Analysis of Middle School Math Systems (AMS)

Further Investigation into Student Experiences, Instruction, and Context

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Executive Summary

Our study is grounded in the premise that the foundation for improved outcomes for *all* students in mathematics is high-quality curricula and coherent instructional contexts at the district and school levels. We are examining the implementation of high-quality mathematics curricula in a set of schools using green-rated curricula and receiving high-quality professional learning and another set of schools using non-green rated curricula and receiving the business-as-usual professional learning. Our goal is to understand how and to what extent district and school instructional guidance and professional supports align and cohere with mathematics standards, local school contexts, teacher knowledge and beliefs about mathematics instruction, and classroom practice. In particular, we are interested in understanding both the enabling and disabling conditions under which teachers can or cannot implement high-quality mathematics curricula effectively as well as the conditions under which students can or cannot thrive.

In our first interim report, we drew on teacher survey data to share preliminary findings on the characteristics of curricula and professional learning that may be associated with teachers' instructional decisions, particularly their decisions to adapt curricula to better meet their students' individual learning needs. In this report, we present analyses of district, school administrator, and teacher interview; student survey; student focus group; and classroom observation data to explore whether:

- Students hold positive perceptions about themselves as math students, are enjoying math class, and are motivated to continue studying math in the future.
- Teachers are employing ambitious, culturally responsive, and equitable instructional practices to provide students with a positive learning environment.
- Teachers possess beliefs that positively influence students' experiences in math class.
- District and school administrators share a clear and coherent vision for high-quality middle school math instruction that can help teachers create and sustain positive learning environments.

Overall, we found the following:

Do students hold positive perceptions about themselves as math students, are they enjoying math class, and are they motivated to continue studying math in the future?

- **Achievement identity.** Students were most likely to feel that their parents think they are good at math and less likely to feel that their classmates believe so. Even though a majority of students reported that their friends think that they are good at math:
  - Black and Hispanic students were less likely to feel that their classmates view them as good at math.
  - Male students were significantly more likely than female students to say that their parents and classmates think they are good at math.
- **Math enjoyment.** A majority of students indicated that they care about learning math and want to be in math class. However:
  - Black and Asian students were significantly more likely than White or Hispanic students to say that they enjoy learning new things in math.
  - Black and Hispanic students were significantly more likely to say that they feel frustrated in math class or often feel down.

  - Female students were less likely to report enjoying, feeling good in, or looking forward to math class and were significantly more likely to report that they feel frustrated, worry about learning new things in math, or feel down in math class.

- **Future plans to study math.** Two-thirds of students indicated that they plan to continue taking math classes to prepare for college (46 percent) or because they like studying math (22 percent). Students' plans to purse math coursework in the future did not appear to differ by race or ethnicity. However, female students were more likely to say that they will keep taking math classes in order to prepare for college while male students were more likely to say that they will keep taking math classes because they like studying math.

Are teachers employing ambitious, culturally responsive, and equitable instructional practices?

- **Ambitious instruction.** Across the lessons we observed, teachers on average earned moderate ratings for their use of ambitious instructional practices. Teachers commonly designed lessons that were aligned with standards and they earned high ratings for presenting mathematical concepts accurately. They were least likely to create opportunities for students to engage in problem solving or use manipulatives.
- **Culturally responsive instruction.** Teachers infrequently employed strategies most commonly associated with culturally responsive teaching, including engaging students' cultural and community funds of knowledge and making interdisciplinary connections. We observed no instances of teachers empowering students to use math as a tool for social justice. However, teachers created ample opportunities for students to engage in mathematical discourse.
- **Equitable instruction.** Teachers predominantly delivered whole-class instruction, suggesting limited efforts to create equitable learning environments. In addition, teachers commonly tasked students with individual work.

Do teachers possess beliefs that positively influence students' experiences in math class?

- Teachers' instructional self-efficacy (or belief that that have the capacity to teach effectively), confidence in teaching in culturally responsive ways, and their perception that their district and school leaders are supportive do not appear to be related to students' achievement identity.
- The teachers of students who were less likely to indicate that they believe they can achieve in math if they work hard enough (growth mindset) were significantly more likely to feel that their curriculum is too rigorous for their students. These teachers also tended to work in schools with significantly more Hispanic students and students who are experiencing poverty (eligible for free and reduced-price lunch).
- Teachers who reported that their curriculum is appropriate for their students' needs (that is, not too rigorous) taught in schools with significantly more students performing at or above 6th-, 7th-, and 8th-grade proficiency in math.

Did district and school administrators share a clear and coherent vision for high-quality middle school math instruction that could help teachers create and sustain positive learning environments?

- Our initial look at how district and school leaders describe their respective visions for math education—and the alignment between the two—suggests that instructional leaders do not consistently share a clear and consistent vision that offers concrete guidance on instructional strategies teachers could employ to realize stated learning goals.

Implications. These findings suggest several implications:

- The real and discouraging racial and gender differences between students' reported math achievement identity and enjoyment of math points to the need for continued attention to improving these outcomes.
- There is considerable need to strengthen professional learning in ambitious, culturally responsive, and equitable teaching to align pedagogical practice with district and school visions for improved academic outcomes for all students.
- Teacher beliefs are associated with schools' historical student performance and demographic characteristics, perhaps contributing to persistent racial and gender disparities in math.
- As organizations, districts and schools might prioritize development of a coherent and shared vision for math instruction, and one that provides concrete guidance on instructional practices to support the vision.

As we look to our final year of data collection, these findings open the door to some potential explorations, including the following:

- To what extent do the study curricula support differentiation that is aligned with standards?
- How do teachers differentiate learning for students performing below grade level?
- How do teachers who use ambitious, culturally responsive, or equitable practices structure their lessons? Do they design learning environments differently from teachers who did not use these practices routinely?
- Is there evidence that districts and schools are making explicit investments in professional learning and other instructional resources needed to help teachers realize a common vision for high-quality math?
- Is there a relationship between the quality of a curriculum and the quality of instructional delivery? Does instructional practice differ by curriculum rating or curriculum?

I. Introduction

The Bill & Melinda Gates Foundation created a set of investments, the Coherent Instructional Systems portfolio, that envisions broad availability of evidence-based product design principles and market information. Together, the investments aim to help entities involved in both supply and demand develop and select the best possible solutions for students who are Black, Latino, multilingual learners or are experiencing poverty. The portfolio is grounded in the belief that these priority students will succeed in coherent instructional systems that are built on effectively implemented evidence-based solutions. Paramount to the foundation's vision is understanding and defining dimensions of quality that make individual solutions effective and translating them into information about the key drivers of curricular efficacy. In particular, the education field does not know enough about how teachers use, transform, and ultimately deliver curricula to students. The field would also benefit from advancing its understanding of how the characteristics of standards-aligned materials relate to implementation quality and student outcomes.

