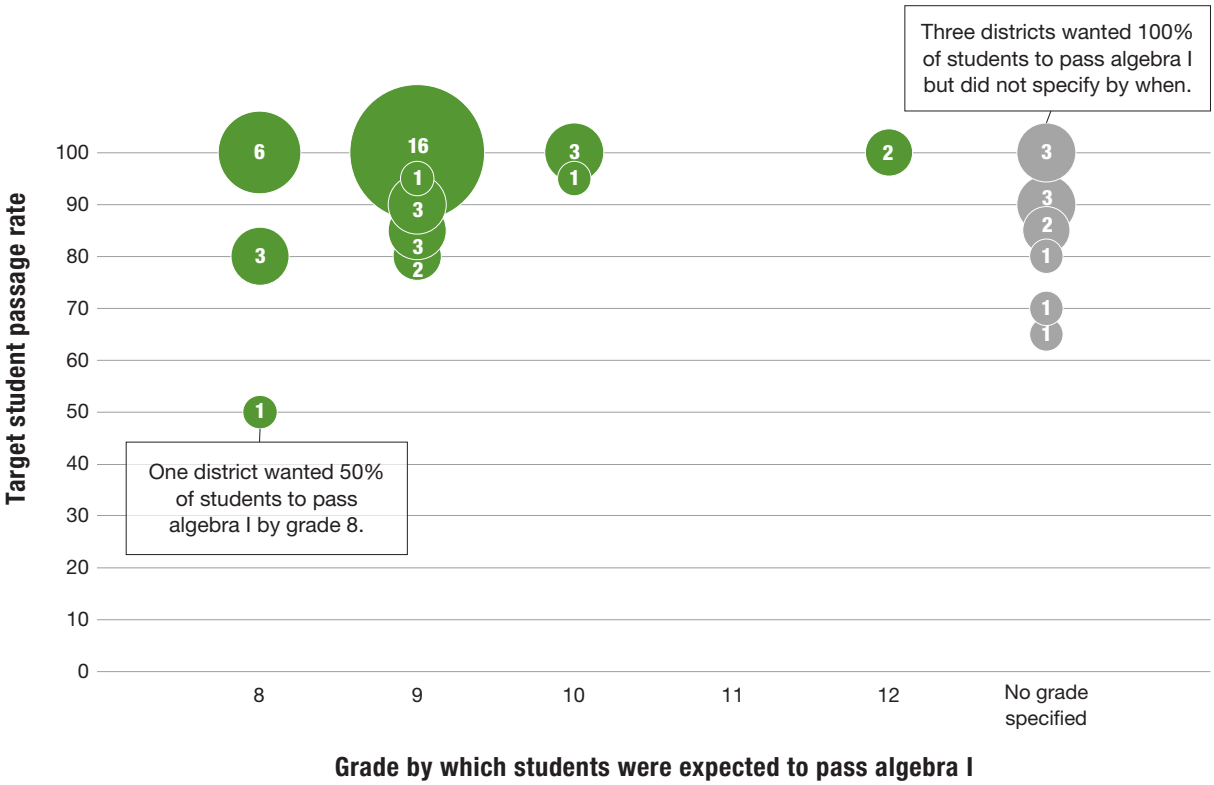
by a variety of factors, including states' graduation requirements (Achieve, undated; Education Commission of the States, 2023) and inequities in students' course access because of course offerings, gatekeeping policies, and necessary prerequisites (NCES, 2022; Nowicki, 2018; Wolfe, Steiner, and Schweig, 2023a). Our analysis adds another factor that might be related to the observed variation in mathematics coursetaking: differing ambitions in districts' math goals.

We focus here on the 60 district leaders who wrote in goals related to algebra I course passage rates and consider two factors to illustrate variation in expectations: (1) the share of students that districts were targeting with their goal and (2) the specific grade level that was targeted. As shown in Figure 2.2, districts most commonly wrote in an algebra I course passage goal targeted toward students at grade 9. Of these goals, districts had target pass rates ranging from 80 percent to 100 percent. Six districts wanted all their 8th graders to pass algebra I by the end of that grade. Two districts wanted 100 percent of students to pass algebra I sometime by grade 12, presumably because it is a high school graduation requirement. As the gray-shaded circles in Figure 2.2 show, still other districts did not specify in their written response a grade level by which students should complete algebra I.

The large variation in algebra I target pass rates likely reflects differences both in baseline student achievement levels and accountability pressures, given that some states modified accountability goals to accom-

FIGURE 2.2

Number of Districts That Had Goals for Algebra I Course Passage Rates, by Target Share of Students Expected to Pass and by What Grade Level



NOTE: This figure depicts response data from the following survey question administered to district leaders in fall 2021 or spring 2023: "What are your district's specific goals for middle school and high school math? For example, a specific goal would be for X% of students to pass Algebra I by the end of 9th grade. If you do not have specific goals, please write 'No specific goals.'" (n = 52). This figure was created using a subset of district leaders who wrote in goals focused on algebra I passage rates, including the share of students that districts are targeting with their goal and the specific grade level, if any, that is targeted. The figure is intended to be illustrative and is not necessarily representative of the goals of the national population of K–12 public school districts. Data have not been weighted to be representative of the national population of public school districts.

modate academic setbacks from the COVID-19 pandemic. One district leader voiced this with the candid admission that "[i]t's bad . . . maybe 20-ish percent of kids [are] at standard." For districts in this position, such a high pass rate goal as 80 percent to 100 percent likely would be unattainable. Yet other district leaders noted that they had to keep standards high because their states had not relaxed their assessment or course-taking graduation requirements. And at least one superintendent in our study expressly advocated for maintaining high expectations: "I do not believe now is the time to take our foot off of the gas on believing in kids and their capability and what they should accomplish when they are in public education."

District Leaders' Expectations About Coursetaking Also Varied in Ambition and Across School Contexts, Raising Equity Concerns

A necessary input for ambitious secondary math goals is the presence of the math courses to enable students to achieve the desired levels of performance. Like the types of goals themselves, we found wide variation across district contexts in the math courses that district leaders expect college-bound students to take. This variation raises equity concerns, because high school mathematics coursetaking is important for students' postsecondary access and persistence.

In spring 2022, we asked district leaders, "At a minimum, which math courses would you recommend high school students in your district/CMO take to be ready for college?" Figure 2.3 shows that district leaders agreed that algebra I, geometry, and algebra II were necessary courses for college-bound students. Nine in ten leaders (or 87 percent) said that they recommended that their students take algebra I to be college-ready. Meanwhile, 84 percent said that they recommended that their students take algebra II, and 82 percent said similarly about geometry. Beyond those courses, we see a steep drop in the degree of consensus about needed math courses. For example, only 47 percent of district leaders said that they would recommend precalculus, 33 percent said that they would recommend trigonometry, 31 percent said statistics and probability, and 21 percent said calculus. Very few district leaders recommended that college-bound students typically complete computer science, coding, or data science, which are courses that fall outside the typical mathematics sequence we described previously.

Importantly, we observed differences in district leaders' expectations around coursetaking for college-bound students by district context. The clearest pattern we observed was a difference in recommendations between leaders of majority White districts and leaders of districts serving mostly students of color. Higher percentages of leaders of majority White districts said that they recommended that their students take such courses as algebra I, geometry, trigonometry, and computer science to be college-ready. (We observe the same pattern for other courses too, but differences are not statistically significant.) For example, 36 percent of leaders of majority White districts recommended that their students complete trigonometry if the students were interested in attending college, compared with 21 percent of leaders in districts serving mostly students of color.

We found a high degree of similarity between the courses that district leaders would recommend college-bound students take, and the courses they said their college-going students actually completed. In results not shown, we found that leaders of urban districts and districts serving mostly students of color were substantially less likely than their counterparts to indicate that college-bound students typically complete critical math courses. For example, 47 percent of leaders of majority White districts indicated that their students typically take trigonometry if they intended to go to college, whereas only 31 percent of leaders of districts serving mostly students of color said similarly.

These disparities in district leaders' reports of expectations or recommendations around math coursetaking—and the need to increase high-level coursework, particularly among students in historically underserved settings—did not go unnoticed in at least two of our interview districts. One district prioritized 8th grade algebra, developing new systems to ensure that all students, including those in schools with higher

FIGURE 2.3

Percentage of District Leaders Who Recommended That the High School Students in Their District Take Various Courses to Be Ready for College

Percentage: 0 – 100

	All districts	Locale			Poverty level		Student racial/ethnic composition	
		Urban	Suburban	Rural	Low poverty	High poverty	Majority White students	Majority students of color
Algebra I	87	75	80	**91**	88	86	**91**	**75**
Algebra II	84	72	78	**88**	83	85	86	77
Geometry	82	**62**	73	**88**	81	84	**86**	**72**
Precalculus	47	37	47	49	48	45	48	42
Trigonometry	33	24	35	34	37	25	**36**	**21**
Statistics and probability	31	26	28	33	33	29	33	26
Introduction to college math	21	20	23	21	21	23	24	15
Calculus	21	14	25	20	27	14	23	18
Computer science	19	12	23	18	19	17	**22**	**9**
Coding	9	8	10	9	12	5	10	6
Quantitative reasoning	8	8	7	9	9	7	9	6
Data science	6	2	7	7	6	7	7	4

NOTE: This figure depicts response data from the following survey question administered in spring 2022: "At a minimum, which math courses would you recommend high school students in your [district/CMO] take to be ready for college?" (n = 270). Respondents were instructed to select all that apply. The survey question included an "Other" option, which was selected by 8 percent of respondents and has been omitted from this figure. Numbers in bold indicate that the subgroup percentage of district leaders reporting that they recommend that high school students take various courses is statistically significantly different ($p < 0.05$) from the percentage of remaining district leaders not in that subgroup who said the same. Only respondents whose district or CMO serves high school grades in the 2021–2022 school year saw this question.

poverty or a higher proportion of students of color, complete algebra I before they begin high school. Another district was conducting high school scheduling audits to ensure that all students take advanced coursework. The superintendent of this district explained the results as follows: " . . . [W]e actually have found that many of our kids do not even have a high school core sequence that gives them eligibility to be accepted into a [state] university or college."

Enabling Condition 2: Time, Structures, and Resources for Mathematics

To enable coherent instructional systems, schools must commit resources, including time, to this cause (Newmann et al., 2001; Polikoff et al., 2020). We focus in this section on one of the critical time, structures, and resources for mathematics: a supply of mathematics teachers. Having a fully staffed mathematics department with a stable cadre of teachers who are familiar with their district's instructional system is one of the conditions that can help enable instructional system coherence (Newmann et al., 2001; Polikoff et al., 2020).

Concerningly, teacher turnover increased nationally in 2021–2022 after holding steady in the early pandemic school years (Diliberti and Schwartz, 2023). Increased teacher attrition, combined with dwindling interest and a decline in the prestige of the profession (Kraft and Lyon, 2022) and potentially increased demand for teachers (Diliberti and Schwartz, 2022), is raising researchers' and policymakers' concerns about the current and future supply of teachers, including in mathematics. Because so many leaders identified mathematics teachers as a critical barrier, we also focus in this section on district leaders' perceptions about the supply of mathematics teachers.

