RAND AMERICAN EDUCATOR PANELS

Research Report

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Prioritizing Curriculum-Based Professional Learning for Mathematics Teachers

District, Principal, and Teacher Perspectives from the American Educator Panels

Teachers are a key influence on students' educational outcomes (Rockoff, 2004; Rowan, Correnti, and Miller, 2002). Professional learning (PL) is one way to help teachers provide high-quality learning opportunities for students and thus support student academic learning. PL can help teachers develop and continuously improve their content knowledge, pedagogical practices, and implementation of curriculum and instruction to support improved educational outcomes for students (Desimone, 2009; Hill et al., 2020; Thompson and Zeuli, 1999).

In addition, teachers must have knowledge of their students' learning needs and interests, and this knowledge has become even more important as the student population has become increasingly diverse (National Academies of Sciences, Engineering, and Medicine, 2020). Attention to PL for mathematics teachers is especially important considering the recent national declines in mathematics performance. Average scores for 13-year-olds declined 9 points between the 2019–2020 and the 2022–2023 school years (National Center for Education Statistics, 2023).

PL is also an important lever for teacher job satisfaction and retention. Limited opportunities for professional development and advancement are factors that contribute to teachers' decisions to leave the profession (Carver-Thomas and Darling-Hammond, 2017; Ingersoll and Kralik, 2004; Steiner et al., 2023). In a recent national survey, public school teachers who reported that they had adequate time to collaborate with other teachers or who had the opportunity to grow professionally reported less job-related stress, less difficulty coping with job-related stress, and less burnout than their counterparts (Steiner et al., 2023). These findings point to an increased need for attention to

KEY FINDINGS

- Just over half of math teachers nationally reported spending two hours or less per month on math professional learning (PL). Another 29 percent reported spending three to five hours per month.
- Teachers perceived that PL led by knowledgeable facilitators was useful, but principals said that high-quality facilitators were in short supply.
- On average, fewer high school teachers reported that their math-focused PL activities were useful for improving their math instruction than did teachers of other grade levels.
- Districts' two most common actions to help meet student math learning goals were adopting standards-aligned curricula and providing secondary math teachers with more PL about the math curriculum.
- Alignment of PL to the math curriculum was a top priority of both district leaders and principals when selecting external PL opportunities for teachers. This outranked other considerations, such as cost and state recommendations.
- According to principals, selecting PL for math teachers was often a collaborative process that involved teachers and district staff.
- Most math teachers agreed that their PL activities were well aligned with their math curriculum. Teachers said that curriculum-based PL was useful when it included time for collaboration and focused on the specific curriculum they used.

how districts and schools are providing PL to help teachers grow and support their students.

In keeping with the urgent need to focus on students' mathematics learning, recent national survey data suggest a growing focus on providing teachers with *curriculum-based PL* opportunities. This term refers to PL that is anchored in a specific curriculum for supporting teaching and learning as opposed to general forms of PL that are not structured around a specific curriculum (McNeill et al., 2022; Short and Hirsh, 2020). Data from the fall 2023 American School District Panel (ASDP) survey show that roughly two-thirds of districts are leveraging PL that focuses on math curriculum as a key resource to help students reach their math learning goals. Principal survey data from the American Mathematics Educator Study (AMES) also indicate that most principals consider alignment with the curriculum to be a major consideration when selecting external PL providers (i.e., PL that is not provided by school or district staff) for math-focused PL.

PL that is focused on the implementation of the curriculum materials that teachers use in their classrooms can be more effective for supporting teaching and learning than PL that is not anchored in the curriculum (Opfer, Kaufman, and Thompson, 2016; Lynch et al., 2019; McNeill et al., 2022). In addition, curriculum-based PL for science, technology, engineering, and mathematics teachers is associated with above-average student performance gains (Hill et al., 2020).

Despite recent reports of districts' and school leaders' focus on providing teachers with curriculum-based PL opportunities, we know little about what kinds of curriculum-based PL opportunities teachers participate in or about teachers' perceptions of those experiences. Combining the perspectives of multiple respondent groups on a single topic provides a deeper understanding of the many considerations taken by district leaders and principals for selecting PL and of math teachers' perspectives about and experiences with PL.

This report provides the perspectives of multiple respondent groups—districts, principals, and math teachers—on math-focused PL for teachers. We explore the factors that district and school leaders consider when selecting math-focused PL; the autonomy that principals have to make PL selection decisions; teachers' experiences with math-focused PL, such as the amount of time spent on various PL

activities; perceived usefulness of activities; and the extent to which principals and math teachers report that math-focused PL is curriculum aligned.

We present findings for (1) our respondent groups nationally and (2) principal and teacher responses for the four largest states—California, Florida, New York, and Texas—for which we have state-representative oversamples. Where relevant, we discuss differences in principal and teacher reports by grade bands (i.e., elementary, middle, or high schools) and, in some cases, offer insights into how district responses varied by locale and size. We supplement our survey data with qualitative data from interviews with district leaders, principals, and teachers to expand on our interpretation of the survey data and better understand educator experiences with math-focused PL. The findings in this report will be of interest to district and school leaders as they consider and develop PL opportunities for math teachers.

Data and Methods

RAND's American Educator Panels (AEP) include nationally representative samples of public-school teachers, principals, and school districts: (1) the American Teacher Panel includes over 27,000 teachers, (2) the American School Leader Panel includes over 8,000 principals, and (3) the ASDP includes over 1,200 public school districts. Across these panels, RAND administers several surveys each year.

In this report, we combine survey and interview data from the district, principal, and teacher panels gathered during the 2023–2024 school year. We combine data from multiple sources to widen our perspective on math-focused PL and discuss math PL from the perspectives of districts, school leaders, and teachers.

Survey Data

We use four surveys in this report: the fall 2023 and spring 2024 ASDP surveys and the spring 2024 AMES surveys of mathematics teachers and principals (American Teacher Panel and American School Leader Panel). The surveys we draw on for this report address math-focused PL in addition to an array of other topics (e.g., teacher staffing, perceptions of curriculum materials, and school and district policies related to assignment of students to mathematics courses).

Sample sizes, completion rates, and specifications to produce survey weights are available in the technical documentation for each survey (Grant et al., 2024a; Grant et al., 2024b; Schweig et al., 2024). Descriptive statistics for all AMES survey items are available in the technical documentation (Schweig et al., 2024). Descriptive statistics for all ASDP survey items are available on Bento.[1]

We supplement the survey data by merging in school- and district-level characteristics from the 2022–2023 Common Core of Data files from the National Center for Education Statistics, which is the most recent year available. To aid interpretation, we color-coded the figures that present survey results for each group of respondents. District data are presented in green, principal data are presented in yellow, and teacher data are presented in blue.

Interview Data

The interview data in this report come from semi-structured interviews with 23 district leaders who responded to the winter 2023 and spring 2024 ASDP surveys and semistructured interviews with 54 K–12 mathematics teachers and 52 K–12 principals who participated in the spring 2024 AMES surveys. The ASDP interviews were conducted by researchers at the Center on Reinventing Public Education. Teacher and principal interviewees were sampled from AMES survey participants who agreed to be contacted for an interview. We purposefully sampled from this group to achieve variation in their experiences along the dimensions of grade level, school poverty, school racial composition, educator race and gender, educator years of experience, and state.

Analytic Approach

For all survey items included in this report, we present nationally representative weighted averages of districts, principals, and teachers. Our analysis explored whether survey responses related to math-

focused PL differ by district or school context across multiple subgroups; however, for brevity and consistency, we typically report only on differences by focus states (California, Florida, New York, and Texas) and grade level. The exception is the district data, which are aggregated above the grade level and do not include state representative samples. Unless otherwise noted, the text discusses only differences among subgroups that are statistically significant at the level of $p < 0.05$. When we report results by grade level (i.e., elementary, middle, and high school) we use Common Core of Data classifications.[2]

We qualitatively analyzed the interview data to generate key themes. Our analysis focused on the questions about teachers' access to math-focused PL and the role that principals play in identifying math-focused PL opportunities for their teachers. For more information about our methods, see the "How This Analysis Was Conducted" section at the end of this report.

Terminology

In this report, we use the following terms to refer to our respondent groups. The term *district leaders* refers to leaders of traditional public school districts who completed ASDP surveys on behalf of their districts; *principals* refers to principals in traditional public school districts and charter management organizations; *teachers* refers to teachers of mathematics, including elementary teachers who teach all subjects including mathematics. In this report, we address *math-focused PL for teachers*, which we sometimes refer to as math-focused PL, teacher PL, or simply PL.

This report combines data across multiple surveys and interviews, each of which used slightly different language to refer to similar topics. We use the original wording of the survey item in figures and tables. In the text of this report, we use a consistent set of terms to refer to key topics across our different data sources for ease of interpretation. We used internally consistent definitions of these terms even when the language used on specific instruments varied.[3]

Table 1 crosswalks the terms we use in the text of the report with the language in the survey and interview questions. Some of the text in this report that describes our data, methods, and analytic approach is recycled from other reports that use AMES and ASDP data (Diliberti et al., 2023; Steiner, Morales, and Mulhern, 2024).

TABLE 1
Terminology

Term Used in Report	Terms Used in Surveys and Interviews	Definition
Professional learning	Professional learning, professional development	Supports that teachers receive to improve their teaching practice and knowledge (e.g., coaching and feedback, workshops, collaborative learning, professional learning communities [PLCs]). These supports could be provided online or in person (Zuo, Doan, and Kaufman, 2023).
Curriculum-based PL	Curriculum-based PL, curriculum-aligned PL	PL that integrates or uses the curriculum materials that teachers use in their classroom every day (Zuo, Doan, and Kaufman, 2023).
Curriculum	Curriculum, instructional materials	Any materials that are intended to provide learning opportunities for students (Doan and Shapiro, 2023).
Standards-aligned curriculum or instructional materials	High-quality curriculum or materials, standards-aligned curriculum or materials	Materials rated as fully meeting expectations of EdReports' college- and career-ready standards (Doan and Shapiro, 2023).