The Analysis of Middle School Math Systems (AMS) study aims to assess (1) the characteristics of curricula rated "green" by EdReports as compared to "non-green" curricula (including one curriculum not rated by EdReports; see text box), (2) the contribution and characteristics of professional learning that support teachers in delivering curricula, and (3) how and why curricula transform in teachers' hands. Ultimately, the study intends to understand both the enabling and disabling conditions under which teachers can or cannot implement high-quality math curricula as well as the conditions under which students can or cannot thrive. A core goal is to investigate whether certain investments or practices can improve conditions for teaching and learning, thereby making middle school math experiences more enjoyable and productive for priority students. The study is organized around five broad inquiry areas (see text box).

Middle school math curricula in the study

Green-rated curricula

1. Illustrative Math
2. Into Math
3. Eureka Math

Non-green- or non-rated curricula

4. CA Math (Glencoe)
5. Big Ideas
6. Key Elements of Mathematics Success (KEMS)

The AMS study team has partnered with four districts to conduct the study. In our first interim report (August 2022), we analyzed teacher survey data to explore three of our inquiry areas. The chief findings from our preliminary results follow:

Study inquiry areas

1. Curricular efficacy
2. Curriculum characteristics that influence instructional enactment
3. Characteristics of professional learning that supports teacher needs and effective instructional enactment
4. Adaptations in instructional enactment
5. What influences planned and unplanned adaptations in instructional enactment

Curriculum characteristics:

- On average, *green-rated curricula are more aligned* with the Common Core State Standards (CCSS) than non-green-rated curricula. Among the green-rated curricula, Eureka Math is the most aligned with the CCSS.

- Although two of the green-rated curricula—Illustrative Math and Eureka Math—are *more cognitively demanding* than the non-green-rated curricula, all of the study curricula are less cognitively demanding than the CCSS recommends.
- Teachers using green-rated curricula are significantly more likely to believe that their curricula are too cognitively demanding for their students and that they have insufficient time to reasonably cover curriculum content during the school year.
- None of the study curricula meet our Culturally Responsive Math Teaching (CRMT) tool's standard for cultural responsiveness.

Professional learning characteristics:

- Teachers were most likely to receive professional learning that focuses on culturally responsive practices and analyzing student work or assessment data.
- Teachers were most likely to perceive professional learning activities as valuable to their math instruction; their understanding of how students learn math; their responsiveness to students' backgrounds, cultures, and points of view; their mindset and biases about students and setting higher expectations for all students; and strategies that improve their math instruction.
- However, on average across all areas of professional learning, teachers felt that the support they received only impacted their math instruction to a limited extent (including strengthening their approaches to demonstrating respect for students' cultural backgrounds), suggesting ample room for improvement.
- Less than half of teachers felt that their professional learning was aligned with feedback from observations of their teaching or connected to their daily lessons.

Adaptations in instructional enactment:

- The majority of teachers reported that they made productive adaptations to their curricula, including modifying lessons to ensure a more equitable experience for their students. In particular, they differentiated instruction not only for multilingual learners and students performing below grade level but also for students performing above grade level.
- Only a small percentage of teachers who modified their curriculum to promote culturally responsive mathematics teaching also reported the use of strategies that explicitly leverage students' cultural and community funds of knowledge.

In this report, we build on these findings by reflecting on district, school administrator, and teacher interview; student survey; student focus group; and classroom observation data to investigate four questions:

1. Do students hold positive perceptions about themselves as math students, are they enjoying math class, and are they motivated to continue studying math in the future?
2. Are teachers employing ambitious, culturally responsive, and equitable instructional practices?
3. Do teachers possess beliefs that positively influence students' experiences in math class?
4. Do district and school administrators share a clear and coherent vision for high-quality middle school math instruction that can help teachers create and sustain positive learning environments?

In the first section of this report, we describe our district, school, and classroom samples; detail our data sources; and outline our analytic methods. In the second section, we present interim findings in response to the above four questions. In the final section, we discuss implications for the findings, the methodological limitations that influence the extent to which we can draw generalizable conclusions from the data presented in the report, and conclude with potential next steps as we complete our final round of data collection.

II. Report Sample, Data Sources, and Methods

A. Sample

The AMS study team is partnering with four districts to conduct the study. Within these districts, we are studying schools that use one of six focal curricula of interest: Illustrative Math, Into Math, Eureka Math, California Math, Big Ideas, or Key Elements of Mathematics Success (KEMS). These four districts bring their own policy, demographic, and instructional contexts, and are in a range of stages in formulating and implementing a vision for middle school math. As districts among the largest in the nation, they experience challenges common in education across the United States, not least of which is how to support students in engaging with and making progress in math, particularly during the critical middle school years.

Though most of our data collection is being conducted in a small set of middle schools in each of these districts, we have provided information on each district in previous reports to provide broad context. This context is also relevant for the district-level interview data shared here and other analyses potentially influenced by context. Although we do not share the figures included in our earlier reports, we briefly summarize this context by noting similarities and differences across the districts. For example, District 1 has a much larger percentage of Black students and a lower percentage of students who score at or above the state's proficiency level than other districts; District 4 has a considerably higher percentage of students who score at or above the state's proficiency level and, in the case of grades 6 and 7, student achievement performance exceeds the national average proficiency level. District 4 also has many fewer teachers new to the profession than do the other districts. Districts 2 and 3 have many more students who are eligible for free and reduced-price lunch.

This report draws on the study's full sample (students and teachers from 39 middle schools[1]) as well as on the study's deep dive sample (students and teachers from a subset of 12 middle schools). To create the full sample of schools for study participation, the team worked with each of the four participating districts to identify and recruit a set of schools with grades 6–8 that were using the curricula of interest and were willing to participate. This resulted in 10 participating schools in District 1, six schools in District 2, eight schools in District 3, and 15 schools in District 4. Overall, the student demographics of the study's full sample reflect the district sample in measures of student math proficiency and eligibility for free and reduced-price lunch, though there are slight differences in student composition by race and ethnicity. In three of the four school districts, our full study sample has a slightly lower percentage of Hispanic or Latino students than does the district overall.

The deep dive schools (12 schools; three schools per district, representing each of the focal curricula in the district) contributed additional data on teachers' instructional enactment and student perspectives on their classroom experiences. We purposively selected these 12 deep dive schools from among the 39 schools in the full study sample to ensure our deep dive sample had meaningful variation in math achievement and teacher experience. In some cases, the students in the deep dive sample do not perfectly align with the broader school district's student demographics. Differences in race and ethnicity, free or reduced-price lunch status, and math proficiency vary by school district:

- **District 1.** On average, a lower percentage of students in the three District 1 deep dive schools score at or above the state's proficiency level in math when compared to the district. The deep dive schools

[1] The full sample originally included 41 schools, but two schools declined to participate.

also have a lower percentage of Asian, Hispanic or Latino, and White students but a higher percentage Black or African American students than the school district overall.