A Lack of Effective Mathematics Teachers Was the Most Commonly Reported Barrier to Achieving Districts' Mathematics Goals

In spring 2023, we asked district leaders to identify specific barriers to achieving their mathematics goals. We listed 13 possible barriers, along with a 14th "other" option, and asked them to select all that applied. As shown in Figure 2.4, the single most common barrier—which 41 percent of district leaders selected—was finding and retaining effective mathematics teachers. In an interview, one district leader highlighted a common theme: "We're seeing the same thing as what everybody else is seeing. There's no teacher pool; [instead,] there's a teacher drip. And that impacts the quality, the experiences, and the level of education that we see in every subject area, including mathematics."

District leaders in all our case study sites described how the definition of *effective mathematics teaching* had shifted away from a procedure-based instruction and toward conceptual understanding and how this has compounded the difficulty of finding high-quality mathematics teachers. "I've taught . . . and coached teachers in mathematics for a while, and [our new conceptual mathematics curriculum] is the most different way I've ever seen anyone teach mathematics," explained the middle school mathematics director in one district, " . . . [T]hat comes with a lot of its own troubles, right? It's changing people's mindset about mathematics." A superintendent in a different district added that "[p]art of the problem is that we don't ask mathematics teachers in this country to be mathematicians. We ask them to be teachers with some knowledge of mathematics." A leader in the same district noted, "Our mathematics instruction is terrible. We devote a lot of time every month to helping [teachers] understand good mathematics instruction. And I'll be honest, I feel like a failure . . . because I'm not seeing a whole lot of movement."

Notably, district leaders' concerns about an adequate supply of mathematics teachers outranked many other commonly cited challenges in this subject area, such as students' feelings about math and insufficient preparation for higher-level mathematics coursework. For example, 38 percent of district leaders said that student interest in math was a barrier to meeting their goals, and 34 percent said that anxiety about mathematics was a barrier. Equally interesting are the barriers that do *not* rise to the top of district leaders' concerns. Roughly one-quarter of district leaders also identified insufficient supports for struggling students and poor mathematics preparation going into middle school as barriers to meeting mathematics goals. Fewer than 20 percent of districts identified such things as a lack of funds or lack of demand for advanced mathematics courses, lack of high-quality mathematics curricula, or lack of high-quality formative assessments as barriers to improving mathematics goals.

FIGURE 2.4

Percentage of District Leaders Who Indicated Various Factors Are a Main Barrier to Accomplishing Their Mathematics Goals

Percentage
0 100

	All districts	Locale			Poverty level		Student racial/ethnic composition	
		Urban	Suburban	Rural	Low poverty	High poverty	Majority White students	Majority students of color
Finding and retaining effective math teachers	41	52	32	45	35	49	37	52
Lack of student interest or motivation in math coursework	38	43	35	39	32	45	34	49
Student math anxiety	34	30	34	35	**25**	**44**	30	39
Insufficient supports (e.g., tutors) to help struggling students in math	28	27	22	30	**19**	**40**	23	40
Insufficient preparation of students for middle grade–level math coursework	24	35	20	25	19	33	**17**	**47**
Insufficient preparation of students for high school-level math coursework	16	31	10	18	11	21	**11**	**31**
Obtaining high-quality math curricula generally	15	12	18	14	14	16	15	8
Lack of high-quality math formative assessments	14	25	13	14	18	9	16	11
Insufficient teachers to offer more-advanced math courses at the secondary level	13	22	10	13	10	18	10	23
Inequitable expectations and outcomes across middle schools in the district	10	**33**	15	**6**	8	14	9	17
Inability to prioritize this goal due to other competing district goals	9	12	6	11	13	5	11	5
Insufficient demand from students for advanced math courses at the secondary level	9	6	4	11	11	7	9	9
Insufficient funds to offer more-advanced math courses at the secondary level	6	4	**1**	8	7	2	6	1

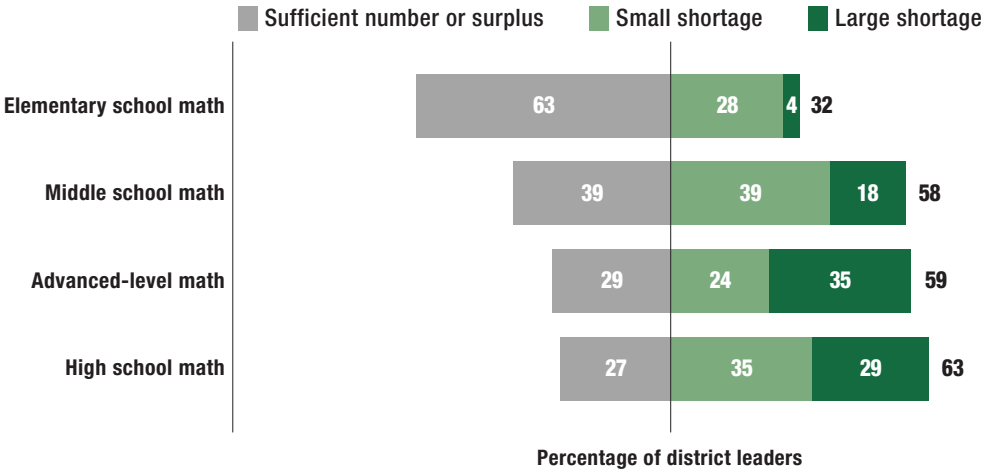
NOTE: This figure depicts response data from the following survey question administered in spring 2023: "Which of the following, if any, are the main barriers to accomplishing this goal?" (n = 213). All spring 2023 respondents—including those who did not write in a specific mathematics goal—were asked this question. Those districts that were asked about their mathematics goals in fall 2021 did not receive this subsequent survey item about barriers to accomplishing their goals at that time. Respondents were instructed to select all that apply. The spring 2023 survey question included an "Other" option, which was selected by 9 percent of respondents, and an "N/A. We do not have specific goals" option, which was selected by 33 percent of respondents. These response options have been omitted from this figure. Numbers in bold indicate that the subgroup percentage of district leaders reporting that a factor is a main barrier to accomplishing their mathematics goal is statistically significantly different ($p < 0.05$) from the percentage of remaining district leaders not in that subgroup who said the same.

Two-Thirds of District Leaders Said That They Anticipate Shortages of Middle and High School Mathematics Teachers in 2023–2024

We asked district leaders in the spring 2023 survey whether they anticipated a shortage of mathematics teachers going into the 2023–2024 school year. As shown in Figure 2.5, two-thirds of district leaders anticipated some degree of shortages among middle and high school mathematics teachers for the 2023–2024 school year, including for *advanced mathematics teachers* (which we defined on the survey as those who teach, for example, advanced placement [AP] courses, statistics and probability, or calculus). Among those district leaders who anticipated some degree of shortage at the middle and/or high school levels, most anticipated that these mathematics teacher shortages would be small. However, district leaders who anticipated concerns

FIGURE 2.5

Percentage of District Leaders Who Indicated That There Will Be a Shortage of Mathematics Teachers in 2023–2024 at Specific Grade Bands, by Level of Shortage



NOTE: This figure depicts response data from the following survey question administered in spring 2023: "Looking ahead to next school year (2023–2024), do you anticipate there will be a shortage or a sufficient number of math teachers in your district at the following levels?" (n = 214). Bars will not sum to 100 percent because of a small number of district leaders who selected "Don't know" at each grade band. Bars may also not sum to totals because of rounding.

about shortages of advanced-level math teachers in 2023–2024 more often predicted that these shortages would be large.

Fewer district leaders (about three in ten) anticipated a shortage of elementary mathematics teachers than secondary mathematics teachers. The vast majority of these district leaders expected small, rather than large, shortages at the elementary level.

Urban District Leaders and High-Poverty District Leaders Were Concerned About (Mostly Small) Shortages of Elementary Mathematics Teachers

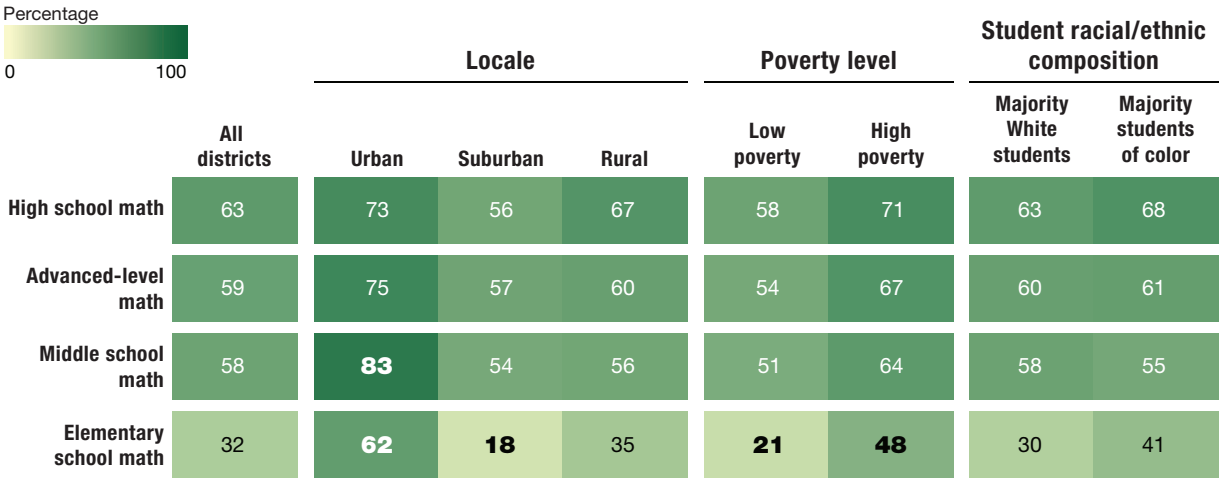
District leaders' perceptions about potential teacher shortages depended somewhat on their district context. Leaders of historically disadvantaged districts—urban districts and high-poverty districts—were more likely than their counterparts to report concern about a small or large shortage of elementary school mathematics teachers in 2023–2024 (see Figure 2.6). We generally see similar patterns at the secondary (middle and high school) level, although not all differences are statistically significant. This comports with long-standing patterns of more-severe staff shortages in historically disadvantaged schools (Sutcher, Darling-Hammond, and Carver-Thomas, 2016) and mirrors what we heard during interviews. In a typical comment, one leader told us, "I think we are continuing . . . to fight in a highly competitive and shrinking market of [teacher] talent. I think it's gonna be just as tough next school year."