District and Principal Considerations When Selecting Math-Focused Professional Learning for Teachers

To Meet Their Math Learning Goals, Districts Most Commonly Adopted New Math Curricula and Provided More Curriculum-Based Math Professional Learning

In fall 2023, more than three-quarters of districts reported having one or more goals for students' middle or high school math performance.[4] We asked these goal-oriented districts what actions they were taking to meet these goals for middle and high school math.

Providing more PL to secondary math teachers about the curriculum was the second most-popular action, selected by 71 percent of districts that reported having goals for students' math learning. As shown in Figure 1, urban districts and large districts were significantly more likely than their counterparts to provide more PL to their secondary math teachers about the math curriculum. For example, nearly all—93 percent—of urban districts indicated taking this action, compared with 84 percent of suburban districts and 64 percent of rural districts. The interviews with district leaders confirmed that helping teachers use the math curriculum effectively was a goal of teacher PL. As one district leader said of their PLCs, "First step, to get [teachers] aligned on math curriculum."

Alignment of Professional Learning with Math Curricula Was District Leaders' Top Consideration When Selecting External Professional Learning Opportunities for Teachers

In spring 2024, a majority of districts—81 percent—said alignment of PL with the math curricula that teachers use was a major consideration when selecting external PL opportunities to support teachers' mathematics instruction (Figure 2). The remaining 19 percent of districts said the alignment was a minor consideration. This suggests that all districts surveyed believed that math-focused PL should align, at least to some extent, with the curricula that teachers use in their classroom.

For districts, alignment of external PL opportunities with math curricula outranked other considerations, including cost and recommendations from other sources. For example, 47 percent of districts said cost was a major consideration, and 36 percent said similarly about recommendations or requirements from their state department of education.

The interviews with district leaders suggest that student assessment data are another important consideration when selecting math-focused PL. Some of these leaders said that the goal of PL is to ensure that teachers understand how the mathematics curriculum is aligned to state mathematics standards and state assessments. Other leaders who discussed using student assessment data as a consideration when selecting PL opportunities for math teachers said that they reviewed student assessment data to identify areas of the curriculum where teachers needed more support and made decisions accordingly. Next, we turn to principals' responses, where we find similar patterns in how principals approached selecting math-focused PL.

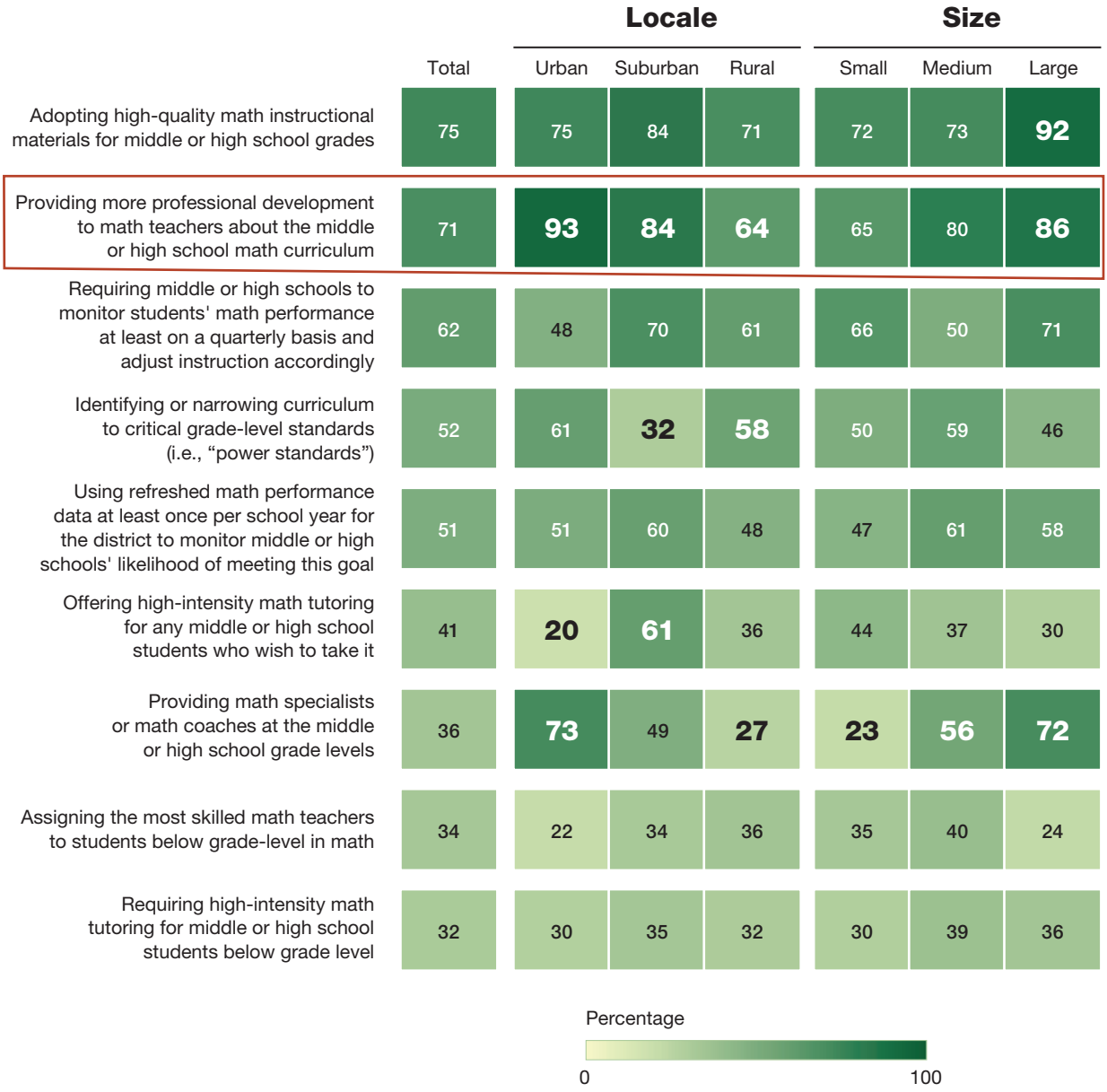
Alignment with the Mathematics Curriculum Was Principals' Most Common Consideration When Selecting Professional Learning

Alignment of PL with math curriculum was also one of the top factors that principals said influenced their selection of external PL opportunities and providers to support teachers' mathematics instruction. Nearly all principals—98 percent—reported taking this into consideration (Figure 3). Seventy-two percent indicated that it was a major consideration, and 26 percent indicated that it was a minor consideration. Recommendations from other principals or recommendations or requirements from the state department of education were not major considerations for most principals.

Similar to those of district leaders, principals' interview responses confirm that they too consider

FIGURE 1

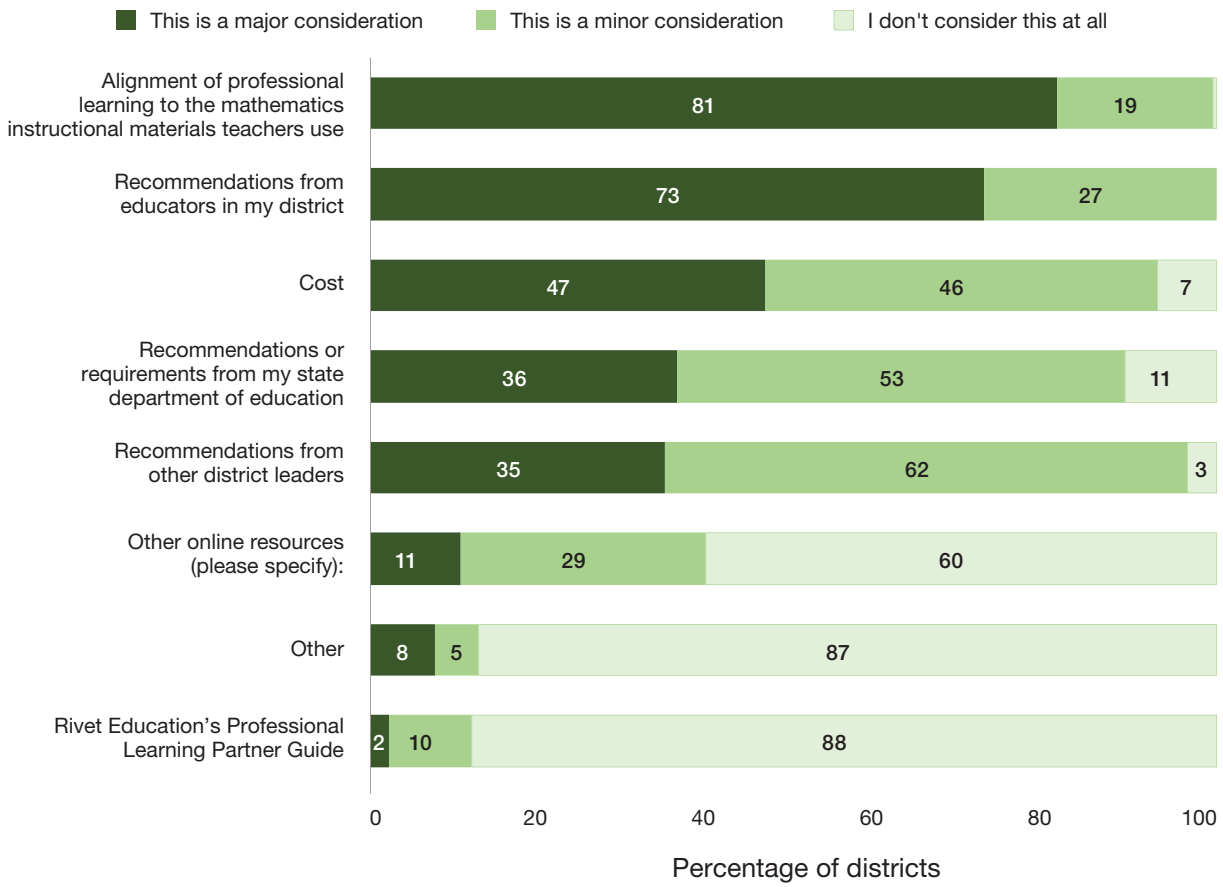
Actions That Districts Were Taking (Including and in Addition to Professional Learning) to Meet Middle or High School Math Goals