- **District 2.** On average, a lower percentage of students in the three District 2 deep dive schools are White or proficient in math, and a higher percentage of students are Black or African American or eligible for free or reduced-price lunch than the school district overall.
- **District 3.** On average, a higher percentage of students in the District 3 deep dive schools are proficient in math in 6th and 7th grade than the school district overall.
- **District 4.** On average, a lower percentage of students in the three District 4 deep dive schools are Hispanic or Latino or eligible for free or reduced-price lunch, and a higher percentage of students are Asian, White, and proficient in math than the school district overall.

B. Data sources

Within the four study districts, we conducted interviews with one or more staff in the district's central administration—someone familiar with or responsible for math strategy, instruction, or both. For the full study sample, we conducted school administrator interviews (generally with the school principal) and collected teacher and study survey data and other data publicly available to understand school or district characteristics. For the deep dive subsample, we also conducted classroom observations, post-observation teacher interviews, and student focus groups.[2] All these data included in the analyses shared in this report were collected during the 2021–2022 school year. Exhibit 1 lists all the data sources we used for this report.

Exhibit 1. Study data sources

Data source	Description	Sample size	Collection period
District administrator interview	We conducted these interviews with district administrators. Interview topics included approaches to selecting and implementing math curricula, the district's vision for high-quality math instruction, and the professional learning supports provided for math teachers.	6 district administrators [a]	Fall 2021/winter 2022
EDFacts	These are grade-level school data on the historical performance of schools in AMS districts (including those outside of the study)		2018–2019
Common Core of Data	School-level data including school-level percentages of students by race/ethnicity category and free and reduced-priced meals status		2020–2021
School administrator interview	We administered this interview to principals or other school administrators.[b] Interview topics included vision for high-quality math instruction, approach to providing instructional leadership, and the professional learning supports, including coaching, provided to math teachers in their school.	33 administrators[c]	Fall 2021
Teacher background survey	This survey asked about teaching background and experience, perceptions and use of various math curricula, and teaching practices.	126 teachers	Fall 2021

[2] We conducted one focus group per deep dive school.

Data source	Description	Sample size	Collection period
Teacher follow-up survey	This survey asked about professional support, teacher beliefs, enactment and adaptation of curriculum planning, and instructional delivery.	87 teachers	Spring 2022
Student survey	This survey asked about students' math beliefs and engagement (see Appendix B for detailed information on the outcomes measured).	1,331 students for the fall survey and 1,456 students for the spring survey[d]	Fall 2021 Spring 2022
Classroom observations (Deep dive schools only)	These observations captured what happens during actual math instruction. We used two tools to code our observations: The Mathematics Scan (M-Scan) measured standards-based mathematics teaching practices by assessing use of mathematical tasks, mathematical discourse, mathematical representations, and mathematical coherence. To complement our use of the M-Scan, we used the Culturally Responsive Math Teaching (CRMT) classroom observation tool. The tool documented instances when we observed CRMT practices that aligned with our theory of action.	41 M-Scan observations (21 teachers, 1 – 3 observations per teacher); 48 CRMT observations (25 teachers, 1 – 3 observations per teacher)	Spring 2022
Post-observation teacher interview (Deep dive schools only)	In these interviews conducted after each classroom observation, teachers reflected on excerpts of the video-recorded lesson to explain (1) the rationale behind instructional decisions and *adaptations* they made to the intended and planned curriculum, (2) whether and how *professional learning* activities influenced the observed lesson, and (3) their perspective on *effective culturally responsive and equitable teaching.*	25 teachers	Spring 2022
Post-observation student focus group (Deep dive schools only)	Students were asked to reflect on video excerpts of the observed lesson to explore the extent to which students (1) experienced the lesson as intended by their teacher; (2) perceived the learning environment to be responsive to their individual needs, culturally responsive, and equitable; and (3) perceived that the learning environment positively influenced their math beliefs, identity, engagement, enjoyment, persistence, and performance.	11 focus groups[e]	Spring 2022

[a] We conducted a third interview with a district administrator in District 3 but did not receive permission to include the interview content in this analysis.

[b] In a few cases, the principal delegated math instructional leadership to an assistant principal or instructional coach and requested that we interview this person instead.

[c] We intended to interview school administrators from all 39 schools in the full sample, but we were unable to conduct interviews with six schools due to scheduling conflicts or unresponsiveness.

[d] District 2 and District 3 did not participate in the fall data collection activities—the former as a condition of participation; the latter due to a compressed timeline based on when we received research approval. This explains why fewer students completed the survey in the fall than the spring.

[e] We were unable to conduct a student focus group in one of the 12 deep dive schools.

C. Methods

1. Analysis of standards-based mathematics instructional practice

To explore the extent to which teachers in our deep dive sample employ standards-based instructional practices, we used the Mathematics Scan (M-Scan) (Bostic et al., 2021; Walkowiak et al., 2014,

2018) classroom observation tool. The M-Scan is a validated observation protocol designed to assess the degree to which teachers create opportunities for students to:

- Engage in *cognitively demanding* tasks
- Identify, apply, and adapt a variety of strategies to *solve problems*
- *Connect mathematics* to other mathematical concepts, their own experience, to the world around them, and to other disciplines
- Use, contextualize, illustrate, and translate math ideas and concepts through *multiple representations* (such as pictures, graphs, symbols, words)
- *Use mathematical tools* (such as calculators, pattern blocks, fraction strips, counters, virtual tools) to represent abstract mathematical concepts
- Express their mathematical ideas openly and communicate their mathematical thinking clearly to their peers and teacher using the *language of mathematics*
- Provide *explanations and justifications*, both orally and on written assignments

Additionally, the M-Scan assesses the degree to which teachers:

- *Structure a lesson* to be conceptually coherent such that activities are connected mathematically and build on one another in a logical manner
- Present mathematical concepts and model mathematical discourse clearly and *accurately* throughout the lesson

The M-Scan tool co-developers (the master coders) trained three Mathematica coders on conducting observations with the tool in a five-day training. The master coders have substantial classroom teaching experience and are math education experts. The three coders have classroom teaching experience or completed substantial coursework in math at the postsecondary level. The training involved reading, listening to conversations about each coding dimension, watching videos, and coding practice videos. The training involves a four-phase process: (1) preparation, (2) training and mastery phase, (3) reliability phase, and (4) drift test phase. The master coders tracked and recorded trainees' progress in attaining and maintaining reliability through the four phases. Trainees practiced with the master coders on at least two full class mathematics videos. After the training session, trainees watched two video-recorded classes independently and took notes. Afterward, trainees' ratings were compared to those of the master coders. After trainees watched and coded the assigned set of "training" videos, the master coders identified gaps and looked for convergence. More training videos were assigned if gaps were present. Trainees moved to the reliability phase when ratings from the training videos converged with ratings from the master codes. Trainees watched and coded six mathematics "reliability" video observations, without conferring with the master coder. After the master coder verified that the trainee was reliable, the trainee was able to code mathematics observations using the M-Scan.