Two-Thirds of District Leaders Said That Their District or State Had Taken Action to Boost the Supply of Mathematics Teachers

Following several years of heightened attention on teacher turnover and shortages because of pandemic-era learning conditions (e.g., Diliberti and Schwartz, 2023; Schwartz and Diliberti, 2022), we asked district leaders in spring 2023 whether they or their state had enacted various policies since the 2021–2022 school year to

FIGURE 2.6

Percentage of District Leaders Who Indicated That There Will Be Some Level of Shortage of Mathematics Teachers in 2023–2024 at Specific Grade Bands, by District Subgroup



NOTE: This figure depicts response data from the following survey question administered in spring 2023: "Looking ahead to next school year (2023–2024), do you anticipate there will be a shortage or a sufficient number of math teachers in your district at the following levels?" (n = 214). For each grade band, respondents were asked to select from among the following response options: "sufficient number or surplus," "small shortage," "large shortage," or "don't know." This figure depicts the percentage of district leaders who selected "small shortage" or "large shortage." Numbers in bold indicate that the subgroup percentage of district leaders reporting some level of shortage for that grade band is statistically significantly different ($p < 0.05$) from the percentage of remaining district leaders not in that subgroup who said the same.

increase the number of applicants for mathematics teaching positions. We listed 11 policy changes and asked district leaders which of these their district or state had enacted.

Our data suggest that district leaders and state policymakers are using a wide variety of policy changes to increase staffing levels. In spring 2023, 65 percent of district leaders said that they or their state have enacted one or more of the 11 policies we asked about (or have taken a similar "other" option). This includes 47 per-cent of district leaders who said that their state has enacted one or more policies we listed and 44 percent who said that their districts have enacted one or more changes. The typical district leader indicated that they or their state had made two of the policy changes we listed.

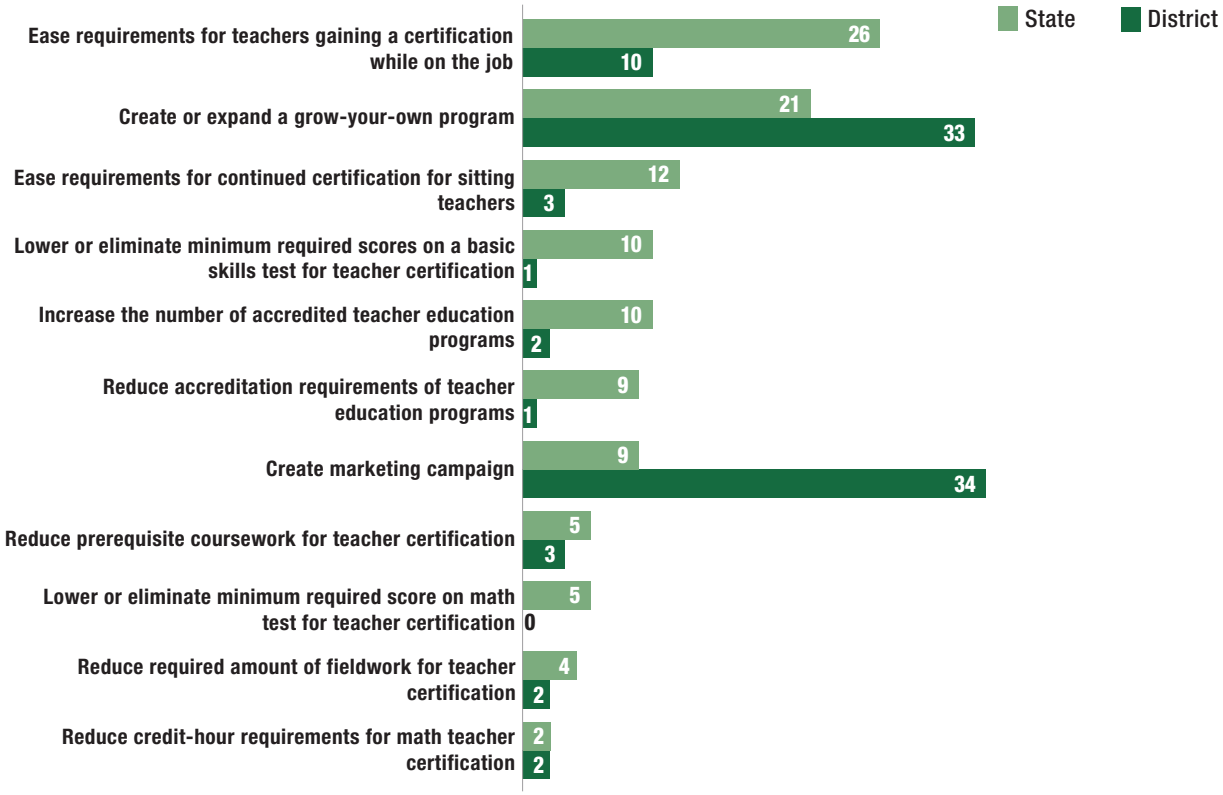
In interviews, district leaders noted the importance of both state and local action to increase teacher supply because some adjustments, such as easing teacher licensure requirements, were outside the legal authority of individual districts and required state action. As one district leader explained, "We can come up with the greatest ideas, thoughts, and so forth. We still have the [state] Department of Education and law that guides [us]."

As shown in Figure 2.7, at the district level, policy changes were concentrated in two areas: increased marketing campaigns (which 34 percent of district leaders said their district has done) and the creation or expansion of grow-your-own teacher programs (which 33 percent of district leaders said their district has done). Leaders of urban districts and districts serving mostly students of color were particularly likely to indicate that their district had created or expanded a grow-your-own program to boost mathematics teacher applicants.

As our interviews reveal, grow-your-own programs can take several forms. In districts where we talked with leaders, nearly all had a specialized program that targeted paraprofessionals and partnered with higher education organizations to help them gain full professional certification. At least one district used a partnership with a local teacher preparation program to offer customized student teaching experiences. Another dis-

FIGURE 2.7

Percentage of District Leaders Who Indicated That Their District or State Enacted Various Policies Since the 2021–2022 School Year to Increase the Number of Applicants for Mathematics Teaching Positions



NOTE: This figure depicts response data from the following survey question administered in spring 2023: "Which changes, if any, has either your state and/or your district enacted since the 2021–2022 school year to increase the number of applicants for math teaching positions?" (n = 221). For each policy, respondents were asked to select from among the following response options: "N/A. No change," "Our district enacted this change to increase math applicants," "Our state enacted this change to increase math applicants," and "I don't know." Respondents could select more than one response option if the same policy change was enacted at both the state and district level. This figure depicts the percentage of district leaders who indicated that their district or state enacted changes to increase mathematics applicants. On the survey, we defined grow-your-own teacher programs as partnerships between a district, community organizations (such as after-school programs), and teacher preparation programs to train prospective teachers to become certified.

trict took their programs much further, targeting students themselves as part of a future solution. A leader in this district described their approach as starting as early as kindergarten with encouragement, continuing in middle school with shadowing teachers, and "then in high school . . . [there is] a customized curriculum [and] work-based learning as a junior and senior . . . and graduating as a high school student with an apprenticeship certificate where you can teach immediately with a one-to-one veteran mentor and finish a college degree."

Urban Districts Have Cast a Wider Net to Hire Mathematics Teachers

We asked district leaders in fall 2022 what sources they were using to hire mathematics teachers. As shown in Figure 2.8, we found that districts were using many sources to find and hire mathematics teachers. Two-thirds of districts or more recruited teachers from local or nonlocal teacher preparation programs, used district advertisements, principals' or teachers' social networks, or recruitment fairs. Fewer—but still sizable—proportions of districts reported hiring mathematics teachers from alternative teacher certification programs, from grow-your-own teacher programs, and from local minority-serving instructions. Very

FIGURE 2.8

Percentage of District Leaders Who Indicated That Their District or CMO Hires Mathematics Teachers from Specific Sources

Percentage
0 100

	All districts	Locale			Poverty level		Student racial/ethnic composition	
		Urban	Suburban	Rural	Low poverty	High poverty	Majority White students	Majority students of color
Graduates from other local college or university teacher preparation programs	92	96	93	92	95	88	95	85
Responses to district advertisements	86	81	85	87	88	84	86	89
Principals' or teachers' social networks	81	**92**	83	80	79	86	**79**	**92**
Graduates from non-local college or university teacher preparation programs	76	**91**	82	72	80	70	77	74
Recruitment fairs	66	**88**	70	62	62	72	**60**	**87**
Alternative certification programs	55	71	50	55	**46**	**65**	52	66
Grow-your-own program graduates	40	**64**	31	42	**33**	**51**	**36**	**56**
Graduates from local minority-serving institutions' teacher preparation programs	35	**71**	43	**28**	35	36	**29**	**55**
Outside recruiters	12	**42**	7	11	**6**	**19**	**7**	**27**

NOTE: This figure depicts response data from the following survey question administered in fall 2022: "From which sources does your district/CMO hire your math teachers?" (n = 280). For each source, respondents were asked to select from among the following response options: "not a source," "a small source," or "a large source." This figure depicts the percentage of district leaders who selected a "small" or "large" source. The survey question included an "Other" option, which was selected by 19 percent of respondents and has been omitted from this figure. Numbers in bold indicate that the subgroup percentage of district leaders reporting that a source is used to some degree is statistically significantly different ($p < 0.05$) from the percentage of remaining district leaders not in that subgroup who said the same.

few districts (only 12 percent) used outside recruiters to hire teachers. A human resources director we interviewed noted the realities of an extremely tight labor market: "We've been more aggressive across the board with our student teachers and in hiring early. There's not a stone that we haven't [turned]."

Overall, urban district leaders cast a wider net to hire mathematics teachers, possibly for several reasons. First, these districts have historically struggled to retain teachers (Sutcher, Darling-Hammond, and Carver-Thomas, 2016). These districts and others have struggled with acute teacher shortages, including in mathematics, during the COVID-19 pandemic (Diliberti and Schwartz, 2023; NCES, undated-c; Schwartz and Diliberti, 2022). Urban districts might also have more options available to them because they tend to be located in population centers, likely in proximity to institutions with teacher preparation programs. For example, urban districts might be able to more easily connect with local universities that train teachers in their area.

Furthermore, urban district leaders were more likely than their suburban and rural counterparts to rely on educators' social networks, use nonlocal teacher preparation programs, hold recruitment fairs, use grow-your-own teacher programs, recruit from minority-serving instructions, and use outside recruiters. At the same time, not all urban districts were equal in their ability to recruit new teachers. One human resources director in a district in a city that was not perceived to be an attractive destination found that they had greater success recruiting candidates of color from local universities than they did when they reached out to high-profile historically Black colleges and universities.

CHAPTER 3

Instructional System Components to Support Mathematics

As we described in Chapter 1, in coherent instructional systems, the components constituting the system send similar or reinforcing messages to teachers about what and how to teach, thereby providing clear guidance; therefore, they are likely to lead to high-quality instruction and student learning (Wang et al., 2022). The survey data and interviews with district leaders in this chapter shed light on three key components of an instructional system (curriculum, assessments, and professional learning) that are essential to supporting coherence, thus enabling high-quality instruction and students' mathematics learning.