NOTE: This figure depicts response data from the following survey questions administered in fall 2023 to a nationally representative sample of districts: "What actions is your district taking this school year (2023–2024) to meet this [middle/high] school math goal?" (n = 184). Only respondents who indicated their district has one or more specific goals for middle and/or high school math received this question. Respondents were asked separately about actions taken to meet middle and high school math goals, but data were combined for reporting purposes. Respondents were instructed to select all that apply. The survey question included an "Other" option, which was selected by 6 percent of respondents and has been omitted from this figure. We also omitted three survey items selected by less than 30 percent of respondents overall: (1) "Offering additional math courses to students below grade level," (2) "Hiring additional teachers or aides for middle or high school math classes," and (3) "Adding more math instructional minutes." Numbers in bold indicate that the subgroup percentage of districts that reported taking an action to meet math goals is statistically significantly different ($p < 0.05$) from the percentage of remaining districts not in that subgroup who said the same. There is a box around the second row to direct the reader to the item discussed in the narrative. Text color in the table alternates between white text and black text solely for the purposes of visibility.

FIGURE 2

Considerations for Districts in Selecting External Professional Learning Opportunities to Support Teachers' Mathematics Instruction



NOTE: This figure depicts response data from the following survey question administered in spring 2024 to a nationally representative sample of districts: "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 = 154). For each consideration, respondents were asked to select among "I don't consider this at all," "This is a minor consideration," and "This is a major consideration." Percentages might not sum to 100 because of rounding.

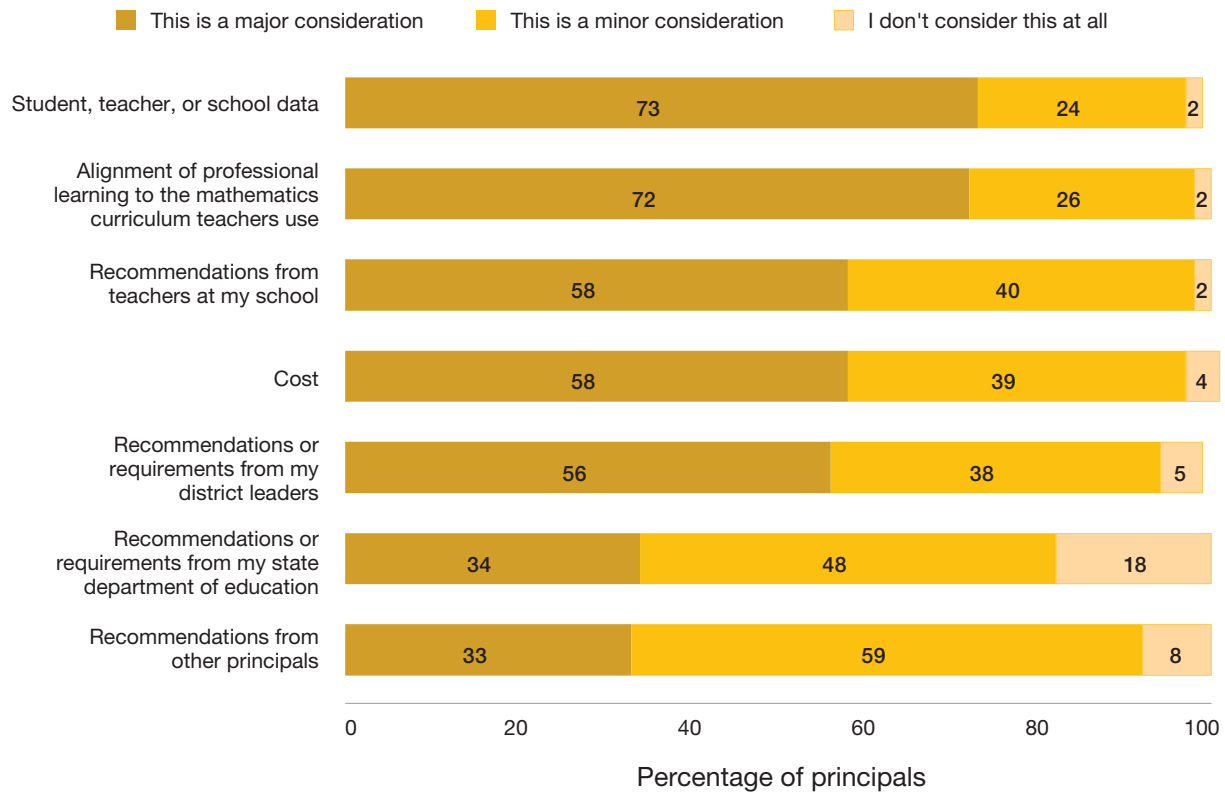
multiple sources of information when selecting external math-focused PL. We asked the principals we interviewed to describe the types of information that informed selection of math-focused PL regardless of whether they or someone else was the primary decisionmaker. (We discuss principals' autonomy to select external PL in the next section.) We did not ask interviewed principals to react to a structured list of considerations; we therefore interpret principals' responses as the information that was top of mind in their thinking.

Two-thirds of interviewed principals said that they used student data, such as annual state tests, diagnostic assessments, and curriculum-based assessments, to help them select PL for math teachers. Many of these principals used student assessments to identify areas where students were not achieving in math and where teachers' instruction might benefit from PL.

About one-third of interviewed principals used teacher data, such as observations, to select math-focused PL. These principals talked about how watching live teaching during a classroom visit, for example, helped them pinpoint areas where PL could help teachers improve their math instruction. One principal described how they used classroom observations to provide guidance to the math coach

FIGURE 3

Principal Considerations for Selecting External Professional Learning Providers and Opportunities to Support Teachers' Mathematics Instruction



NOTE: This figure depicts response data from the following survey question administered in spring 2024 to a nationally representative sample of principals, "How much do each of the following factor into your decisions when selecting external professional development opportunities and providers to support teachers' mathematics instruction?" (n = 1,654). For each consideration, principals were asked to select among "I don't consider this at all," "This is a minor consideration," and "This is a major consideration. This question was asked only of principals who had previously indicated that they have autonomy to choose external vendors for professional development. Percentages might not sum to 100 because of rounding.

about areas in which teachers could improve their instruction:

> [Professional learning is] also based on classroom observations. So, when I walk around or my AP [assistant principal] walks around, I will come back and say to the math coach . . . "I was in [teacher's class] for 30 minutes, and all I saw was whole group instruction. So, I need you to go in there and show how to do a short whole group, and then [model how to] make those small groups run."

Half of the interviewed principals indicated that teacher feedback informed their decisions about math-focused PL. These principals said that they asked teachers what PL would help them improve their math instruction. One principal said they used teacher input "to decide which training we want. [E]very year I ask my teachers what they need, what are their strengths, and what are their weaknesses . . . what would be helpful to them to . . . improve their math instruction."

Principals must balance many competing priorities for how teacher PL time is focused, and using the curriculum to support instructional improvement in math is not always the top priority. Elementary principals, for example, highlighted that teacher PL must focus on subjects other than math. About one-quarter of the principals we interviewed

talked about district requirements and initiatives influencing the amount of math-focused PL teachers received.

One principal highlighted this tension: "You only have so much time in a day. We only have so many PL days built into our calendar. So we still have our hands tied a little bit with that because [there's] only so much time and so many things to get done." Half of the principals we interviewed said that cost had to be taken into consideration. A principal of a small district noted that their PL budget was particularly constrained: "We have a small budget and professional development is incredibly expensive, so that's one of the biggest factors that goes into it."

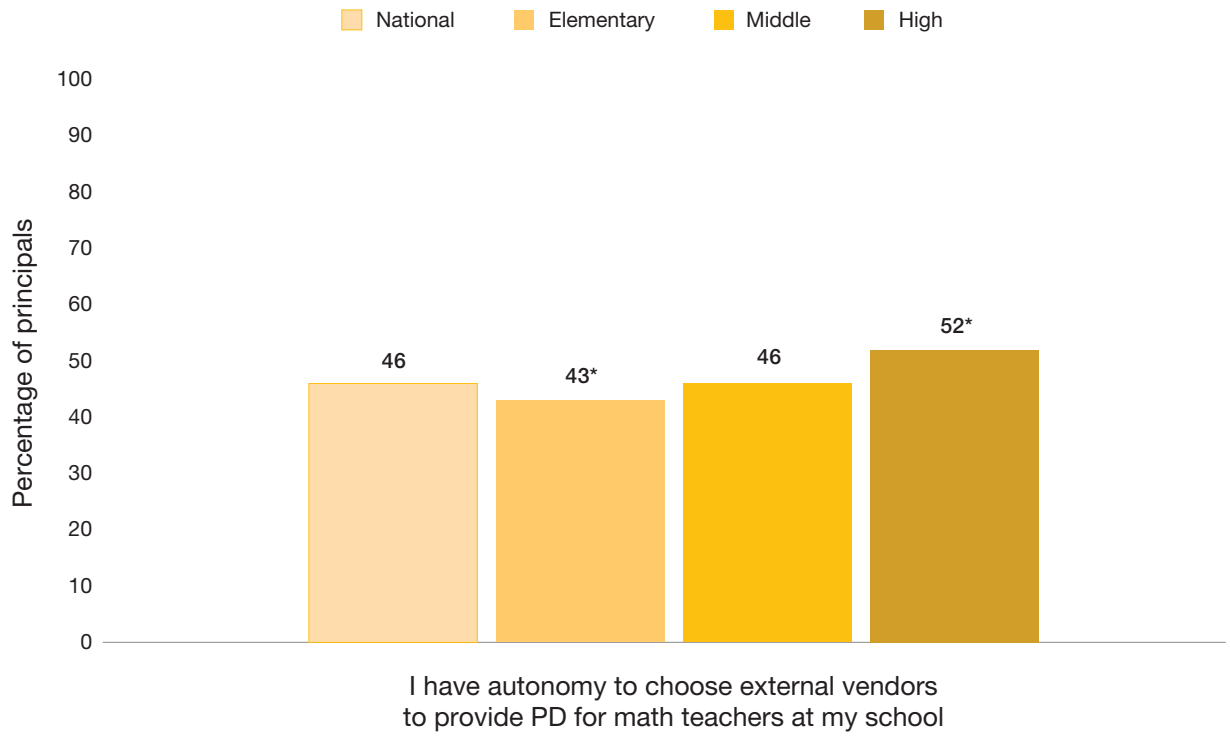
According to Interviewed Principals, Selecting Math-Focused Professional Learning for Teachers at Their School Was Often a Collaborative Process

About half of the principals we surveyed (46 percent) reported having autonomy to choose external vendors to provide PL to math teachers at their school (Figure 4). Elementary principals were least likely to report having autonomy to choose external PL providers, and high school principals were most likely to report having such autonomy.