To use the tool, coders watch the first 30 minutes of a video-recorded lesson and take notes throughout the 30-minute segment to record what occurs during the lesson. Coders write their notes on the back of the coding sheet or on separate pieces of paper. The notes are used as examples and references when completing the M-Scan coding for that segment. After the first 30 minutes, the video is paused to allow coders to reflect and mark "soft codes" (that is, initial ratings) on the coding sheet by underlining the number corresponding to the initial code. These marks serve as indicators of what happened during the first part of the lesson. After assigning "soft codes" for the first 30 minutes, coders continue watching the lesson, following the procedures from the first 30-minute segment. Once coders have watched the entire lesson, they assign final codes of 1 to 7 to each dimension, where 1 and 2 represent a low rating (limited evidence of this domain), 3 to 5 represent a moderate rating, and 6 and 7 represent a high rating (more evidence and stronger in nature).

We used M-Scan's scoring rubrics to rate both the quality and frequency with which a teacher demonstrated each of the nine elements of instructional delivery (referred to below as M-Scan domains) during a lesson listed above. We analyzed M-Scan ratings for a total of 41 lessons representing 25 different teachers, one to three observations per teacher depending on whether they taught more than one grade level.

We conducted in-person observations in District 3 schools and video observations in the remaining districts. In-person observations were coded by one of the master coders who co-developed the tool and co-facilitated M-Scan training. All video observations were coded by one or two coders. During the data collection period, roughly 25 percent of the lessons were double-coded. Additionally, the master coders randomly checked for reliability on 20 percent of the videos. The master coders resolved coder discrepancies.

To analyze M-Scan data, we aggregated all teacher scores to calculate average ratings for each M-Scan domain.

2. Analysis of culturally responsive math teaching (CRMT) practice

To explore teachers' use of culturally responsive pedagogical practices, we used a CRMT classroom observation tool that we developed to analyze CRMT practice. In five-minute intervals, the tool documents the extent to which teachers create opportunities for students engage in the following:

- **Real-world mathematical inquiry and problem solving.** Engage in real-world inquiry and problem solving using authentic data or information (Aguirre & del Rosario Zavala, 2013; Jones, 2015; Turner et al., 2012).
- **Multiple representations of mathematics.** Explore multiple representations of mathematical concepts and alternative solutions to problems (Ainsworth, 2006; Edmonds-Wathen, 2019; Jitendra et al., 2007; Pape & Tchoshanov, 2001; Selling, 2016)
- **Mathematical discourse.** Discuss mathematics in meaningful and rigorous ways (such as debating or critiquing ideas or solution strategies, using mathematics terminology, developing explanations, communicating reasoning, making generalizations) (Aguirre & del Rosario Zavala, 2013; Jones, 2015; Turner et al., 2012).
- **Multilingual learner language support and scaffolding.** Develop math content knowledge and competencies as a multilingual learner (Aguirre & del Rosario Zavala, 2013; Hanzlian, 2013; Jones, 2015; Turner et al., 2019)

- **Engaged student and community funds of knowledge.** Draw on students' cultural and community funds of knowledge as a learning asset (Aguirre & del Rosario Zavala, 2013; Jones, 2015; Turner et al., 2012).
- **Interdisciplinary connections.** Make interdisciplinary connections (Aguirre & del Rosario Zavala, 2013; Jones, 2015; Turner et al., 2012).
- **Empowered mathematical inquiry and decision making.** Explore social justice issues of relevance to students using math as a tool (Aguirre & del Rosario Zavala, 2013; Jones, 2015; Turner et al., 2012).

Additionally, the tool captures:

- Teachers' use of *student grouping strategies* (such as when students work in small groups or peer pairs)
- *Student–teacher and student-student interactions* (such as instances when a teacher encourages a student to work through a difficult task)
- *Procedural classroom practices* (such as taking attendance)
- Teachers' use of *low-cognitive instructional strategies* (such as asking students to use worksheets to practice rote mathematics procedures)
- Teachers' use of *instructional materials* (such as educational technology, language aids for multilingual learners, and teacher-developed resources).

At the outset of the study, we conducted a literature review and landscape analysis to identify classroom observation instruments that could be used to assess and compare culturally responsive curricular enactment and adaptation (1) across multiple contexts (curricula, districts, schools, classrooms, and instructional units) and (2) using video-recorded lessons (two cameras and two audio sources) or observation data collected in person. We desired a tool that:

- Is *reliable and valid* for use in a large-scale study
- Is appropriate or adaptable to assess instruction in *middle school math learning environments*
- Can be used to document both *culturally responsive* teaching AND *equitable* teaching (inclusive instructional strategies intended to differentiate or personalize instructional content and tasks to ensure all students have equal access to the learning experience, such as heterogenous and cooperative groupings)
- Scores the occurrence or non-occurrence of *observed behavior* rather than require a coder to inferentially *evaluate the quality of observed behavior*
- Is *empirically supported* by culturally responsive practices that have been documented in research on effective or promising practice, rather than *aspirational or theoretical* approaches presenting an ideal or vision for culturally responsive practice

We designed our own tool because our literature review and landscape analysis did not reveal a tool that met these criteria. Our tool has not yet been validated. This report presents data collected using a pilot version of the tool that we iteratively developed by using it to code video examples of culturally responsive practice and based on feedback from our study co-principal investigators, the study's Math Advisory Council, and Maria de Zavala, whose research formed the basis for the tool's core domains.[3]

A team of Mathematica analysts with qualitative research or classroom teaching experience participated in a five-day training on the tool. The training was designed and conducted by the enactment study task lead who also designed the CRMT classroom observation tool (the master coder). The master coder is a learning scientist, has classroom teaching experience, and is an expert in culturally responsive teaching. The training involved the following:

- Group discussions of the research base on culturally responsive teaching and for each of the 13 domains in the tool
- Group discussion of the codes in each domain, including their definition as well as inclusion and exclusion criteria indicating when to apply a code
- Group coding practice using brief video examples of classroom practice
- Independent coding practice using longer video examples of classroom practice

Following training and before data collection began, coders received additional opportunities to independently practice using the tool with new video examples. The master coder tested their independent coding practice for interrater reliability using Cohen's kappa (Cohen, 1960). Coders continued to practice using the tool until coder agreement exceeded 80 percent.