Component 1: Curriculum and Other Instructional Materials

District leaders play an important role in shaping policy and practice around the use of instructional materials. Specifically, district leaders may require or recommend the use of specific instructional materials or may provide their schools with lists of approved materials from which to choose. Granted, district leaders' choices of what instructional materials to require or recommend is shaped by signals, incentives, and policies developed at the state level (see Figure S.1 in Doan, Kaufman, et al., 2022). Even so, the guidance district leaders provide around instructional materials likely influences school leaders' guidance to teachers, which likely shapes what materials teachers use and how they use them in their instruction, and ultimately affects student learning. In a coherent instructional system, district leaders and their state partners incentivize the adoption of high-quality curriculum materials, or materials that are aligned to states' academic standards or other state priorities (Doan, Kaufman, et al., 2022). Adopting standards-aligned materials at the district level is one way that district leaders can support teachers in implementing state standards.

In this section, we focus on what specific mathematics instructional materials district leaders say their districts had purchased for use, who makes decisions about what materials to use, and what district leaders say they prioritize when choosing materials.

In fall 2022, we surveyed district leaders about their mathematics instructional materials and provided them with lists of materials that are appropriate for each grade band (e.g., K–5, 6–8, and 9–12). We asked district leaders which of these materials they had purchased for use in the 2022–2023 school year. Our survey item asked district leaders whether their district had purchased certain materials, not whether their teachers were actually using those materials. Furthermore, although our survey item used the phrase *mathematics instructional resources*, all of the instructional materials we listed on the survey met our definition of *curriculum materials*; our list did not include *supplemental materials* (see the box titled "Definitions of Key Terms"). Therefore, throughout this section, we present our results referring to curriculum materials.

Definitions of Key Terms

Instructional materials are any materials that are intended to provide learning opportunities to students, including both *curriculum materials*, which constitute a full, comprehensive course of study, and other *supplemental instructional materials*, which do not constitute a full course of study, such as isolated activities or lesson ideas found on websites or online repositories.

Curriculum materials are instructional materials that are intended to constitute a full, comprehensive course of study for a particular subject and grade level. Curriculum materials could be provided through a textbook, online platform, or both.

Standards-aligned curriculum materials are any materials that have been rated by EdReports—an organization that rates curriculum materials against state standards—as fully meeting the expectations of college- and career-ready standards.

Supplemental materials are additional materials beyond curriculum materials that do not constitute a full course of study. These can include digital materials that provide additional resources and enrichment for students (e.g., Kahoot!, Quizlet) or intervention materials that are specifically designed to help students who are performing below grade level.

Definitions were obtained from Doan, Kaufman, et al., 2022, and Prado Tuma et al., 2022.

No Single Mathematics Curriculum Material at Any Grade Band Is Used in More Than 20 Percent of School Districts

Using district leaders' reports, we observed little convergence around what mathematics curriculum materials districts had purchased for use in the 2022–2023 school year. In Table 3.1, we display the curriculum materials that 5 percent or more of district leaders at each grade band said that they had purchased for use in the 2022–2023 school year. As shown in Table 3.1, district leaders reported purchasing a wide variety of curriculum materials. For example, the two most commonly adopted elementary curriculum materials identified by district leaders—i-Ready Classroom Math and Go Math—were each purchased by only a small minority (17 percent) of district leaders. i-Ready Classroom Math and Go Math were also among the top three most commonly purchased materials at the middle school level; the third was enVision Math 2020. At the high school level, district leaders most commonly said that they designed their own curriculum materials (14 percent of district leaders indicated doing this). The next most commonly purchased curriculum materials for high school mathematics were Edgenuity and enVision Algebra I/Geometry/Algebra II, according to district leader reports.

Notably, district leaders' reports of what curriculum materials they had purchased for use in the 2022–2023 school year were generally aligned with teachers' reports of what materials they were actually using in their classrooms in spring 2022, at least at the elementary and middle school levels (see Doan, Eagan, et al., 2022).[1] At all grade bands, teachers most often reported regularly using self-created materials in spring 2022 (Doan, Eagan, et al., 2022). However, aside from self-created materials, the top four mathematics curriculum materials regularly used by elementary mathematics teachers were i-Ready Classroom Math, EngageNY, Go Math, and Eureka Math (Doan, Eagan, et al., 2022). Similarly, at the middle school level, i-Ready Classroom Math and Go Math were among the top four most commonly used curriculum materials reported by teachers (excluding district-created materials) (Doan, Eagan, et al., 2022). At the high school level, however, the top two materials teachers reported using regularly were Pearson Traditional and Big Ideas Traditional, which were not the most common curriculum materials purchased by district leaders (Doan, Eagan, et al., 2022).

[1] These teachers may or may not be employed in the districts included in the sample for the ASDP survey.

TABLE 3.1

Percentage of District Leaders Who Said That Their District or CMO Has Purchased Various Mathematics Curriculum Materials for Use in 2022–2023

Curriculum Materials	Percentage of Districts	EdReports Rating
Elementary grades (K–5)		
Ready or i-Ready Classroom Mathematics (Curriculum Associates)	17	✓+
Go Math (Houghton Mifflin Harcourt)	17	X
enVision Math–2020 (Savvas Learning Company, formerly Pearson)	11	✓+
Eureka Math (Great Minds)	11	✓+
Bridges In Mathematics (Math Learning Center)	9	✓+
Big Ideas Math: Modeling Real Life–2019 (Big Ideas Learning, LLC)	7	X
Everyday Math 4–2020 (McGraw Hill Education)	7	✓+
Engage NY (NYSED)	6	✓+
My Math–2020 (McGraw-Hill Education)	6	X
enVision Math–2012 (Pearson)	5	—
Zearn (Zearn, Inc.)	5	✓+
Illustrative Math (Kendall Hunt) (Imagine Learning, formerly LearnZillion) (McGraw-Hill Education)	5	✓+
Middle grades (6–8)		
Go Math (Houghton Mifflin Harcourt)	15	X
Ready or i-Ready Classroom Mathematics (Curriculum Associates)	13	✓+
enVision Math–2020 (Savvas Learning Company, formerly Pearson)	13	✓+
Edgenuity (Imagine Learning, formerly Edgenuity)	7	X
Illustrative Math (Kendall Hunt) (Imagine Learning, formerly LearnZillion) (McGraw-Hill Education)	7	✓+
Reveal Math, Common Core Edition (McGraw-Hill Education)	6	✓+
Big Ideas Math–Modeling Real Life–2019 (Big Ideas Learning, LLC)	6	X
Big Ideas Math–2013 (Big Ideas Learning, LLC)	6	—
Engage NY (NYSED)	6	✓+
District designed own curriculum materials	5	—
enVision Math 2.0–2016 (Savvas Learning Company, formerly Pearson)	5	X
Eureka Math (Great Minds)	5	✓+
High school grades (9–12)		
District designed own curriculum materials	14	—
Edgenuity (Imagine Learning, formerly Edgenuity)	13	—
enVision A/G/A (Algebra I, Geometry, Algebra II) (Savvas Learning Company, formerly Pearson)	11	✓+
Glencoe Traditional (McGraw-Hill Education)	8	X

Table 3.1—Continued

Curriculum Materials	Percentage of Districts	EdReports Rating
HMH Traditional (Houghton Mifflin Harcourt)	6	X
Pearson Traditional (Savvas Learning Company, formerly Pearson)	5	X

NOTE: This table depicts response data from the following survey question administered in fall 2022: "Which math instructional resources has your district/CMO purchased for use in [grade band] in 2022–2023?" (n = 279). Respondents were asked separately about elementary (K–5), middle (6–8), and high school (9–12) grades. Respondents were shown lists of materials and were instructed to select all that apply. For brevity, this table includes only those materials identified by 5 percent or more of district leaders as purchased for use in the 2022–2023 school year. An X denotes that the material is not aligned with standards, a checkmark indicates that the material is fully aligned with standards, and a dash denotes that a rating was unavailable.

Not All of the Most Commonly Purchased Curriculum Materials Are Standards Aligned, Especially at the Secondary Level

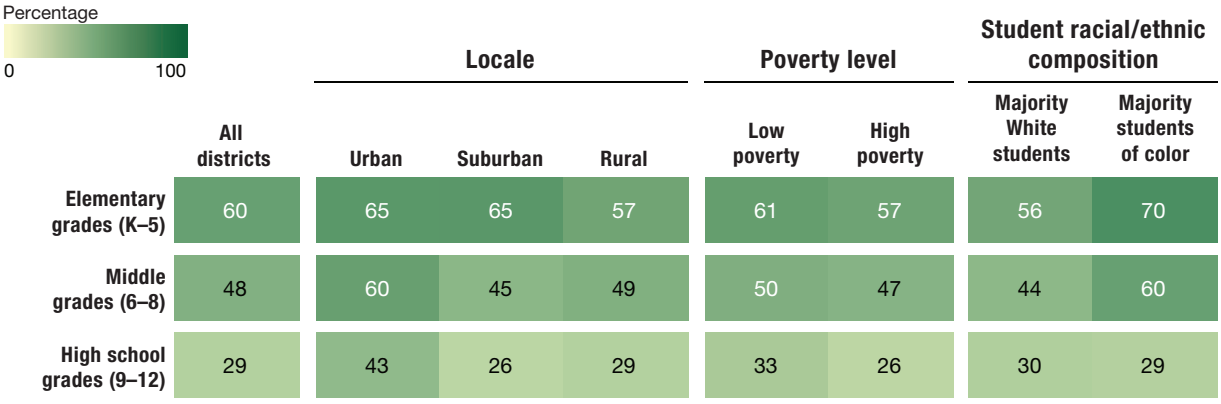
Not all mathematics curriculum materials are of equal quality. The nonprofit organization EdReports provides independent ratings of curriculum materials based on the extent to which materials align with most college- and career-ready academic standards across the United States. As described in the box titled "Definitions of Key Terms," we consider *standards-aligned curriculum materials* to be materials that have been rated by EdReports as fully meeting the expectations of college- and career-ready standards.

As shown in Table 3.1, many—but not all—of the mathematics curriculum materials that district leaders reported purchasing for use in the 2022–2023 school year were standards-aligned materials. At the elementary level, a majority of the most commonly purchased materials were standards aligned. However, Go Math—which was the most commonly purchased material at the middle school level and the second most commonly purchased material at the elementary level—does not meet EdReports' rating of standards aligned. More broadly, district leaders reported purchasing more standards-aligned materials at the elementary level than they did at the middle and especially high school levels. Only one of the most widely purchased high school mathematics curriculum materials identified by district leaders was standards aligned.

Overall, 60 percent of district leaders indicated that their district had purchased at least one standards-aligned mathematics curriculum material for the elementary grades for use in the 2022–2023 school year (see Figure 3.1). In comparison, 48 percent of district leaders said that they had purchased at least one standards-

FIGURE 3.1

Percentage of District Leaders Who Said That Their District or CMO Had Purchased at Least One Standards-Aligned Mathematics Curriculum Material for Use in 2022–2023



NOTE: This figure depicts response data from the following survey question administered in fall 2022: "Which math instructional resources has your district/CMO purchased for use in [grade band] in 2022–2023?" (n = 279). Respondents were asked separately about elementary (K–5), middle (6–8), and high school (9–12) grades. Respondents were shown lists of materials and were instructed to select all that apply.

aligned material for use at the middle school level, and only 29 percent of district leaders said that they had purchased at least one standards-aligned curriculum material for high schoolers. Although we observed variation by grade band, we did not observe significant variation in the adoption of standards-aligned mathematics curriculum materials by district subgroup.