Principals' interview responses revealed that selecting math-focused PL for teachers was a nuanced

FIGURE 4

Principal Autonomy to Select External Professional Learning Providers



NOTE: This figure depicts response data from the following survey question administered in spring 2024 to a nationally representative sample of principals, "This school year, (2023–2024) do you have autonomy to choose external vendors to provide professional development to mathematics teachers at your school?" (n = 3,489). Response options included "No," "Yes," or "I don't know." This figure depicts the percentage of principals that selected "Yes." Asterisks indicate that the subgroup percentage of principals who responded "Yes" is significantly different ($p < 0.05$) from the percentage of remaining principals not in that subgroup who said the same.

process beyond whether principals had autonomy to choose external providers. Most of the principals we interviewed said that they had substantial input into selecting math-focused PL for teachers at their school but were not always the primary decisionmaker.

Principals said that, in practice, decisions about PL were made in collaboration with others in their schools or districts. Some principals said that they shared these decisions with their school curriculum committee or the math instructional coach, whereas others collaborated with district leaders. For example, one principal said, "The principals and the district decide together. . . . [District] input in terms of teacher development is really driven by school performance and our school improvement plan."

A sizable minority of the principals we interviewed—about one in three—said that they were the primary decisionmaker when it came to math-focused PL for teachers at their school. However, even some of these principals said that they considered the opinions of other school and district leaders in their decisions. For example, four principals said that they selected math-focused PL in collaboration with their math instructional coach or a school curriculum committee, and two said that their district leaders often guided their decisions. One principal described the influence of the curriculum coordinator in the decisionmaking process while describing their agency: "I have an 80 percent say in what PL is done. As principal, I can decide what [math teachers] need to be doing even if it is based on recommendations from teachers and coaches. But ultimately it is on me."

A few principals characterized the district as the primary decisionmaker and themselves as having input or influence when it came to the final decision, as illustrated by the comment from this principal: "Well of course central office staff have the majority of the say, but I would say I have quite a bit of influence on what PL teachers need in math."

Teachers' Perceptions of Math-Focused Professional Learning

Just over Half of Math Teachers Reported Spending Two Hours or Less per Month on Professional Learning Opportunities to Support Their Math Instruction

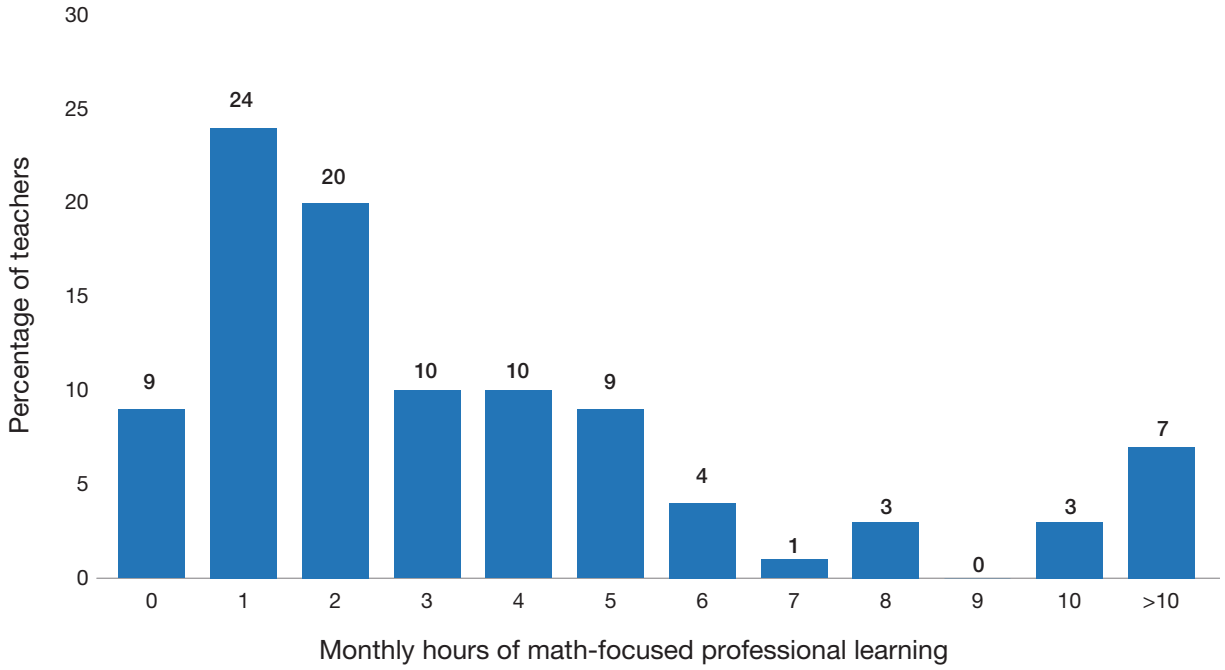
On average, math teachers reported spending 3.9 hours per month on PL to support their math instruction. However, that average masks a wide distribution of responses. About 9 percent of teachers nationally reported spending 0 hours per month on PL to support their math instruction, and about 44 percent reported spending one to two hours. About 29 percent of teachers reported spending three to five hours per month, and very few teachers—only about 18 percent—reported spending six or more hours per month. Figure 5 shows the national distribution of responses for the monthly hours spent on math PL.

Teachers in Florida and Texas reported spending more hours per month on PL to support their math instruction—4.6 hours and 5.4 hours, respectively—than the national average (Figure 6). Teachers in New York reported spending 3.4 hours per month on math-related PL, which is slightly below the national average but not a statistically significant difference, and teachers in California reported spending 3.9 hours, similar to the national average. Although these differences in teachers' reports of monthly PL are relatively small, they could add up to large differences—potentially more than an additional day of PL per teacher—over the course of a school year.

Differences in state policies related to PL could be one factor that influences the amount of time teachers spent on math PL in these four large states. For example, Florida teachers generally have five days for PL each school year, teachers in Texas generally

FIGURE 5

National Distribution of Monthly Hours Teachers Reported Spending on Math-Focused Professional Learning



NOTE: This figure depicts response data from the following survey question administered in spring 2024 to a nationally representative sample of mathematics teachers: "Please think back over the course of this school year (2023–2024). In the average month, how many hours per month have you spent participating in professional learning activities focused on supporting your mathematics instruction?" (*n* = 2,812). This figure depicts the monthly hours for all teachers reporting no more than 40 monthly hours of math PL. A small portion of teachers selecting more than 40 hours was trimmed from the data depicted here to prevent outliers or errors from skewing the averages. Percentages might not sum to 100 because of rounding.

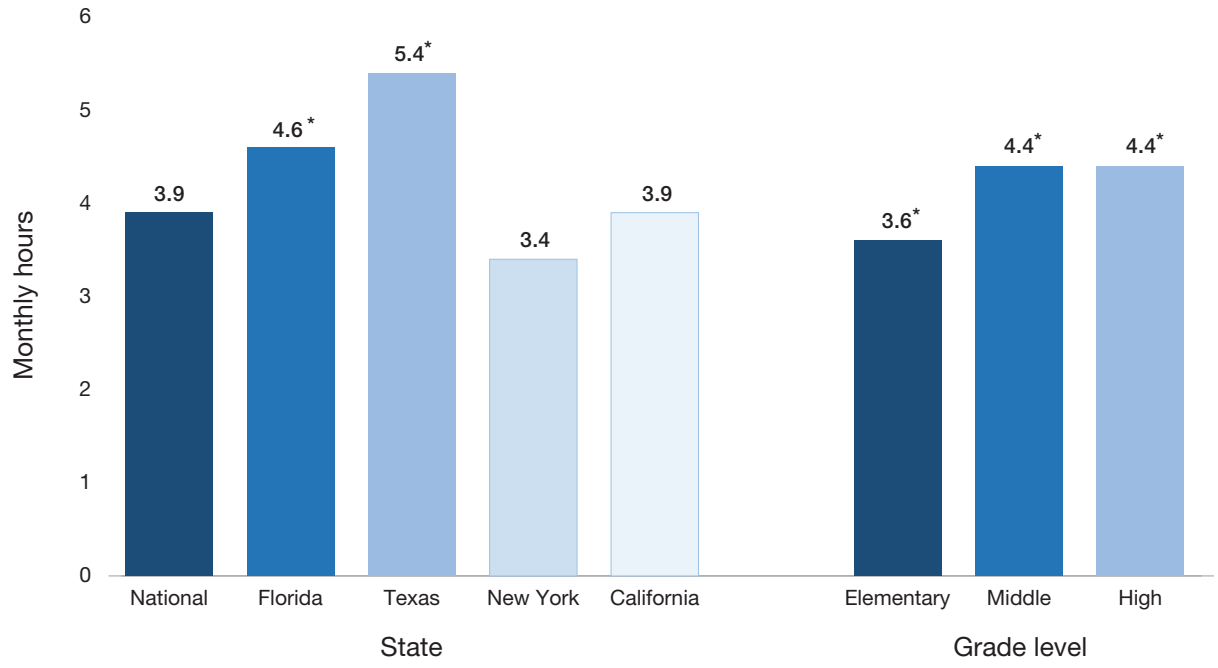
have seven, and California teachers generally have two days, although there is some variation by district (California Department of Human Resources, undated;[5] Florida State Statutes, 2024; Texas Education Association, undated). In New York, PL time is generally locally determined, although state statute requires that teachers complete 175 hours of PL every five years to maintain their licensure; this equates to just over four days per year (New York State Department of Education, undated). Teachers' reports of the time they spent on math PL each month are consistent with state policy. Teachers in states with more PL days reported spending more monthly hours on math-focused PL, on average, than teachers in states with fewer PL days.