We conducted in-person observations in District 3 schools and video observations in the remaining districts. In-person observations were coded by two coders. These coders met after each observation to discuss and resolve coding discrepancies such that final codes reflected a consensus among coders. All video observations were coded by one coder. Coders met weekly to discuss coding questions, and the master coder randomly reviewed coded videos to assess interrater reliability. Coding discrepancies were resolved either by discussion with the coder to reflect a consensus among coders, or at the master coder's discretion, if a specific code was consistently misapplied across multiple observations. In those cases, the master coder refined the code's definition and inclusion or exclusion to ensure more accurate and reliable use in the future.

We analyzed CRMT classroom observation data for the same 48 lessons representing 25 different teachers as we coded using the M-Scan, which included one to three observations per teacher depending on whether they taught more than one grade level. Of these observations, 22 lessons were taught by teachers using green curricula and 19 were taught by teachers using non-green curricula. We observed each of the 48 lessons in their entirety. We coded observed practice in five-minute intervals (for example, a 40-minute lesson would be coded as eight intervals). For a given lesson, the CRMT classroom observation tool documents whether a specific practice or behavior occurred at least once during a five-minute interval. In other words, codes do not reflect the total number of times we observed a practice *within* a specific interval and should not be interpreted in minutes. Instead, we calculate CRMT domain scores as a percentage of intervals during which a teacher exhibited a particular strategy or behavior within a domain at least during the class period. We report domain scores as a percentage of class time for which a domain score suggests the following:

[3] We are in the process in refining the design of the tool based on data collected during the 2021–2022 school year and feedback from coders. We will use this revised version of the tool to conduct classroom observations during the 2022–2023 school year. We hope to validate the instrument in the future for broader use by researchers and educators.

- 25 percent or less suggests *nonroutine, rare, or no* use of a strategy or behavior over the course of a lesson
- 26–49 percent represents *occasional but inconsistent* use of a strategy or behavior over the course of a lesson
- 50 percent or higher suggests *routine or consistent* use of a strategy or behavior over the course of a lesson

To analyze CRMT classroom observation data, we aggregated all teacher scores to calculate average scores for each CRMT domain and subdomain. Subdomains are individual practices or behaviors (or codes) that together comprise a domain. Because our tool is in a pilot phase and not yet validated, we did not construct an overall CRMT score by summing or averaging a teacher's domain scores.

3. Analyses of teacher and student survey data

We analyzed teacher and student surveys using descriptive statistics, calculating frequencies, percentages, and means across survey items and public data on student demographics (percentage by race and ethnicity category and free and reduced-price lunch status) and proficiency rates. Appendix A provides additional detail on the teacher and student survey samples. We disaggregated survey results by areas of interest for our research questions and conducted t-tests and chi-square tests to detect significant differences in response patterns between disaggregated groups. Throughout the report, we conduct analyses using scales we developed as part of our surveys. Appendix B lists all these scales, including definitions of each construct measured by the scale and the survey items that we used to construct the scales.

4. Content analyses of interviews with teachers, school administrators, and district administrators and student focus groups

For our interviews and focus groups, we used NVivo qualitative data analysis software to systematically code these data. We iteratively built a codebook that used both descriptive (for example, occurrence or non-occurrence of specific instructional practices) and inferential (such as satisfaction with the curriculum) codes that are aligned with our theory of action. Our analysis allowed for us to capture data-driven or emergent themes during the coding process as well. We auto-coded responses to all questions in the interview and focus group protocols and conducted a content analysis of the qualitative transcripts. Once coding was complete, we ran coding frequencies and used NVivo to explore and identify emergent themes and patterns.

III. Findings

Our study begins with the premise that the foundation for improved outcomes for *all* students in mathematics is high-quality curricula and coherent instructional contexts at the district and school levels. We examine the implementation of high-quality mathematics curricula in a set of schools using green-rated curricula and receiving high-quality professional learning and another set of schools using non-green rated curricula and receiving the business-as-usual professional learning. Our goal is to understand how and to what extent district and school instructional guidance and professional supports align and cohere with mathematics standards, local school contexts, teacher knowledge and beliefs about mathematics instruction, and classroom practice. In particular, we are interested in understanding both the enabling and disabling conditions under which teachers can or cannot implement high-quality mathematics curricula effectively as well as the conditions under which students can or cannot thrive.

In our first interim report, we drew on teacher survey data to share preliminary findings on the characteristics of curricula and professional learning that may be associated with teachers' instructional decisions, particularly their decisions to adapt curricula to better meet their students' individual learning needs. In this report, we present analyses of district, school administrator, and teacher interview; student survey; student focus group; and classroom observation data to address four research questions:

1. Do students hold positive perceptions about themselves as math students, are they enjoying math class, and are they motivated to continue studying math in the future?
2. Are teachers employing ambitious, culturally responsive, and equitable instructional practices?
3. Do teachers possess beliefs that positively influence students' experiences in math class?
4. Do district and school administrators share a clear and coherent vision for high-quality middle school math instruction that can help teachers create and sustain positive learning environments?

In this section, we share preliminary results in response to these questions.

A. Do students hold positive perceptions about themselves as math students, are they enjoying math class, and are they motivated to continue studying math in the future?

The ultimate purpose of investing in high-quality math curricula and professional learning to support teachers' delivery of curricula is to make a positive impact on student performance and their experiences in the classroom. In our August 2022 report, we took a brief look at students' math enjoyment to determine whether students using green-rated curricula enjoy their math classes more than students who do not. We found that students in a classroom using a green-rated curriculum were significantly more likely to say they enjoy learning new things about math and significantly less likely to say they don't care about learning math.