Leaders Said That School Autonomy in Selecting Mathematics Curriculum Materials Is the Norm

In fall 2022, we asked district leaders about the main way in which schools in their district or CMO selected math curriculum materials. We listed six response options that capture *who* in the district makes decisions about curriculum material use. We interpret this survey item as an indication of what staff position in the district has autonomy or decisionmaking authority over curriculum materials.

As shown in Figure 3.2, only 18 percent of district leaders said that district staff mainly select which curriculum materials their schools will use. Urban district leaders were the most likely to say that decisions around curricula are made at the district level: Forty-three percent of urban district leaders said that mathematics curriculum decisions are made at the district level, compared with only 20 percent of suburban and 15 percent of rural districts.

Instead, district leaders reported that it was generally the norm to give schools and teachers at least some degree of autonomy around the mathematics curriculum they use. Forty-three percent of district leaders said that school staff make decisions about curriculum, subject to district approval. In these districts, school staff either propose what curriculum materials to use or (far less commonly) select from a list of district-approved materials. Meanwhile, 39 percent of district leaders indicated that decisions around mathematics curriculum materials are made entirely at the school level, most often by teachers—either individually or in collaboration with other teachers.

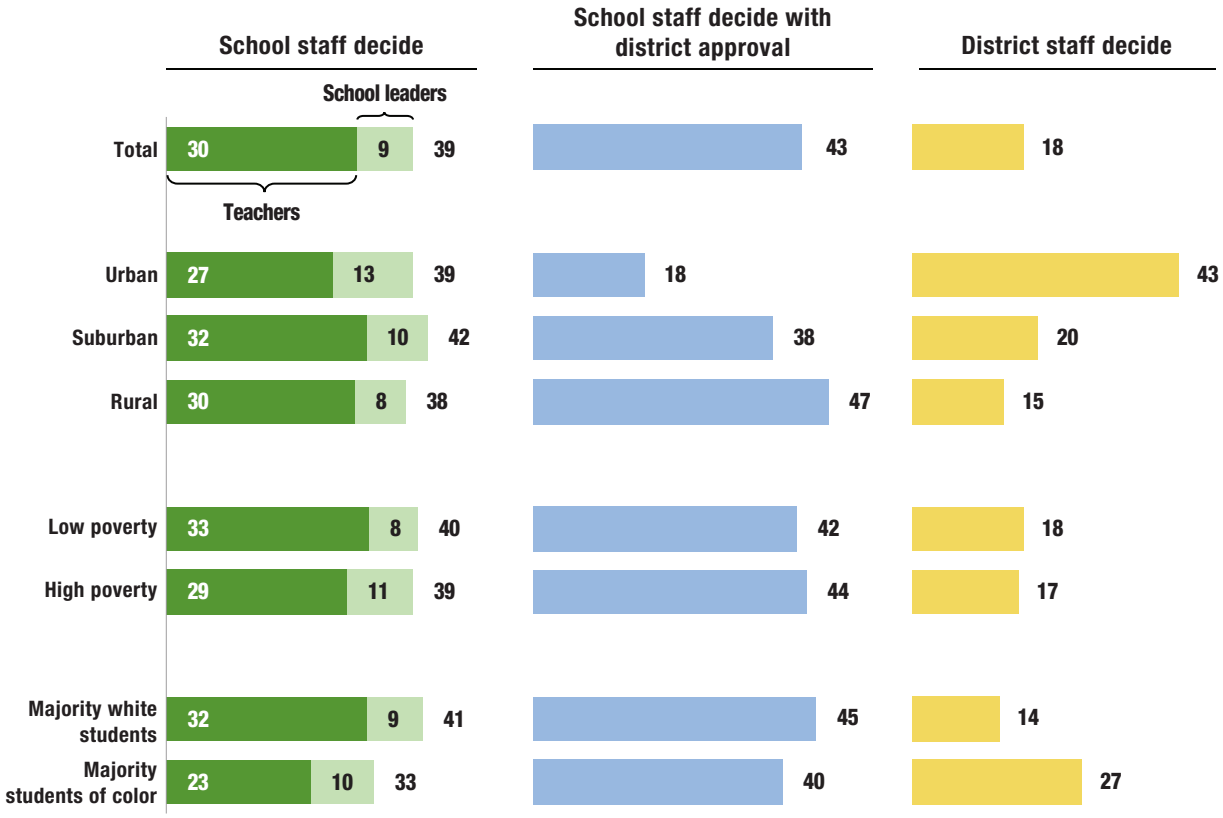
Our colleagues asked teachers in a spring 2022 survey who they perceived to be the decisionmakers around mathematics instructional materials. At that time, 48 percent of mathematics teachers said that they or their colleagues were the main decisionmakers around materials (Doan, Kaufman, et al., 2022). However, 46 percent of teachers said that district leaders were the main decisionmakers (Doan, Kaufman, et al., 2022). These patterns are somewhat hard to interpret but might suggest that teachers perceive there to be tighter control over instructional materials than district leaders do.

Teacher and/or school-level autonomy over choices of instructional materials, including curriculum materials, can affect their instruction. On one hand, giving teachers some degree of autonomy over curriculum materials allows them to exercise judgment and select what they feel is most responsive to the student populations they teach. On the other hand, a high degree of school and teacher autonomy is likely to lead to a high degree of variation in the quality of materials used across classroom settings, raising concerns about whether students are receiving equitable access to high-quality instruction.

In interviews, leaders in several urban districts talked through how teacher autonomy can lead to variation in curriculum across schools. One leader in a district talked about how variation had a real downside because of high student mobility: "When kids move from school A to school B, they can't be dropping off one big topic and picking up another one and expecting fast results." Another district leader discussed the trade-offs associated with school or teacher autonomy versus more-central control at the district level: "[Autonomy] is a draw for teachers—they want to be able to do what they need to do. And so if you become a district that is so centralized that you're continuously forcing curriculum and resources down people's throats. . . . But you can't just have it be a free-for-all."

FIGURE 3.2

Percentage of District Leaders Who Indicated That Various Staff Members Are the Main Decisionmakers About Which Mathematics Curriculum Materials to Select



NOTE: This figure depicts response data from the following survey question administered in fall 2022: "What's the main way schools in your district/CMO select math curriculum?" (*n* = 282). Respondents were asked to select from among several response options, which were then further collapsed. The responses "Teachers mainly decide which curricula to use on their own," and "Teachers mainly decide which curricula to use in collaboration with other teachers" were collapsed into the dark green teachers bar and are added to the response "School leadership mainly decides which curricula teachers will use," which is shown in light green. The response options "School staff proposes curricula, which the district/CMO must approve," and "Schools must select from a list of district/CMO-approved curricula" were collapsed into "School staff decide with district approval," which is shown in blue. The final response option, "The district/CMO mainly selects which curricula its schools will use," is shown in yellow. Bars may not sum to totals because of rounding.

Districts Typically Trusted In-House Staff to Determine What Materials to Use

Given the high degree of variation in curriculum materials district leaders reported purchasing, we wanted to understand where leaders seek information about which mathematics instructional materials should be adopted in classrooms. Results from spring 2023 suggest that district leaders most commonly looked internally for reliable information about what mathematics instructional materials teachers should use, as opposed to using external sources. As shown in Figure 3.3, nine out of ten districts turned to their own administrators or mathematics instructional specialists for guidance on materials, and eight out of ten districts trusted information from mathematics teachers at their schools. In interviews, leaders described convening adoption committees made up of internal mathematics specialists, principals, and teachers when selecting new curriculum materials.

Meanwhile, roughly half of district leaders reported turning to external networks, such as their state departments of education, professional associations, and other district leaders, for reliable information about what mathematics instructional materials teachers should use in their classrooms. Leaders of majority White

FIGURE 3.3

Percentage of District Leaders Who Indicated That They Trust Various Sources for Reliable Information About Which Mathematics Instructional Materials Teachers Should Use in Their Classrooms

Percentage
0 100

	All districts	Locale			Poverty level		Student racial/ethnic composition	
		Urban	Suburban	Rural	Low poverty	High poverty	Majority White students	Majority students of color
My district administrators, including mathematics instructional specialists	89	73	**99**	87	91	87	89	89
Mathematics teachers at my school or other schools	81	75	85	80	86	72	85	70
My state department of education	52	43	47	56	50	60	56	52
Other district leaders	47	61	48	45	52	43	50	39
My professional association(s) of district representatives	45	44	57	42	47	45	**50**	**32**
EdReports.org	27	**65**	27	23	28	26	25	35

NOTE: This figure depicts response data from the following survey question administered in spring 2023: "Who do you trust for reliable information about which math instructional materials teachers should use in their classroom?" (n = 222). Respondents were instructed to select all that apply. The survey question included an "Other" option, which was selected by 7 percent of respondents and has been omitted from this figure. Numbers in bold indicate that the subgroup percentage of district leaders reporting that they trust a source is statistically significantly different ($p < 0.05$) from the percentage of remaining district leaders not in that subgroup who said the same.

districts were more likely to rely on professional associations of district representatives for information on instructional materials than their counterparts in districts serving predominantly students of color.

A sizable minority of district leaders (roughly three in ten) said that they trusted EdReports' ratings of curriculum materials as a reliable source of information about which mathematics instructional materials their teachers should use. Notably, urban district leaders indicated that they trusted these materials to a greater degree than their nonurban peers did. Perhaps related to district leaders' low trust in EdReports ratings, few district leaders reported using EdReports to inform which curriculum materials to adopt. In spring 2022, only 24 percent of district leaders said that they used EdReports ratings to inform adoption of mathematics curriculum materials (results not shown).

When Selecting Mathematics Curricula, District Leaders Prioritized Alignment with State Standards and Student Engagement

We asked district leaders in fall 2021 about what curriculum features were very important when deciding what middle school mathematics curricula to adopt.[2] We found that, although district leaders made very different choices about what curriculum materials to purchase, they tended to value similar aspects of these materials. Roughly six in ten district leaders identified the alignment of curriculum materials to state standards and student engagement as factors that were very important when considering curriculum adoption

[2] We asked district leaders specifically about how they make decisions about the adoption of middle school math curricula but assume that these findings generally apply for elementary and high school as well. We are comfortable with this assumption because we have asked similar questions to teachers and principals in other American Educator Panels surveys and obtained similar results.

(see Figure 3.4). We have asked similar questions of teachers and found that, regardless of subject and grade level, teachers also rank alignment with state standards and student engagement as their top priorities when selecting tasks and activities from their instructional materials to use in the classroom (Diliberti, Woo, and Kaufman, 2023; Doan, Eagan, et al., 2022).

Meanwhile, about four in ten district leaders identified differentiated supports for students and associated professional development as very important factors. Two in ten or fewer district leaders identified other factors—such as online lessons, integration of social and emotional learning, and cost—as very important.