We also found significant differences in monthly hours of math-focused PL by grade level. Elementary teachers reported spending the least amount of time each month on PL related to math instruction—3.6 hours on average. Middle school teachers and high school teachers each reported spending 4.4 hours, on average, on PL related to math instruction each month. These statistically significant differences for elementary teachers are unsurprising. Elementary teachers often teach English language arts, science, and social studies, in addition to math, and thus might spend relatively less of their PL time on any one content area, whereas middle and high school math teachers are more likely to teach math only.

Recent national surveys indicate that teachers who participate in PL more frequently are more likely to deem it effective for improving their teaching or student learning (Zuo, Doan, and Kaufman, 2023). At the same time, our AMES results indicate that most principals perceive that teachers do not have enough time for math-focused PL. Seventy-three percent of

FIGURE 6

Average Monthly Hours Teachers Spent on Math-Focused Professional Learning by State and Grade Level



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principals who responded to AMES reported that inadequate time for math-specific PL was an obstacle to students' math learning.

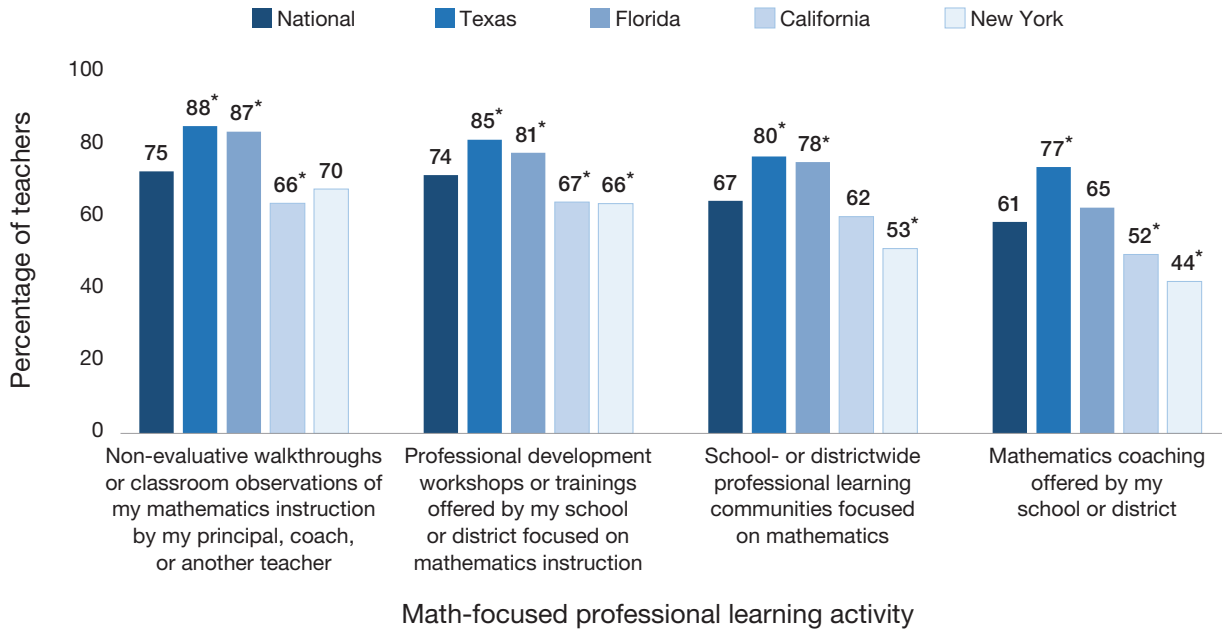
Although the amount of PL time is an important consideration, a critical question is whether PL time is spent in ways that provide quality opportunities for teachers to meet the learning needs of their students (Desimone, 2009; Garet et al., 2011). Although our data do not address the quality of teachers' PL experiences, later in this report, we provide some insight into the PL activities and the features of curriculum-based PL that teachers said were useful.

Teachers Participated in a Variety of Math-Focused Professional Learning Activities; Participation in Florida and Texas Exceeded the National Average

Teachers routinely participate in a variety of math-focused PL activities. We asked about frequency of participation in four common math-focused PL activities—trainings or workshops offered by the school or district, coaching, non-evaluative walk-throughs or observations of instruction, and school-wide or districtwide PLCs (Figure 7). More than half

FIGURE 7

Percentage of Teachers Participating in Math Professional Learning Activities, by State



NOTE: This figure depicts response data from the following survey question administered in spring 2024 to a nationally representative sample of mathematics teachers: "Please indicate the extent to which each of the following types of professional learning activities have been useful for improving your mathematics instruction this school year (2023–2024). If you did not participate in this activity, please indicate that you did not participate" (n = 3,161). This figure depicts the percentage of teachers who selected any response other than "I did not participate." Asterisks indicate that the percentage of teachers participating in each type of PL for that subgroup of teachers is significantly different ($p < 0.05$) from the remaining teachers not in that subgroup.

of teachers nationally reported participating in each of these activities. Non-evaluative walkthroughs were reportedly the most common PL activity, and math coaching was the least common.

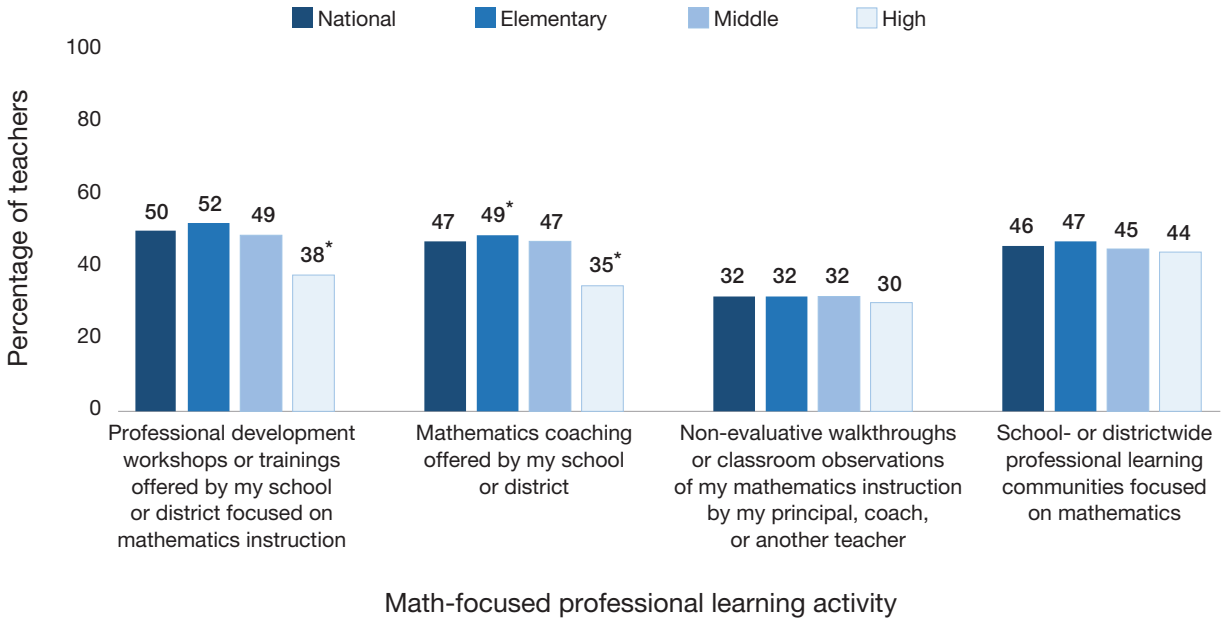
We found no differences in teachers' reported participation in different PL activities by grade level but observed some variation by state (Figure 7). Participation rates among Florida and Texas math teachers were above the national average for all four activities. Teacher participation was below the national average in California and New York. One possible explanation for these differences in participation across states is the amount of time teachers reported spending on PL to support their math instruction. Teachers in Florida and Texas reported more hours of math-focused PL per month than teachers in California and New York, which might have enabled participation in a greater variety of PL activities.

High School Teachers Regarded Workshops or Trainings Focused on Instruction and Coaching as Less Useful Than Teachers of Other Grade Levels

We asked teachers who participated in each of the four types of PL activities shown in Figure 7 to rate the usefulness of each activity for improving their math instruction. About half of teachers nationally said that professional development workshops or trainings that focused on math instruction, school or district PLCs focused on math, and math coaching were useful for improving their math instruction (Figure 8). In contrast, despite being the most commonly reported type of PL (Figure 7), only about one-third of teachers said that walkthroughs and classroom observations were useful.