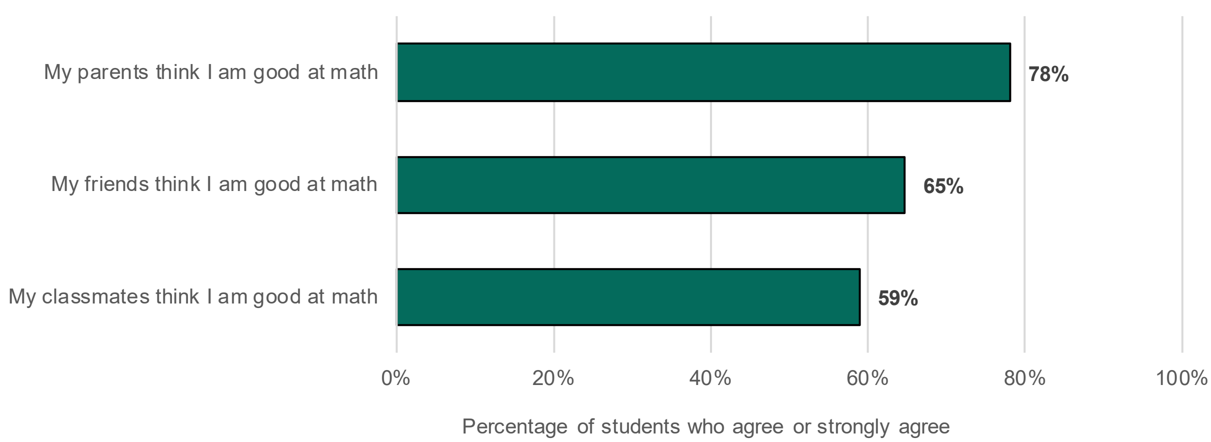
Decades of research have demonstrated that students' beliefs about themselves, and their mathematical abilities as well as their enjoyment of mathematics are strong predictors of mathematics performance. Students who do not believe they can perform well in mathematics tend to perform at lower levels than students who believe they can excel (e.g., Chen, 2003; Cleary & Chen, 2009; Goetz et al., 2008; Lopez, 2017; Mason & Scrivani, 2004; Pinxten et al., 2014; Riegle-Crumb et al., 2011; Schommer-Aikins et al., 2005). Studies have also demonstrated that race, ethnicity, and poverty are among the most significant predictors of rigorous mathematics course taking (Sciarra, 2010). Reflecting on this research, in this first section we look at our overall sample to explore three questions:

1. What are students' perceptions of their own math achievement identity?
2. What do they say about their enjoyment of math?
3. What are their plans for continuing to take math courses?

To answer these questions, we analyzed student survey data for our full sample and student focus group data collected in the deep dive schools. Below we present findings from our analyses: first, for the overall sample; second, by student race and ethnicity; and third, by gender. This first subgroup analysis is important because the AMS study focuses particularly on how to positively influence the math experiences of students who are Black, Latino, multilingual learners, and/or experiencing poverty—our priority populations. [4] Although our study did not originally aim to explore gender differences in middle school math, we added the second subgroup analysis because our preliminary analyses have revealed noteworthy differences in beliefs between male and female students that are consistent with prior research. Studies have found that female students report lower confidence in their math abilities than their male counterparts, even though they tend to enroll in comparable coursework and earn comparable grades (Halpern et al., 2007).

Findings for sample overall. *Achievement identify* refers to the individual belief that one can perform successfully in an academic setting or that others perceive oneself as academically successful. Students in our full sample were most likely to feel that their parents think they are good at math (78 percent) and less likely to feel that their classmates think so (59 percent). However, a majority of students reported that their friends think that they are good at math (65 percent) (Exhibit 2).

Exhibit 2. Students' math achievement identity



Source: AMS Spring 2022 Student Survey, question 6.

[4] In our first year of data collection, we did not capture demographic measures for whether a student is multilingual or experiencing poverty. In our second year of data collection, we will collect information to capture whether the student is multilingual or in special education but will not collect measures of poverty status, which we determined would be too unreliable to measure directly from students and so are unable to report on this subgroup.

Math enjoyment refers to the extent to which students find learning math and math class fun. A large percentage of students indicated that they care about learning math (88 percent) and want to be in math class (80 percent) (Exhibit 3). However, students were less likely to report that they enjoy learning new things in math (38 percent), feel good in math class (31 percent), and look forward to being math class (30 percent). Thirty-four percent of students indicated that they are likely to feel frustrated in math. Students were more likely to have this feeling of frustration than other negative feelings, such as getting worried about learning new things in math (21 percent) or often feeling down when in math class (16 percent).

"Sometimes we can have the answer when others in the class don't, so she [the teacher] compliments you and says that you are doing a good job and it boosts your confidence about how smart you are."

"I try my best. When I don't understand it, I get stressed because I can't get the answer and figure it out."

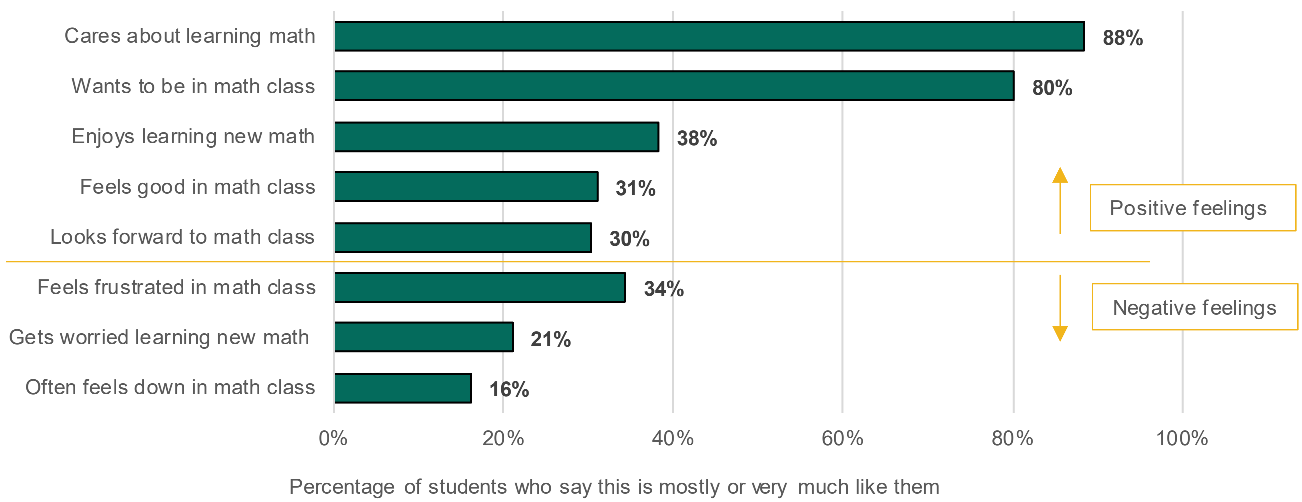
— Students, District 2

"I like math but…participating is kind of hard for me because if I get something wrong, I just get upset at myself."

— Student, District 3

During focus groups, students expressed emotions related to feeling good or feeling frustrated (see adjacent text box).

Exhibit 3. Students' math enjoyment



Source: AMS Spring 2022 Student Survey, question 5.