Despite district leaders' general agreement about the most important considerations, we observed some differences in lower-ranked priorities by district demographics. For example, leaders of urban districts and leaders of districts serving mostly students of color—that is, leaders of districts that tend to serve more-diverse student populations—were more likely to indicate that supports for English learners and cultural relevance were very important features to consider when choosing a mathematics curriculum. Leaders of historically disadvantaged districts—the same districts whose students were most negatively affected by prolonged pandemic-related school closures (see, e.g., Goldhaber et al., 2022; Institute of Education Sciences, undated; NCES, undated-a)—were also most likely to indicate attention to addressing unfinished learning needs after pandemic-related disruptions to schooling as a very important feature. Finally, urban district leaders were particularly likely to indicate a positive review by EdReports as a very important consideration—a finding that is consistent with urban district leaders' above-average trust in EdReports as a reliable source of information about what curriculum materials to adopt.

Component 2: Assessments

In mathematics, educators monitor student achievement using various kinds of assessments, including formative, interim or benchmark, and summative assessments. As described by Perie, Marion, and Gong (2009), different assessments are used by different stakeholders for different purposes. Formative or diagnostic assessments are generally administered by classroom teachers for the purpose of identifying gaps in student learning. Teachers can then use the data from these assessments to adjust their instruction to address these gaps. Meanwhile, interim assessments (such as NWEA's MAP Growth assessment or Curriculum Associates' i-Ready assessment) provide data that can be aggregated to the school or district level. School and district leaders use these assessment data to monitor students' learning progress against a set of standards and predict student performance on summative assessments. Reports from educators suggest that they widely use both published and locally created mathematics benchmark assessments at the elementary and secondary levels (Woo and Diliberti, 2023).

Finally, in accordance with the 2015 Every Student Succeeds Act (and formerly per the No Child Left Behind Act) elementary students are assessed in grades 3 through 8 via annual statewide summative assessments. In grades 9 through 12, states assess students' mathematics achievement using a wide variety of assessments, including end-of-course exams in a single mathematics content area, such college admission exams as the ACT or SAT, or state-developed assessments (Achieve, undated; Education Commission of the States, 2018; NCES, undated-d). These assessments vary in the specific mathematics content they cover. Some assessments, such as the ACT or Smarter Balanced, are comprehensive. Other assessments, such as end-of-course assessments, are specific to a mathematics content area, such as algebra I or geometry (Achieve, undated).

All of these assessments, regardless of type, have a role to play in a coherent instructional system. In an ideal instructional system, these assessments are aligned with the academic standards and with the curricula teachers are using. Standards- and curriculum-aligned assessments help send clear and consistent messages to teachers about what should be emphasized in their instruction.

FIGURE 3.4

Percentage of District Leaders Who Indicated That Various Features of a Middle School Mathematics Curriculum Are Very Important for Their Decision to Adopt It

Percentage
0 100

		Locale			Poverty level		Student racial/ethnic composition	
	All districts	Urban	Suburban	Rural	Low poverty	High poverty	Majority White students	Majority students of color
Quality of alignment of the curriculum materials to the state standards and district curriculum guidance	59	65	67	55	61	57	60	58
Engaging content for students	57	54	58	57	59	53	57	55
Inclusion of differentiated extensions to lessons for students performing above and below the content level	41	52	**53**	**36**	**48**	**32**	41	42
PD for teachers about its use	39	43	45	37	39	40	40	39
Supports for students learning English	22	**39**	29	**18**	22	22	**17**	**37**
Ease of use for teachers	21	24	21	21	19	25	19	32
Attention to addressing unfinished learning within grade level curriculum materials	20	**44**	15	19	**13**	**31**	**17**	**30**
Degree to which curriculum materials require that students explore, interpret, conjecture, and apply data science in tasks and projects	19	30	27	**15**	21	16	18	21
Inclusion of both online and in-person lessons	15	19	23	12	17	14	16	13
Positive review by EdReports	12	**24**	12	10	12	11	11	12
Integration of social and emotional learning supports	11	17	16	9	12	10	11	12
Cultural relevance to students	11	**32**	17	**6**	**7**	**15**	**6**	**22**
Cost	11	7	11	11	9	13	10	13

NOTE: This figure depicts response data from the following survey question administered in fall 2021: "How important are the following features of a middle school math curriculum to your district/C-MO's decision to adopt it?" (n = 314). For each feature, respondents were asked to select from among the following response options: "not at all important," "somewhat important," "important," or "very important." This figure depicts the percentage of district leaders who selected "very important." Respondents could also write in an "other" option (which 11 percent of respondents indicated was very important), which has been omitted from this figure. Numbers in bold indicate that the subgroup percentage of district leaders reporting that a curriculum feature is very important for their decision to adopt it is statistically significantly different ($p < 0.05$) from the percentage of remaining district leaders not in that subgroup who said the same. PD = professional development.

In this section, we discuss some of the challenges district interviewees identified relating to assessments and how districts began to modify their assessment programs with an eye toward coherence.

District Interviewees Described a Series of Challenges in Implementing System-Wide Formative Assessments

In interviews, district leaders identified a series of challenges relating to the use of formative assessments in particular. First, interviewees said that it was a priority to obtain or develop formative assessments that provided a bridge between curriculum materials and state standards to be used districtwide. In districts where not all students are using the same materials, these leaders told us that they needed better system-wide data to identify specific learning gaps. The following example illustrates these challenges using one district leader's experiences. This district allows schools to pick from a curriculum menu. The deputy chief of learning told us, "We really wanted to have a pulse . . . of, as a district, how well kids are mastering current standards." Although this district had used—and continues to use—the NWEA MAP Growth tests as a benchmark tool, they noted that this did not work well as a formative assessment that can guide "immediate classroom discussions or decisions and instructional decisions."

Second, we heard from leaders in several school districts about difficulties convincing school personnel to use common assessments and tools. One district leader, having invested considerable time and energy in the development of in-house formative assessments aligned to state standards, noted not being able to systematically analyze the findings from these assessments because uptake had been low. One leader explained, "We don't know how teachers are giving a test, whether they're giving them as pre or post [test] or somewhere in between. We don't really know at what point in the instructional cycle these are being given since people are doing them . . . however they would like to." Other district leaders believed that some teachers avoided giving the new assessments because they anticipated that students would do poorly on them: "The feedback that we've heard . . . is that the tests are hard."

To reduce costs and increase instructional system coherence, one interviewed district leader engaged internal stakeholders (e.g., mathematics teachers, school leaders, and coaches) to develop a robust set of state standards–based assessments that could be used regardless of which curriculum their school had purchased. Another district had taken this approach and gone a step further, developing a portal that combined not only common assessments but also district-vetted instructional materials and a guide to help school leaders understand core concepts to better assess mathematics instruction. According to this district leader, "[h]aving it on one page for leaders when they go into observations so they could really give sound feedback . . . that was specific to Algebra I; that was very helpful."

In a success story, school district leaders pointed to the analysis of regular common assessments as a central component of their improved mathematics performance after the COVID-19 pandemic. According to this leader, "[w]e had a spreadsheet with every school . . . and every single teacher there. And we actually recorded their [weekly common formative assessment] data. . . . And we looked at that every week." Leaders in this system attributed the high degree of compliance to a tight focus on a single mathematics subject (algebra I) and systematic communication at all levels of the organization, starting with outreach to associate superintendents and school leaders and extending to weekly email communication with teachers.

Component 3: Professional Learning

Professional learning opportunities are a third component of instructional systems. Ideally, professional learning opportunities are aligned with the other components of the instructional system, especially with curriculum. Professional learning opportunities that focus on curriculum can potentially help shape the

extent to which teachers use standards-aligned curriculum materials and how they use these materials in their classroom. Previous RAND research has shown that teachers who received frequent curriculum-focused professional learning opportunities were more likely than their counterparts to regularly use standards-aligned materials (Zuo, Doan, and Kaufman, 2023).

Alignment to Mathematics Curriculum and Peer Recommendations Were the Most Common Factors Influencing Districts' Choice of Mathematics Teacher Professional Learning

We asked district leaders in spring 2023 about the factors that they consider when selecting external professional learning opportunities and providers to support teachers' mathematics instruction. We listed six factors and asked whether these factors were a minor or major consideration or not a consideration at all. We focus on district leaders' perceptions of what factors were major considerations.

Alignment to curriculum materials (and recommendations from educators) stand out as major considerations in the selection of external professional learning opportunities (see Figure 3.5). Regardless of school context, eight out of ten district leaders (or more) indicated that these were major considerations. Fewer but still sizable numbers of district leaders reported that other factors were major considerations when selecting external professional learning opportunities. For example, about half noted that recommendations from their state department of education or other district leaders were major considerations. Leaders of high-poverty districts were especially likely to highlight recommendations or requirements from their state departments of education, while suburban district leaders were especially likely to select recommendations from other district leaders. Meanwhile, only three in ten district leaders said that recommendations from professional associations were a major consideration, and only 3 percent said similarly about Rivet Education's Professional Learning Partner Guide.

When we interviewed district leaders, we heard that the necessity of aligning professional learning to the curriculum was driven in part by the district's switch to conceptual mathematics. Professional learning had to align with the curriculum because the new curriculum required a shift in teachers' pedagogical approach and mathematical mindset. As one leader described, "the curriculum itself will show you how to teach it, but if you don't understand kind of the mathematics behind it [you aren't going to be able to teach it well.]" This leader went on to describe a typical example where the teachers abandoned the conceptual curriculum approach and taught their students using the procedural approach "because when [the teachers] were in school, that's how they learned."

Our interviews also revealed that some districts were turning away from external professional learning providers and moving those operations in-house. Leaders from districts that did so cited three reasons: cost, quality, and the need for programming that was a tighter contextual fit. As one district leader explained, "Next year we're scaling back [our external coaching vendors]. It's expensive and if we're not gonna see the impact of it, and if our partners can't guarantee us really high-quality people and we don't get the outcomes, I'm not spending the money on it." Another leader—highlighting the challenge of finding professional development opportunities that are tied to intellectually rigorous content delivered in a high-poverty, urban setting—noted

> I generally have been disappointed with outside development and developers. I think it's hard . . . to visit other schools [using the same instructional program] because . . . schools around us just don't look like ours [in terms of student population]. And so that's a big hurdle, especially for mindsets.

In place of external providers, the district sought to ramp up its capacity for internal professional development by planning a demonstration lab that would highlight successful educators within its system and give teachers a chance to see what quality instruction in conceptual mathematics looks like in practice.