FIGURE 8

Teacher-Reported Usefulness of Math Professional Learning Activities by Grade Level



NOTE: This figure depicts response data from the following survey question administered in spring 2024 to a nationally representative sample of teachers: "Please indicate the extent to which each of the following types of professional learning activities have been useful for improving your mathematics instruction this school year (2023–2024). If you did not participate in this activity, please indicate that you did not participate" (n = 2,279). Response options included "Not useful for improving my math instruction," "Slightly useful for improving my math instruction," "Moderately useful for improving my math instruction," and "Extremely useful for improving my math instruction." This figure depicts the percentage of teachers who selected either "moderately" or "extremely" useful for supporting math instruction. Asterisks indicate that the percentage of teachers participating in each type of PL for that subgroup of teachers is significantly different ($p < 0.05$) from the remaining teachers not in that subgroup. This figure includes only teachers who indicated that they participated in each type of PL.

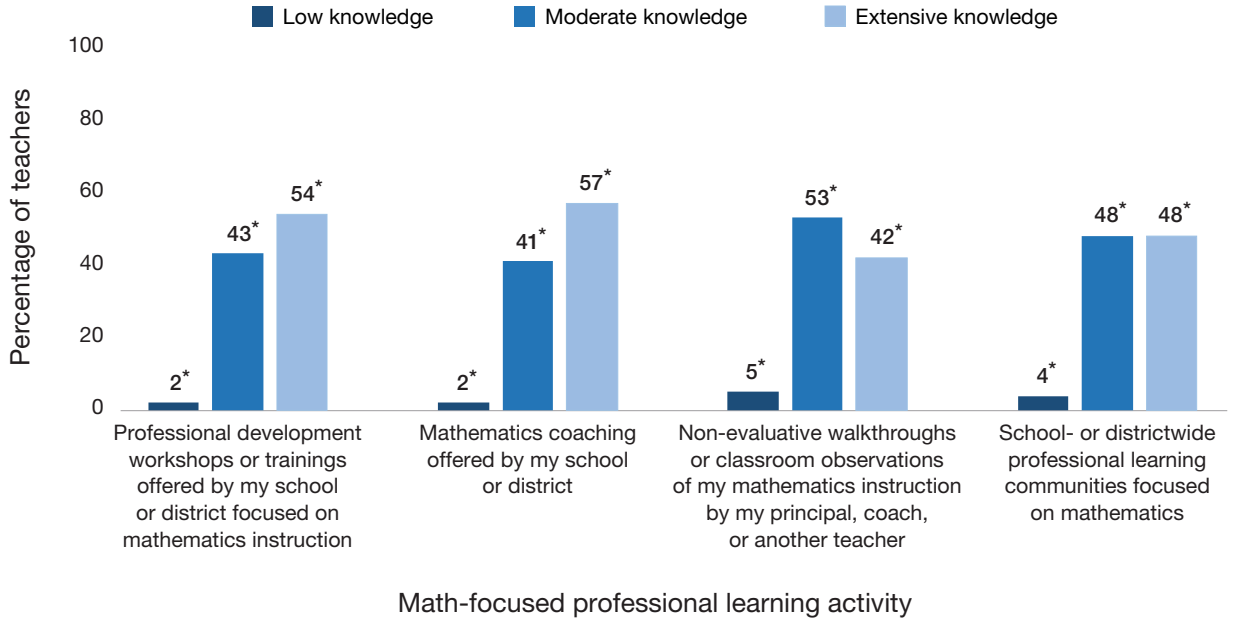
We did not find differences in perceived usefulness among our four focus states, but we did find differences by grade level. More elementary school teachers than teachers of other grade levels said that trainings or workshops, coaching, and PLCs were moderately or extremely useful. On average, fewer high school teachers reported that the four PL activities we asked about were useful than teachers of other grade levels (although not all differences were statistically significant). High school teachers were least likely to say that workshops or trainings focused on instruction and math coaching were useful for improving their math instruction. High school teachers reported that PLCs were the most useful activity.

The Expertise of Professional Learning Facilitators Matters to Teachers, and Principals Said High-Quality Facilitators Were in Short Supply

In addition to asking teachers about how useful they found each type of PL to be for improving their math instruction, we also asked them how much knowledge they perceived facilitators of each type of PL to have. To explore how facilitator knowledge is related to PL usefulness, we disaggregated teachers' responses on usefulness of PL by whether the teacher reported the facilitator to have low, moderate, or extensive knowledge (Figure 9). Unsurpris-

FIGURE 9

Teacher-Reported Usefulness of Types of Math Professional Learning by Teacher-Reported Facilitator Knowledge



NOTE: This figure depicts response data from the following survey question administered in spring 2024 to a nationally representative sample of teachers: "Please indicate the extent to which each of the following types of professional learning activities have been useful for improving your mathematics instruction this school year (2023–2024). If you did not participate in this activity, please indicate that you did not participate" (n = 2,279). Response options included "Not useful for improving my math instruction," "Slightly useful for improving my math instruction," "Moderately useful for improving my math instruction," and "Extremely useful for improving my math instruction." This figure depicts the percentage of teachers who selected either "moderately" or "extremely" useful for supporting math instruction. These data are disaggregated by another survey item, "In your opinion, how much knowledge did the people who led or facilitated each of the professional learning activities have?" Asterisks indicate that the percentage of teachers who found each type of PL to be useful for that subgroup of teachers is significantly different ($p < 0.05$) from the remaining teachers not in that subgroup. This figure includes only teachers who indicated that they participated in each type of PL.

ingly, when teachers perceived facilitators to be more knowledgeable, they also perceived that type of PL to be more useful.

Very few teachers—5 percent or less—rated PL activities as either moderately or extremely useful if they perceived the facilitator to have low knowledge. Facilitator knowledge seems to be particularly important for professional development workshops or trainings and coaching offered by schools or districts. Fifty-four percent of teachers who rated their workshop or training facilitator as having extensive knowledge found the workshops or trainings either moderately or extremely useful. Similarly, 57 percent of teachers who rated their coach as having extensive knowledge found coaching moderately or extremely useful.

The principals we interviewed also considered the availability of high-quality facilitators when selecting math-focused PL. Quality, or expertise, of the facilitator was a particular concern when principals talked about engaging external vendors and for principals in rural areas. One principal of a rural school put it this way, "It's really hard in a rural area to really get a high-quality person that specializes in the specific thing [we need]."

Curriculum-Based Professional Learning

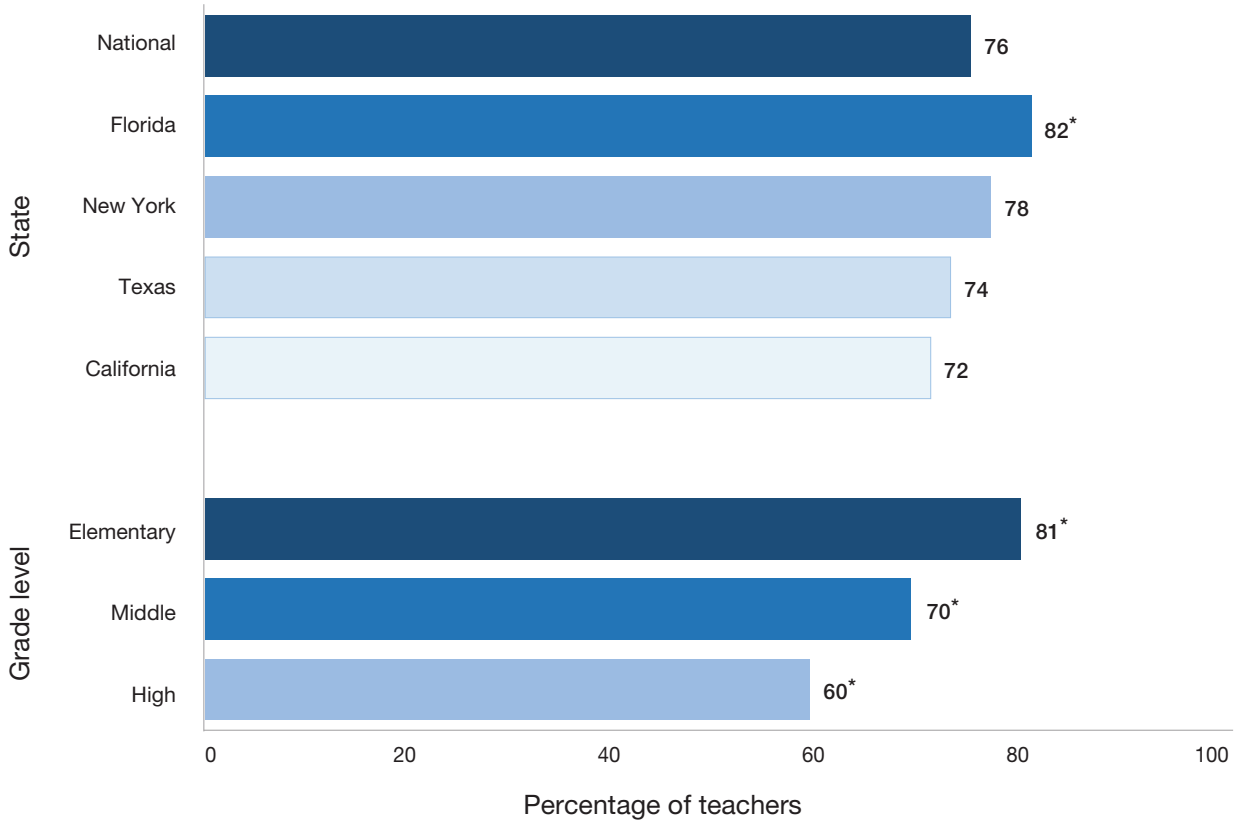
Many Principals Prioritized Curriculum-Based Math-Focused PL, and Most Teachers Agreed That Professional Learning Activities Were Well Aligned with the Math Curriculum

Earlier in this report, we noted that, when selecting math-focused PL, districts and principals prioritized alignment with the math curriculum teachers use. Districts and principals prioritized curriculum-based PL because they believed that helping teachers learn how to use their curriculum would promote student achievement in math.