Middle school is a critical time during which students begin to make decisions about whether to pursue college preparatory coursework in mathematics in high school. Race, ethnicity, and poverty are among the most significant predictors of rigorous mathematics course taking (Sciarra, 2010). Black and Latino students, particularly those experiencing poverty, are less likely to enroll in cognitively demanding mathematics courses in secondary school (Riegle-Crumb & Grodsky, 2010). Even when controlling for prior achievement, mathematics course taking patterns play a critical role in explaining variations in academic performance outcomes (Wang & Goldschmidt, 2003), and failing a mathematics course in middle school is a stronger predictor of not graduating from secondary school than is low test scores (Balfanz et al., 2007).

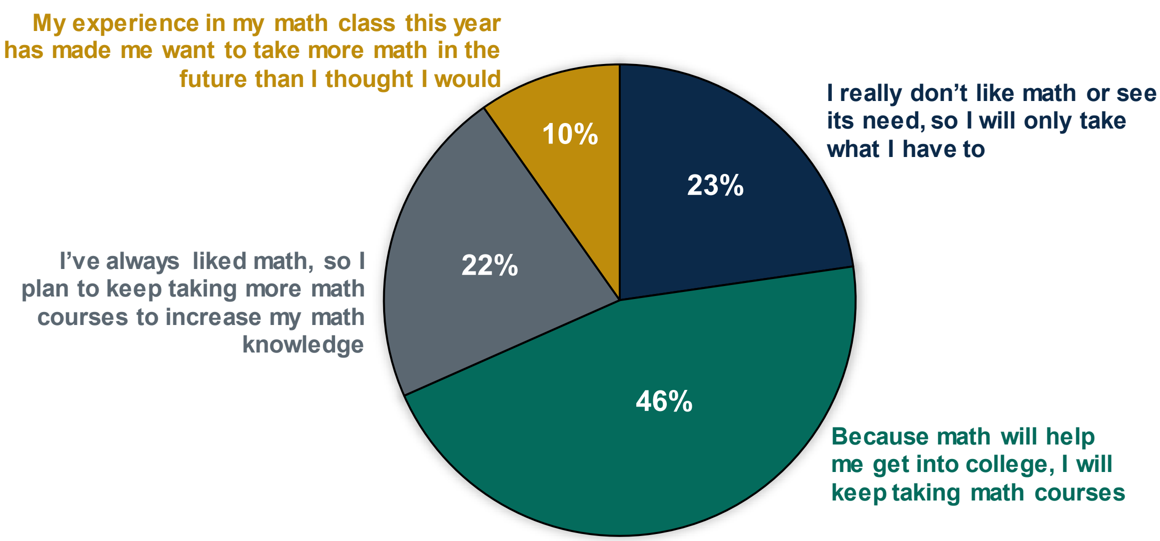
We asked students to select one of four options that best described their current thinking about continuing to take math coursework (Exhibit 4). Although 23 percent of students said they don't like math or see its need, two-thirds of students indicated plans to continue taking math classes based on a recognition that it would be important to future college plans (46 percent) or because they like it (22 percent). Only 10 percent of students reported that their current classroom experiences have positively changed their desire to take more math coursework than they thought they would.

"I don't love math, but I understand it's like something I'm going to have to do and it's a part of life."

"I do kind of wonder if we ever use it in the real world. …I haven't really been using the stuff we're learning right now…usually everything's online, usually everything's like, given to you and you usually don't have to solve for anything a lot."

— Students, District 4

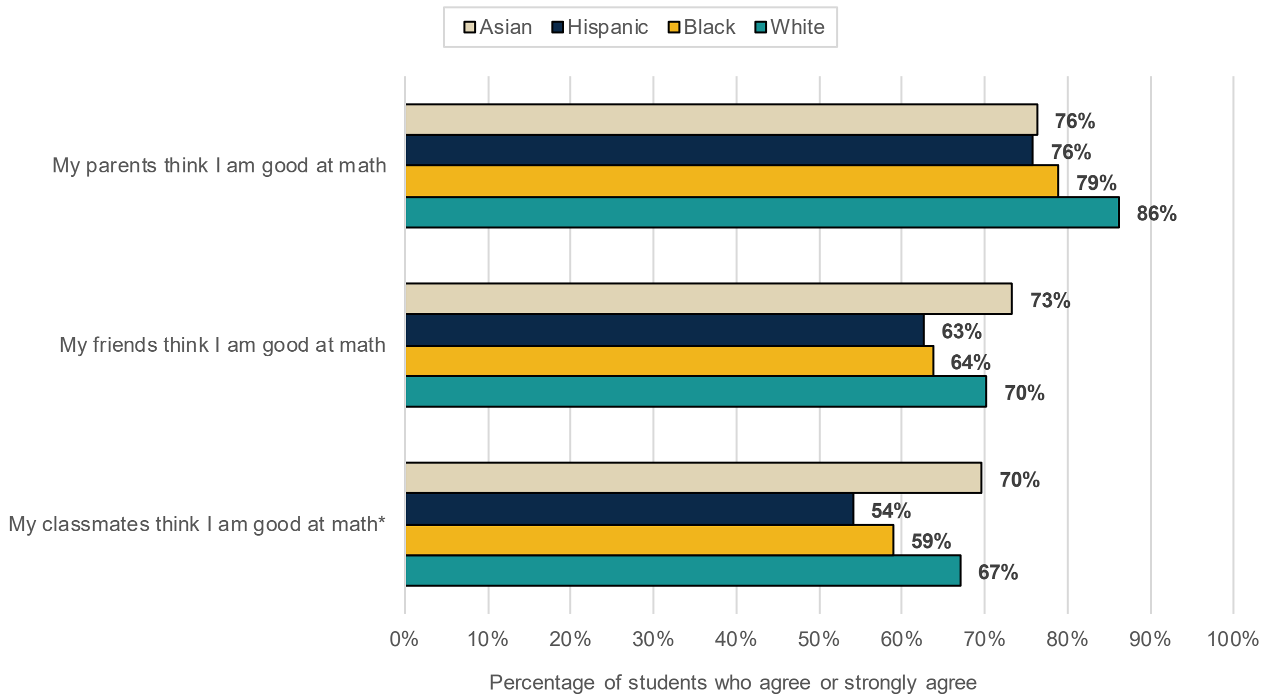
Exhibit 4. Students' plans to continue taking math coursework



Source: AMS Spring 2022 Student Survey, question 7.

Findings by race and ethnicity. Next, we summarize what we found in looking at these same three measures by race and ethnicity. We found a significant difference between students in their math achievement identity in terms of whether their classmates think they are good at math. As opposed to parents or friends, those with whom they are engaging directly in the classroom appear to play more of a role in differentially influencing their math achievement identity. Students who are Black and Hispanic are less likely to feel that their classmates see them as good at math (Exhibit 5).