FIGURE 3.5

Percentage of District Leaders Who Indicated That the Following Factors Were a Major Consideration When Selecting External Professional Learning Opportunities and Providers to Support Teachers' Mathematics Instruction

Percentage: 0 – 100

	All districts	Locale			Poverty level		Student racial/ethnic composition	
		Urban	Suburban	Rural	Low poverty	High poverty	Majority White students	Majority students of color
Alignment of professional learning to mathematics curriculum teachers use	84	93	93	**79**	82	84	82	88
Recommendations from educators in my district	81	79	88	78	86	73	81	77
Recommendations or requirements from my state department of education	56	46	51	60	**49**	**72**	56	68
Recommendations from other district leaders	49	32	**68**	**43**	55	42	52	45
Recommendations from my district professional association(s)	29	28	32	28	28	29	27	33
Rivet Education's Professional Learning Partner Guide	3	2	5	2	4	1	3	2

NOTE: This figure depicts response data from the following survey question administered in spring 2023: "How much does each of the following factor into your decisions when selecting external professional learning opportunities and providers to support teachers' mathematics instruction?" (n = 215). For each factor, respondents were asked to select from among the following response options: "I don't consider this at all," "This is a minor consideration," or "This is a major consideration." This figure depicts the percentage of district leaders who selected "This is a major consideration." Respondents could also write in other online resources (which 4 percent of respondents indicated were a major consideration), which has been omitted from this figure. Numbers in bold indicate that the subgroup percentage of district leaders reporting that a factor is a major consideration when selecting external professional learning opportunities and providers to support teachers' mathematics instruction is statistically significantly different ($p < 0.05$) from the percentage of remaining district leaders not in that subgroup who said the same.

CHAPTER 4

Discussion and Recommendations

In coherent instructional systems, all components of schools' instructional systems—including curriculum, assessments, professional learning, teacher evaluation, and state standards—are aligned in ways that meet students' needs and lead to achievement gains for all students (Wang et al., 2022; Wang et al., 2023). Certain conditions—such as having a vision for academic improvement and dedicating sufficient time and resources—propel coherent instructional systems. In this report, we examined district leaders' perspectives about some components of their instructional systems and some of the conditions that enable coherence.

As we describe in the paragraphs that follow, our survey and interview data lead us to conclude that the idea of *coherence*—or alignment of instructional system components—is on many districts' radars, but many districts may need help making coherence a priority or implementing it.

Many districts (about four in ten) *did not* have any specific goals for secondary mathematics. This is both striking and concerning because having a clear vision for academic improvement is a critical starting point to enable the development of coherent instructional systems. However, the fact that a small majority of districts *did* report having set specific goals suggests that many leaders recognize that having goals that can unite staff and guide improvement efforts is important.

Our data also show that the goals districts do set vary widely in their quality. Some districts' goals were not specific enough to be useful or their targets varied substantially. This might be appropriate given that districts are starting in different places, but it also raises concerns about equity if district leaders in different contexts have differing expectations for their students.

District leaders also recognized the importance of teachers in meeting their goals. More district leaders ranked an inadequate supply of teachers as a barrier than identified other commonly cited challenges to improving math achievement, such as student math anxiety and insufficient math preparation. Two-thirds of district leaders said that they (or their states) were experimenting with policy shifts to boost the supply of math teachers. Taken together, these responses suggest that district leaders recognize that mathematics teachers are a critical resource.

With regard to the components—not just the enabling conditions—of a coherent instructional system, beyond goal-setting and teacher supply, our survey and interview data suggest that district leaders may be thinking broadly about the alignment of the various instructional system components. For example, 59 percent of district leaders said that alignment of mathematics curriculum materials to state standards (and other district guidance) was not only a very important factor in their decision to adopt it but also ranked as their top consideration. Eighty-four percent of district leaders indicated that alignment to curriculum materials is a major consideration when selecting external professional learning opportunities and providers to support teachers' mathematics instruction. At the elementary (but not secondary) level, a majority of districts have purchased at least one standards-aligned mathematics curriculum material. In one case study interview, a district leader described the value of coherence and explained how increasing instructional system coherence, along with increasing the use of shared teaching practices may have directly led to student achievement gains (see the box titled "Instructional System Coherence in Action: What Does It Look Like?").

Instructional System Coherence in Action: What Does It Look Like?

One district in our case studies stands out as a success story in its effort to build instructional system coherence. This district worked toward improvement both by increasing instructional system coherence (or alignment between instructional system components) and by increasing the use of shared teaching practices across classrooms.

Since 2021, this district prioritized algebra I to establish a proof of concept for its model of sustainable change. The district focused on algebra I for two reasons: First, it was a subject in which district students had historically struggled, and second, district leaders had found that early success in algebra I was a key predictor of high school success. The district's chief academic officer explained in spring 2022 that the leadership and curriculum or instruction divisions had "put together a really nice cadence of monitoring Algebra I: classroom walks, feedback, coaching, looking at the standards, looking at common formative assessments, [and] empowering the principal and his team to really understand what needs to be happening on a daily basis as they're entering those Algebra I classes."

By spring 2023, interviews with senior district leaders and a small number of school leaders and mathematics teachers revealed that the district had made concrete progress aligning its instructional materials, assessments (for students and teachers), and professional development strategies. In addition to increasing alignment among instructional system components, district officials worked with school leaders and teachers to encourage the use of shared teaching practices. As the district superintendent told us, "When I joined the organization six years ago, when I'd walk classroom to classroom and ask teachers what they're teaching, one, I didn't get the same answer twice." In the intervening years, the district placed a premium on developing common resources. Toward that end, district officials worked with school leaders and teachers to develop common grade-level academic standards and biweekly formative assessments. A core component of this approach was the development of an online portal that is accessible to teachers, school leaders, and district officials as a "one-stop shop" that contains both formative student assessments and curriculum materials for teachers and scope and sequencing documents tied specifically to teacher evaluation for school leaders.

School leaders and teachers alike appeared to embrace the new materials. One middle school principal explained, "You don't have to guess about what we're teaching. You don't have to guess about how much time to spend on it. You don't have to guess about which assessment to give. It's just no guesswork at all if you just kind of follow this pacing."

And although the system is new, preliminary evidence suggests that these investments have paid off in terms of increased student learning. By midway through the 2021–2022 school year, leaders noted incremental payoffs from schools that had piloted the new approach. By the end of the year, they could boast of algebra I gains in every high school in the district. Moreover, several high schools and middle schools had algebra I scores that were on par with or even exceeded prepandemic scores.

On the other hand, we also see signs that district leaders are struggling with coherence. For example, only 29 percent of districts had purchased a standards-aligned mathematics curriculum material for use in high school. Only 27 percent of district leaders said that they trusted independent nonprofit EdReports to give them reliable information about which mathematics instructional materials teachers should use in their classrooms. Only 24 percent said that they actually used EdReports ratings to inform their selection of curriculum materials. Interviewed district leaders discussed grappling with incomplete formative assessments, including ones that are often poorly connected with curriculum choices or misaligned with state standards.

Unfortunately, our survey and interview data do not shed much light on *why* district leaders may be struggling with the development of coherent instructional systems. It may be that district leaders do not recognize the importance of coherence, cannot prioritize this among other competing objectives, do not have the infor-

mation they need to measure the coherence of their system, or lack the sources to make their system more aligned. We hope to learn more about the "how" in future ASDP surveys and interviews.

Recommendations

Recognizing the importance of building a coherent instructional system to improve mathematics instruction and, thereby, mathematics achievement, we offer the following recommendations to district leaders:

- **Districts should set specific goals that help unite school system leaders and teachers around a shared purpose and that articulate a clear vision for academic improvement.** As they navigate goals with a student body that is in the midst of pandemic recovery, district leaders will need to think strategically about the goals they set. "Good" goals have enough specificity to capture the student population of interest, articulate how to measure success and monitor progress toward the goal, and are appropriately achievable under a documented timeline given the district's current status. Goals should also have a clear focus on equity. Such goals can help district leaders unify their staff around a vision and put in place curriculum, assessments, and teachers that are appropriately aligned to help districts achieve these goals. To inform their goal-setting, districts would do well to backward map and identify interim goals, starting with expectations of what students should be able to do upon graduation from high school, to assess whether students—and schools—are on track to achieve these goals. Coursetaking is a good example of how districts might backward map their goals. These goals likely would include not only pass rates tied to algebra I but also targets for increased enrollment in other mathematics courses, such as algebra II and higher-level mathematics courses (such as precalculus, statistics, and trigonometry) that are gateways to higher education. While acknowledging that a single mathematics pathway likely is not appropriate for all students, districts should monitor which students are in these courses with an eye toward increasing equity in enrollments in higher-level mathematics courses.
- **Districts (and their state partners) need to further explore policy changes to recruit, develop, and retain high-quality mathematics teachers in the current labor market.** District leaders identified a lack of high-quality mathematics teachers as the number-one barrier to achieving mathematics goals, and teachers are a critical to supporting the development of coherent instructional systems. Many leaders expected shortages of secondary teachers in the 2023–2024 school year. State leaders can assist their district partners in recruitment efforts by expanding alternative certification routes that allow districts to recruit promising candidates from other careers and build their workforces internally by empowering paraprofessionals. They can also explore policy mechanisms (such as boosting teacher pay) to make the teaching profession a more attractive career to both enter and stay in.
- **Although some degree of flexibility is important to meet student needs, districts should encourage their schools and staff to adopt mathematics curricula, assessments, and professional learning opportunities that are intentionally aligned to one another and that meet state standards.** State standards should be the backbone of a coherent instructional system. As a first step in moving toward coherence, district leaders should further encourage their staff to adopt standards-aligned curriculum materials and, perhaps, curriculum materials that have built-in assessments. These leaders might encourage their classroom teachers to adopt standards-aligned materials by purchasing materials that are aligned with standards and by strongly recommending or requiring their schools to use these materials. To guide decisions about what to purchase, district leaders might look to such sources as EdReports or their state departments of education. Too few district leaders who took our survey indicated using such tools as EdReports to make informed decisions when adopting curricula. From there, district leaders can work toward further instructional system coherence. For example, districts might provide their teachers

and principals with professional development opportunities that focus on the use of these standards-aligned curriculum materials and how to use assessment data to inform their instructional practices.

APPENDIX

Data Sources and Methods

In this appendix, we describe the data sources we used to write this report. We also briefly describe our methods for analyzing each of the data sources.

Data Sources

ASDP Survey Data

In this report, we primarily used data from four surveys administered to district leaders across the United States via the ASDP.

We randomly sampled traditional public school districts and CMOs and invited them to enroll in the ASDP between fall 2020 and spring 2023. Of the roughly 4,200 districts that have been invited into the ASDP, roughly 1,100 have agreed to become ASDP members and participate in periodic surveys. Since the ASDP began in fall 2020, researchers have periodically surveyed member districts about various issues of education policy and practice. ASDP surveys are emailed to each district's designated point of contact (most commonly the superintendent), who might share the survey with other district staff to determine the most appropriate person(s) to complete the survey on behalf of the district. We expect that it is common for multiple people in a district to work together to complete ASDP surveys.