In survey responses, teachers tended to agree that their math-focused PL was aligned with the curriculum materials they used. Three-quarters of teachers somewhat or strongly agreed that the PL activities offered by their school or district were well aligned with the math curriculum materials they used (Figure 10). More Florida teachers agreed that their PL was well aligned with the math curriculum than the national average, and fewer California teachers agreed. The reasons for these differences by state are

FIGURE 10

Percentage of Teachers Agreeing That Professional Learning Is Well Aligned with Their Math Curriculum Materials



NOTE: This figure depicts response data from the following survey question administered in spring 2024 to a nationally representative sample of teachers: "Indicate your level of disagreement or agreement with the following statements about the professional learning activities related to mathematics offered by your school or district this school year (2023–2024): … have been well aligned with the mathematics curriculum I use" (n = 2,640). Response options included "Strongly disagree," "Somewhat disagree," "Somewhat agree, and "Strongly agree." This figure depicts the percentage of teachers who selected either "Somewhat agree" or "Strongly agree" that PL activities have been well aligned with the mathematics curriculum. Asterisks indicate that the percentage of teachers who agreed that PL is curriculum-aligned for that subgroup of teachers is significantly different ($p < 0.05$) from the remaining teachers not in that subgroup. This figure includes only teachers who indicated that they participated in PL provided by their school or district this year.

not clear. Differences in the amount of time teachers in each state generally have for PL could be one factor, as could state differences in PL standards or in required PL activities.

More elementary teachers than middle school or high school teachers agreed that their PL was aligned with their math curriculum materials. One possible reason for these differences across grade levels is the greater availability and use of standards-aligned math curricula in elementary grades than in secondary grades (Doan et al., 2023; Kaufman, Doan, and Fernandez, 2021). Secondary mathematics teachers, in contrast, tend to use materials they create themselves (Doan et al., 2023). Thus, offering PL that is aligned with, or incorporates, the curriculum might be relatively more straightforward at the elementary level, where teachers within a school often use a common curriculum.

However, some principals, most of whom were elementary principals, noted that such factors as the need for PL in other subjects—especially literacy—and cost led them to deprioritize math-focused PL. One principal, for example, said, "Our district right now is really focused on reading instruction more than math. . . . I'd have to say [that math is] our second priority [for PL] right now in our district."

Principals' and Teachers' Definitions of Curriculum-Based Professional Learning Varied Widely, Suggesting That Professional Learning Might Not Always Involve the Specific Curriculum Teachers Use

Although we used an internally consistent definition of *curriculum-based PL* in our survey and interviews, the teachers and principals who responded to the survey could have their own experiences or definitions in mind. In our interviews, we asked teachers and principals what the term *curriculum-based PL* meant to them. We did not probe on specific elements of curriculum-based PL because the intent of this broad question was to elicit top-of-mind responses. The teachers and principals we interviewed characterized curriculum-based PL in a variety of ways, some of which suggest that PL might not always focus on the specific curriculum teachers use.

Most teachers and principals described curriculum-based PL as PL that was about the curriculum used in their classrooms or in their schools. Some principals, for example, defined *curriculum-based PL* as providing teachers with information and guidance about how to use their curriculum, as stated by this principal:

> So that means—you are working with a singular curriculum, and you are figuring out the best ways to implement that as well as reflect on how implementation went. Then, you revise the next time. You are learning about the flow of the curriculum.

For some respondents, defining curriculum-based PL was not straightforward. For example, some principals' and teachers' responses focused on features of their curriculum (e.g., alignment to state standards) without referencing PL. A few principals and teachers stated that they did not know the meaning of the term. For example, some teachers who did not mention PL in their responses said curriculum-based PL meant teaching the standards and following the curriculum that the school had adopted. Similarly, some principals in this group

Teachers and principals characterized curriculum-based professional learning in a variety of ways, suggesting that it might not always focus on the specific curriculum teachers use.

said that curriculum-based PL entailed ensuring alignment of what is being taught to state standards or with the scope and sequence used in their districts. One principal said, "To me, [curriculum-based PL means] that you have a viable curriculum or program that meets the needs of state standards, and it is laid out so that you can implement it and teach to that curriculum and know that you are hitting the standards."

Ideally, curriculum-based PL focuses on the specific curriculum teachers use. It would train teachers how to make the instructional shifts needed to support student learning (McNeill et al., 2022). Only a few of the teachers and principals we interviewed described curriculum-based PL in this way. In one such example, a teacher described their PL as an opportunity to develop pedagogical practices needed to implement the math curriculum:

> [S]o when [the PL is] "curriculum-based," it's that we're using that curriculum that they want us to use, and that [the PL] stems off of what [the curriculum] practices are. . . . [For example] students should be doing like 90% of the talking in the classroom and should be developing a conceptual understanding. . . . [O]nce [students] figure things out on their own, it leads to that procedural side of how to do the math. But they want [teachers] to stand back, and want the kids to figure out strategies and methods on their own.

One possible reason for this variation in definitions is that teachers and principals with limited curriculum-based PL experiences might have had fewer examples to draw on in their responses. The variation could also be related to limitations of our interviews, which were capped at 45 to 60 minutes and focused on several topics, leaving us unable to probe for additional examples or ask respondents to elaborate. Although focusing on the specific curricula teachers use might not always be practical, teacher participation in PL that involves the curriculum they use is linked with greater use of standards-aligned instructional materials and practices (Kaufman et al., 2020; Zuo, Doan, and Kaufman, 2023).

Teachers said that their curriculum-based professional learning experiences were useful when they helped them learn the components of the curriculum and how to use the resources provided within the curriculum in their classrooms.

For Teachers, Curriculum-Based Professional Learning Was Useful When It Included Time for Collaboration and Focused on the Specific Curriculum They Used

We asked the teachers we interviewed to describe why their curriculum-based PL—however they defined it—was useful and to share some examples. As we discussed earlier in this report, teachers' definitions of curriculum-based PL were varied and broad and were consistent with general math-focused PL. In keeping with teachers' broad understanding of curriculum-based PL, their responses to this question were consistent with best practices for PL and did not focus on their use of a specific curriculum with pedagogical techniques that support students' learning that is characteristic of curriculum-based PL.

Most commonly, teachers said that their curriculum-based PL experiences were useful when they helped them learn the components of the cur-

riculum and how to use the resources provided within the curriculum in their classrooms. Learning about how to use the curriculum resources was particularly helpful when teachers could practice using the materials with other teachers and later use them with their students.

For some teachers, curriculum-based PL experiences were useful when they were closely related to what they did in their day-to-day teaching and the subject that they teach. One teacher described the usefulness of this connection to practice by saying:

> I think [curriculum-based PL has been useful] especially because [it is] directly focused on what we will be doing in the classroom. At least recently, we haven't often gotten sent to trainings where it's about some great math idea, but something that's not realistic for us to implement in the classroom. I feel like all the things that they have had us do recently have been directly related to what we will be doing, which is good.

Teachers also commented on the activities that made curriculum-based PL experiences useful. These activities included collaboration with other teachers, authentic learning experiences, and opportunities for reflection. These are consistent with the effective features of PL commonly discussed in the literature (e.g., Desimone, 2009, Garet et al., 2001; Hawley and Valli, 1999; Hill et al., 2020). For example, one teacher explained that hearing what other teachers were doing and exchanging ideas with them was helpful, while another teacher found PL most useful when there were opportunities to debrief and ask questions after implementing parts of the curriculum. Specifically, this teacher said:

> So [curriculum-based PL is useful when] it's like how to navigate the curriculum. . . . And if you are having issues or questions that you aren't understanding or you want more support, they have people that will support us, which is nice, because sometimes you don't know what you don't know. And then once you go to implement it, then you realize, OK, I have a specific question.

Implications

Our findings show that alignment of PL with the math curriculum that teachers use is a priority for districts and principals. Teacher participation in PL that helps teachers use their curriculum well can improve instructional practices and boost student achievement (Garrett et al., 2021; Dee and Huffaker, 2024). Moreover, when teachers frequently participate in PL that is aligned with the curriculum materials they use, they tend to report greater use of standards-aligned instructional materials and practices (Kaufman et al., 2020; Zuo, Doan, and Kaufman, 2023).

A large majority of teachers who responded to the AMES survey agreed that their PL was well aligned with the math curriculum they used. Teachers we interviewed said that curriculum-based PL was most useful when it helped them learn about how to use their specific curriculum (as opposed to PL that was not focused on the curriculum), included materials they could use with their students, and was clearly related to their day-to-day instruction. These are all factors that are consistent with research-based best practices (Short and Hirsh, 2020).

At the same time, our results suggest that teachers' and principals' actual experiences of curriculum-based PL vary widely. Teachers' and principals' interview responses suggest that curriculum-based PL might not always employ the specific curriculum teachers use; focus on pedagogical techniques that are linked to improvements in student learning; or include the features of PL, such as collaboration, that teachers find to be useful. We were not able to explore the content of curriculum-based PL in detail in this report, so this is an area for future research.

Our findings illuminate possible barriers to effective math-focused PL. One is insufficient time. Just under 44 percent of teachers spent one to two hours on math-focused PL each month, another third reported spending three to five hours per month, and principals reported that lack of time for teacher PL was an obstacle to students' math learning. In elementary schools particularly, the need for math-focused PL competes with many other school and

district priorities, such as the need for PL on literacy. Although there are likely structural reasons for this, teachers' limited time for PL elevates the importance of ensuring that math-focused PL time is structured well so that it is useful to teachers.

A shortage of high-quality facilitators is another possible barrier to effective math-focused PL. There is growing attention to the critical role that expert facilitators play in providing such rich opportunities for teachers' learning (Gibbons et al., 2021; Tekkumru-Kisa and Stein, 2017). And our teacher survey responses indicate that facilitator expertise is related to perceived usefulness of PL. However, principals—particularly rural principals—noted that facilitators with expertise were in short supply, suggesting that efforts to improve access to expert facilitators are needed. This is an area that can be explored in more depth in future research.

Limited time for PL and the need to focus on other subjects or administrative matters, among other constraints, means that math—and the math curriculum—is not always the main focus of teacher PL. This is especially true in elementary settings in which teachers teach multiple subjects. However, districts' increased focus on providing math teachers with PL about the math curriculum presents an opportunity for district and school leaders to examine their math-focused PL offerings to ensure that they provide teachers with in-depth PL on their specific curricula. This might include training on how to adapt materials for diverse student populations, how to determine which content and materials to prioritize, and how to interpret and respond to student performance when using the materials.

Learning to use a new curriculum takes time. It is promising that so many districts are recognizing that adoption of new curricula must be accompanied by adequate curriculum-based PL that can support teachers' implementation of the materials. Our results show that district leaders and principals are prioritizing curriculum alignment when selecting PL for math teachers. We offer recommendations to districts on how to make the most of their math-focused PL offerings.

Teachers' limited time for professional learning elevates the importance of ensuring that math-focused professional learning time is structured well so that it is useful to teachers.

Recommendations

Ensure Curriculum-Based Professional Learning Is High Quality

As the key decisionmakers when it comes to teacher PL, district leaders and principals should ensure that curriculum-based PL for math teachers is high quality. District and school leaders could draw on emerging research-informed characterizations of curriculum-based PL as their benchmark of quality. For example, curriculum-based PL should focus on the specific materials teachers are using, focus on how to enact pedagogy using those materials, involve collaboration or collective participation, and be responsive to teachers' needs (Short and Hirsh, 2020). These attributes are consistent with our findings on the features of PL that teachers find most useful. District leaders and principals should also select or design math-focused PL that considers the different needs and experiences of teachers across grade levels, such as the need for elementary teachers to focus on other subjects or high school teachers' preferences for PLCs. Continuing to include teachers in the PL selection and development process could help ensure that teachers' needs are met.

Prioritize Facilitator Expertise When Selecting Math Professional Learning Providers

Districts and principals should consider facilitator expertise when developing in-house PL or selecting external PL providers. Publicly available resources, such as Rivet Education's Professional Learning Partner Guide, are designed to assist leaders in finding high-quality providers of curriculum-based PL that have been vetted by experts (see Rivet Education, undated). This resource from Rivet Education is one in a list of resources provided by the Council of Chief State School Officers for education leaders to seek high-quality professional development providers.[6] The rubrics used to vet providers are also publicly available and included in these resources. Schools and districts could use these rubrics to screen external providers for quality or to develop their own high-quality PL.

Limitations

The findings in this report are subject to several limitations. First, although our survey piloting shows a roughly equivalent understanding of the various terms used across surveys and interviews, as shown in Table 1, our instruments did not always provide detailed definitions of key topics related to this report (e.g., PL, curriculum aligned). Therefore, it is possible that some respondents interpreted key terms differently, and we urge readers to keep in mind that the terms we use in this report might cover a broad variety of structures of PL.

Second, like that of all survey and interview research, our data are respondents' self-reports of their experiences. There are potential biases that can emerge from self-reported data, such as imperfect recollection of past events or provision of socially desirable responses.

Third, we do not have systematic measures of how teachers spent their PL time or measures of the quality of math PL that teachers received beyond teachers' self-reported usefulness of certain types of PL activities. The quality of PL experiences can vary across many dimensions and providers. Future research that considers ways to link teachers' PL providers to ratings of quality, would enrich our understanding of the topics we study in this report.

Finally, despite the richness of the interviews conducted with teachers and principals, interviews were capped at 45 to 60 minutes, and the interview questions were developed to capture a variety of topics. Thus, we were unable to systematically explore interviewees' responses in depth or to seek elaboration on all topics.

About the American School District Panel

Some of the findings reported here were generated using the American School District Panel, which conducts nationally representative surveys of public school district leaders twice a year, in addition to focused interviews to gather more context for select survey topics. For more information, visit www.americanschooldistrictpanel.org.

Research Partners

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Funding for the development of the American School District Panel was provided by

How This Analysis Was Conducted

Across each survey administration, each respondent was assigned a weight to ensure that estimates reflect the national population. Characteristics that factor into this process include descriptors at the individual level (e.g., gender, professional experience) and school or district level (e.g., school size, grade level, locale). The 2024 AMES survey contains oversamples of teachers and principals in the four largest states—California, Florida, New York, and Texas—so that, in addition to nationally representative inferences, state representative inferences can be made across those states.

To compare responses for teachers and principals in schools with different demographic profiles, we matched teachers' responses to school-level data from the 2022–2023 Common Core of Data. In this report, we compared responses across subgroups defined by various respondent and school characteristics, testing for whether average responses for certain subgroups differed from a specified reference subgroup. We do not report exhaustively on all subgroup estimates on all survey items, and, for the purposes of consistency and brevity, this report typically includes subgroup comparisons across our four focus states and three grade levels (i.e., elementary, middle, and high school).

We used the Common Core of Data's school-level classifications to group data into elementary, middle, and high school grade bands. Throughout this report, we note where differences across subgroups are statistically significant. We conducted significance testing using two-sided pairwise *t*-tests at the critical value of $p < 0.05$. Because the intent of this report is to provide exploratory, descriptive information rather than to test specific hypotheses, we did not make statistical adjustments for multiple comparisons.

We use data from interviews with 23 superintendents and senior school district leaders (e.g., chief academic officers, human resources directors, directors of schools) in traditional public school districts conducted in winter 2023 and spring 2024. These interviews were conducted by researchers at the Center on Reinventing Public Education. The winter 2023 interviews included 12 leaders, over half of whom were in suburban districts. These leaders represent districts that vary in size from four that served fewer than 1,000 students to one that

served more than 70,000 students. Leaders in winter 2023 were asked questions about math learning challenges and math learning goals. The spring 2024 interviews included 11 leaders representing districts ranging in size from under 1,000 students to over 100,000 students. Districts were evenly distributed in locale. These leaders responded to questions about selecting math-specific PL, math curriculum adoption, and mathematics learning goals.

We conducted virtual interviews, which were 45 to 60 minutes in length, with 54 teachers and 52 principals between April and May 2024. Each participant voluntarily participated in the interview and was provided with an incentive for their participation. All interview participants responded to the AMES teacher or principal surveys in March and April 2024 and indicated agreement to be contacted for an interview. From this pool, we sampled K–12 teachers and principals to achieve variation on dimensions that are often sources of variation in teacher and principal experiences: school poverty status, schools with majority students of color, principal racial and gender demographics, years of experience, and state.

Teacher interviews included questions about teachers' access to high-quality, curriculum-based PL, teachers' use of time for planning and teaching, students' access to challenging math courses, interventions for struggling students, and challenges to high-quality math instruction. Principal interviews included questions about math teachers' access to high-quality, curriculum-based PL; principals' roles in identifying math-focused PL opportunities for math teachers; students' and teachers' placement into math courses; supports for students who struggle in math; and challenges to high-quality math instruction.

The analysis of the interview data involved multiple stages. First, we developed a codebook, which was iteratively refined through multiple researchers' coding the same set of interviews and discussing their coding. Once all the researchers involved in the coding came to a common agreement about the codes and their definitions, two researchers coded all the interviews. Next, we conducted second-level coding addressing the focal research questions related to teachers' and principals' thinking and experiences about PL. These analyses were then completed by generating themes across the interviews, which were used to create memos addressing focal research questions. The findings summarized in these memos informed the findings presented in this report.

Notes

[1] The full set of survey results can be viewed and user-friendly charts can be created in Bento, a free data visualization tool. To learn more about Bento, go to www.getbento.info/about or email bento@kitamba.com.

[2] The Common Core of Data defines an *elementary school* as a school that offers more of grades K–4 than 5–8 and no 9–12, a *middle school* as a school that offers more of grades 5–8 than higher or lower grades but does not offer both K–4 and 9–12, and *high schools* as the remaining schools (NCES, undated).

[3] Our internal piloting of survey items prior to administration suggests that different respondent groups understood these terms in broadly similar ways.

[4] In the district survey, respondents were first asked whether their district had one or more specific goals for middle and/or high school math. Next, respondents who indicated that their district had at least one math learning goal were asked what actions their district was taking to meet their math learning goals. Districts were not surveyed about their goals for elementary school math.

[5] In this resource, teachers are included in bargaining unit 3.

[6] For the full list of resources provided, visit Council of Chief State School Officers, undated.

Abbreviations

AEP	American Educator Panels
AMES	American Mathematics Educator Study
ASDP	American School District Panel
PL	professional learning
PLC	professional learning community

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About This Report

In this report, we use data from the American Mathematics Educator Study (AMES) collected in spring 2024 from kindergarten through grade 12 public school math teachers and principals. We also use data from the American School District Panel (ASDP) collected in fall 2023 and spring 2024. The AMES and ASDP data were gathered through the RAND American Educator Panels (AEP). The AEP are nationally representative samples of teachers, school leaders, and district leaders across the country. The panels are a proud member of the American Association for Public Opinion Research's Transparency Initiative. If you would like to know more about the AMES dataset, please see *American Mathematics Educator Study: 2024 Technical Documentation and Survey Results* (Schweig et al., 2024) for more information on survey recruitment, administration, and sample weighting. If you are interested in using AEP data for your own surveys or analysis or in reading other publications related to the AEP, please email aep@rand.org or visit www.rand.org/aep

The ASDP is a research partnership between RAND and the Center on Reinventing Public Education. The panel also collaborates with several other education organizations, including the Council of the Great City Schools and MGT. For more information, visit the ASDP website at www.americanschooldistrictpanel.org. If you would like to know more about the fall 2023 and spring 2024 survey administrations, see *Technical Documentation for the Eighth American School District Panel Survey* (Grant et al., 2024a) and *Technical Documentation for the Ninth American School District Panel Survey* (Grant et al., 2024b) for more information on survey recruitment, administration, and sample weighting.

RAND Education and Labor

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