Four of the seven surveys that have been conducted via the ASDP since the panel began in fall 2020 have included questions about districts' approach to mathematics. The analyses included in this report rely on a subset of the mathematics survey items included on these four ASDP surveys. We omit only a handful of mathematics-specific ASDP survey items, as follows:

- "What mathematics courses do students need to take to graduate from high school in your District/CMO?" We asked this question in fall 2021. (We include this information in this report but use data on state graduation requirements directly instead of district leaders' reports because state data are more reliable than district leaders' reports.)
- "As of the date you are taking this survey, does your District/CMO use EdReports (an organization that evaluates curricula) to inform which middle school mathematics curricula to adopt?" We asked this question in fall 2021. (We omit this information because we asked this question again in spring 2022. We use the spring 2022 data because they are more recent and not specific to middle school.)
- "Many school districts and CMOs recommend that high school students take a traditional mathematics course sequence that ends in calculus to be college ready. Does your [district/CMO] require or recommend other mathematics course sequence(s) that do not include calculus to prepare students for college (e.g., statistics pathway)? If so, what are those pathways, and what courses are included in it?" We asked this question in spring 2022 (We omit this question because it does not align with the report's focus on coherent instructional systems and because readers can see the same patterns in the other coursetaking data that we do include.)

- "What are your District/CMO's three biggest challenges to success in middle school mathematics?" We asked this question in fall 2021. (We omit this question because it is largely duplicative of the barriers item we asked about in spring 2023 and included in this report. Furthermore, this item asks only about middle school mathematics and includes less comprehensive response options.)
- "What's the main way that schools in your District/CMO select middle school mathematics curricula?" We asked this question in fall 2021. (We omit this question because we asked the same question in fall 2022 and chose to use the more-recent data.)

Interested readers can view district leaders' responses to the full set of mathematics survey items at www.americanschooldistrictpanel.org. Most of the survey items used in our analyses are closed-ended (i.e., respondents are asked to select among a set of predetermined response options). However, our surveys also included several open-ended survey items in which respondents were asked to provide written explanations.

As shown in Table A.1, the four ASDP surveys that included items about mathematics were administered between fall 2021 and spring 2023 and include responses from hundreds of district administrators. Target respondents, sample sizes, and completion rates were relatively similar for each of the four surveys used in this report and are comparable with other surveys administered via the ASDP. The spring 2023 survey sample did not include CMO leaders. However, we do not believe that this difference in sample composition biases our results because only a handful of CMO leaders completed the fall 2021, spring 2022, and fall 2022 surveys.

Membership in the ASDP has grown since it began in fall 2020. Although all districts that were members of the ASDP at the time each survey was administered were invited to participate in each survey, not all member districts completed all four surveys. Thus, there is partial but not complete overlap in the districts that completed the four ASDP surveys used in this analysis.

District leaders' responses to each survey were individually weighted to be representative of the national population of public school districts. Estimates for each survey were then separately produced using cross-sectional survey weights designed to provide nationally representative estimates at the time point at which the survey was administered. As shown in Table A.2, our four weighted survey samples generally match the characteristics of the U.S. population of public school districts. To learn more about the ASDP sampling and weighting process, see Grant et al. (2022).

Survey responses have been weighted to be representative of the national population of public school districts, not the national population of public school students. Students are not evenly distributed across school districts. As shown in Table A.2, among the population of 13,000 school districts in the United States, only 9 percent are urban, whereas 25 percent are suburban and 66 percent are rural. However, roughly 30 percent of the country's 50 million public school students are enrolled in urban districts (NCES, undated-e), and the country's 120 largest school districts—many of which are urban—alone account for roughly 20 percent of all

TABLE A.1

Overview of the ASDP Surveys Used in This Report

	Fall 2021	Spring 2022	Fall 2022	Spring 2023
Start date	October 25, 2021	February 28, 2022	October 13, 2022	March 1, 2023
End date	December 10, 2021	April 10, 2022	December 12, 2022	April 25, 2023
Sample	District leaders and CMO leaders	District leaders and CMO leaders	District leaders and CMO leaders	District leaders only
N	359	291	300	222
Completion rate	36.4	28.2	26.1	20.1

TABLE A.2
Descriptive Statistics for Survey Respondents' Districts

	Percentage				
	Weighted Survey Sample, Fall 2021	Weighted Survey Sample, Spring 2022	Weighted Survey Sample, Fall 2022	Weighted Survey Sample, Spring 2023	Population of Public School Districts
District enrollment size					
Small (fewer than 3,000 students)	71	72	73	72	73
Medium (3,000 to 9,999 students)	20	19	22	22	19
Large (10,000 or more students)	9	9	5	6	7
Locale					
Urban	9	9	6	7	9
Suburban	25	26	27	26	25
Rural	66	65	67	67	66
Poverty status					
Low poverty	56	61	58	58	61
High poverty	44	40	42	42	39
Student racial/ethnic composition					
Majority White students	74	73	75	75	78
Majority students of color	26	27	26	25	23

NOTE: The population sample consists of U.S. public school districts (approximately 13,000 districts) in the original sampling frame for ASDP recruitment. We obtained district characteristics from the Common Core of Data files. Weighted proportions were calculated using cross-sectional survey weights, which were calibrated to match national averages.

student enrollment (NCES, undated-f). Thus, although rural district leaders represent a majority of school districts, they do not represent a majority of public school students.

ASDP Qualitative Interview Data

We complement our survey data with data from a set of interviews with superintendents and senior school district leaders (e.g., chief academic officers, human resources directors, directors of schools) in three traditional public school districts and two public CMOs conducted over four waves between September 2021 and May 2023. These systems range in size from fewer than 4,000 to more than 40,000 students. They were selected for variation in structure and geography, and not because they were exemplary in any way. The systems covered in our qualitative data are more urban and serve more students from low-income households and more students of color than those in the country as a whole.

Topically, the first three waves of interviews were designed to capture superintendents' and senior leadership's experiences responding to the COVID-19 pandemic and addressing its implications for students, families, and educators. During fall 2022, we conducted a wave of interviews with these and other sites on political dynamics and then returned to our original sites for a fourth wave on the topics of staffing challenges and academic recovery, with a particular emphasis on mathematics instruction.

At each site, for each wave, we conducted at least five interviews per wave for a total of more than 100 interviews across the project. Interviews lasted between 30 minutes and 60 minutes and each was audio-recorded and transcribed.

Common Core of Data

Published annually by the NCES, the Common Core of Data (CCD) contains basic information on school district demographics. We primarily rely on CCD data from the 2020–2021 school year. However, we also used some data from the 2019–2020 school year, given lower-than-normal levels of data quality on student poverty status in the 2020–2021 CCD. We used the CCD to sort districts into the following three categories, which yield seven subgroups:

1. locale (urban, suburban, and rural)
2. student racial and ethnic composition (we categorize districts in which more than half of students are Black, Hispanic, Asian, Pacific Islander, American Indian or Alaska Native, or of two or more races as having *majority students of color*, with the remaining districts categorized as having *majority White students*)
3. district poverty level (districts in which half or more of students qualify for a free or reduced-price meal are categorized as *high poverty*, whereas the remainder are categorized as *low poverty*).

It is important to keep in mind that each district that took our surveys belongs to three of the seven subgroups—for example, a single school district can be suburban, be designated low poverty, and enroll mostly White students. Thus, patterns observed across locale, poverty status, and student racial and ethnic composition might be driven by the same set of districts that share multiple characteristics.

EdReports' Ratings of Curriculum Materials

EdReports is an independent, nonprofit organization that reviews published K–12 curriculum materials to determine whether materials align with most college- and career-ready academic standards across the United States. EdReports rates individual mathematics curriculum materials separately by grade level. We report the highest rating received by a curriculum material for any grade level in a grade band (e.g., elementary [K–5], middle [6–8], and high [9–12]). We used EdReports' ratings to classify districts' mathematics curriculum materials as fully standards-aligned or not. Ratings of curriculum materials were last updated in summer 2022.

Methods

Analyzing Closed-Ended Survey Items

Our method for analyzing closed-ended survey data remains consistent between survey waves. Therefore, the description of our methods is simply an update from that in a previous RAND publication (Diliberti and Schwartz, 2023). We examined differences in district leaders' responses by district characteristics. In this report, we describe only those differences among district subgroups (e.g., locale, district poverty level) that are statistically significant at the 5-percent level unless otherwise noted. For all survey estimates, we conducted significance testing to assess whether subgroups were statistically different at the $p < 0.05$ level. Specifically, we tested whether the percentage of district leaders in one subgroup reporting a response was statistically different from the percentage of remaining district leaders who took the survey (e.g., leaders of urban districts versus other respondents who did not lead an urban district). Because of the exploratory nature of this study, we did not apply multiple hypothesis test corrections.

Analyzing Open-Ended Survey Items

Our ASDP surveys included several open-ended survey items. In fall 2021 and spring 2023, district leaders were asked, "What are your District/CMO's specific goals for middle school and high school mathematics?

For example, a specific goal would be for X% of students to pass Algebra I by the end of 9th grade. If you do not have specific goals, please write 'No specific goals.'" In total, 359 district were asked this question in fall 2021, and 222 districts were asked this question in spring 2023, including 98 districts that participated in both surveys and were asked this question twice.

One analyst performed open coding of emergent themes from district leaders' written responses and clustered them into a coding scheme. The analyst reviewed an initial set of responses to the fall 2021 survey to develop and refine a coding scheme and then applied this scheme to the full set of fall 2021 and spring 2023 survey responses. The codes used by the analyst correspond to the goal categories presented in Table 2.1, including such goals as "increase course enrollment and/or passage rates," "improve student performance on state summative assessments," and "close achievement gaps."

After reviewing district leaders' written responses and investigating overlap between our fall 2021 and spring 2023 samples, we decided to pool our two survey samples, increasing our sample size and allowing us to examine districts' secondary mathematics goals in more detail. In creating our pooled analytic sample, we defined a set of exclusion criteria. Specifically, we excluded those districts that did not provide a substantive response at either time point (e.g., left the survey item blank). For those districts that participated in both surveys, we generally included their more recent (spring 2023) goal in our analytic sample, except in cases where districts provided substantive information only in fall 2021. After implementing these exclusion criteria, our final analytic sample includes unique, substantive responses from 411 district leaders. Although our sample is large and includes a diverse set of school districts, we caution readers not to overinterpret these results. Given our sample construction, our results are not necessarily representative of the national population of K–12 public school districts because we do not apply survey weights. Furthermore, we asked district leaders an open-ended survey item. Some district leaders did not provide a written response to this survey item, and, among those who did, some leaders were far more detailed in their responses than others. Thus, our estimates based on these survey items likely fail to precisely capture the variety and complexity of districts' secondary mathematics goals.

Analyzing Qualitative Interview Data

We began analyzing interview data by reading and cleaning all transcripts to identify initial themes and ideas. We then coded all data using topical, low-inference categories, such as mathematics goals, instructional challenges, and recruitment and retention of teachers. We reviewed the data within each category and returned to our initial themes and ideas to look for patterns within each category. We created matrices to capture the data by theme and by site and respondent; these matrices allowed us to identify patterns across the data corpus. We reviewed and refined these themes as a research team and then mapped them onto the ASDP survey findings. The interview data are not generalizable in the same ways that the ASDP survey data are in this report; however, they provide deeper description of some survey findings and qualitative insights into the thinking and experiences of leaders as they consider mathematics instruction in their districts.

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