Exhibit 5. Students' math achievement identity, by race and ethnicity

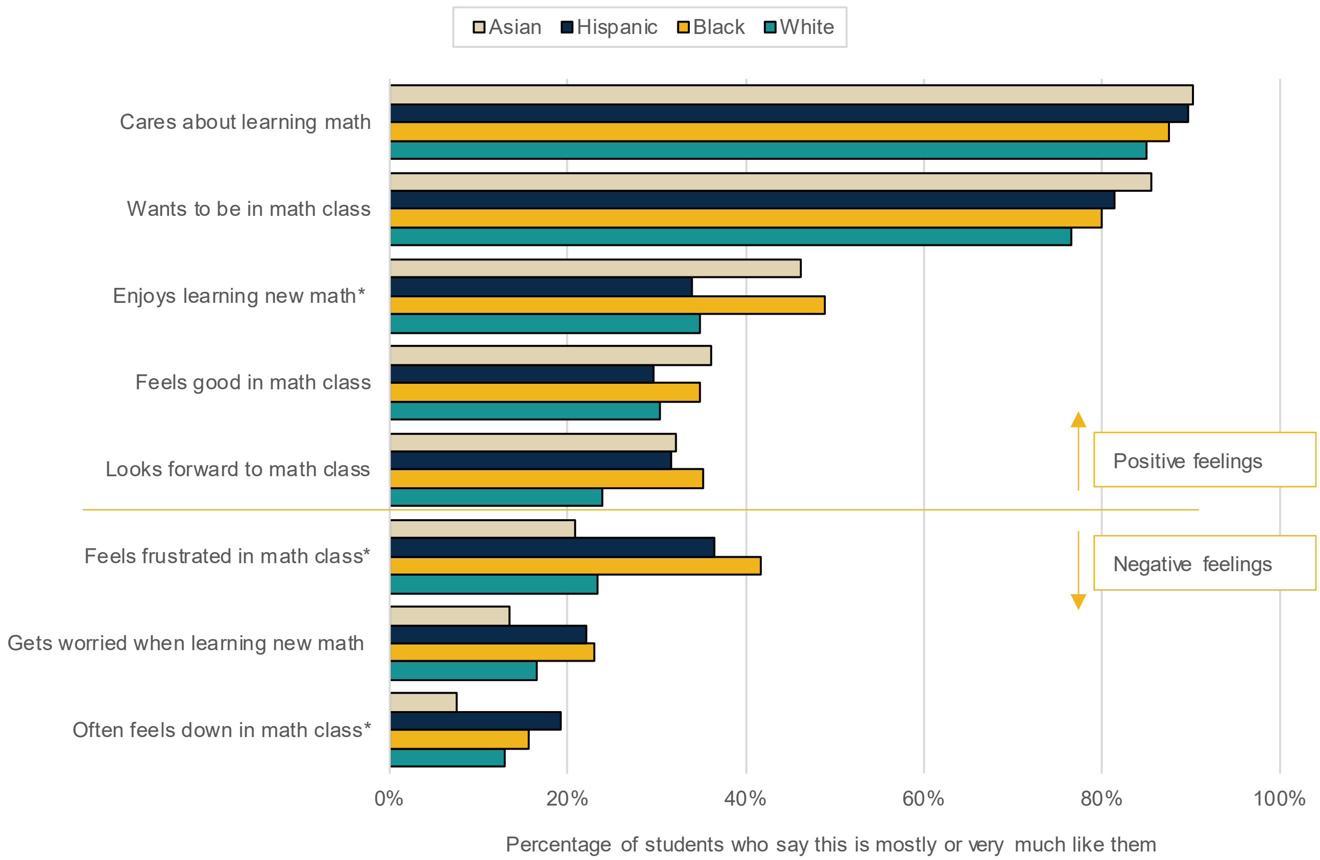


Source: AMS Spring 2022 Student Survey, question 6.

Note: Figures by race and ethnicity exclude three categories. Two had very small sample sizes: Native Hawaiian or other Pacific Islander and American Indian/Alaska Native. The third—multiracial (students who chose more than one race/ethnicity)—is hard to interpret given that, by definition, these students fall into multiple categories.

* $p < 0.05$.

Exhibit 6. Students' math enjoyment, by race and ethnicity

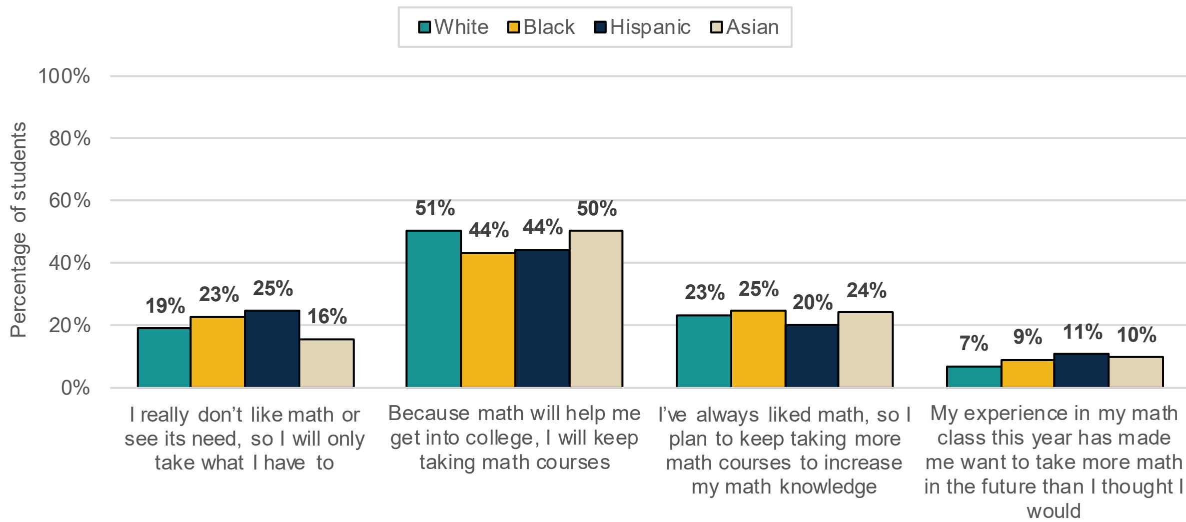


Source: AMS Spring 2022 Student Survey, question 5.

* $p < 0.05$.

Significant differences also exist in their enjoyment of math (Exhibit 6). Students who are Asian and Black were significantly more likely than White or Hispanic students to say they enjoy learning new things in math (a positive finding for at least one of the priority populations). However, Black and Hispanic students were significantly more likely to say that they feel frustrated in math class or often feel down. When we asked students to indicate which of the following statements best describes their plans to pursue math coursework in the future, we found no significant differences by race and ethnicity (Exhibit 7).

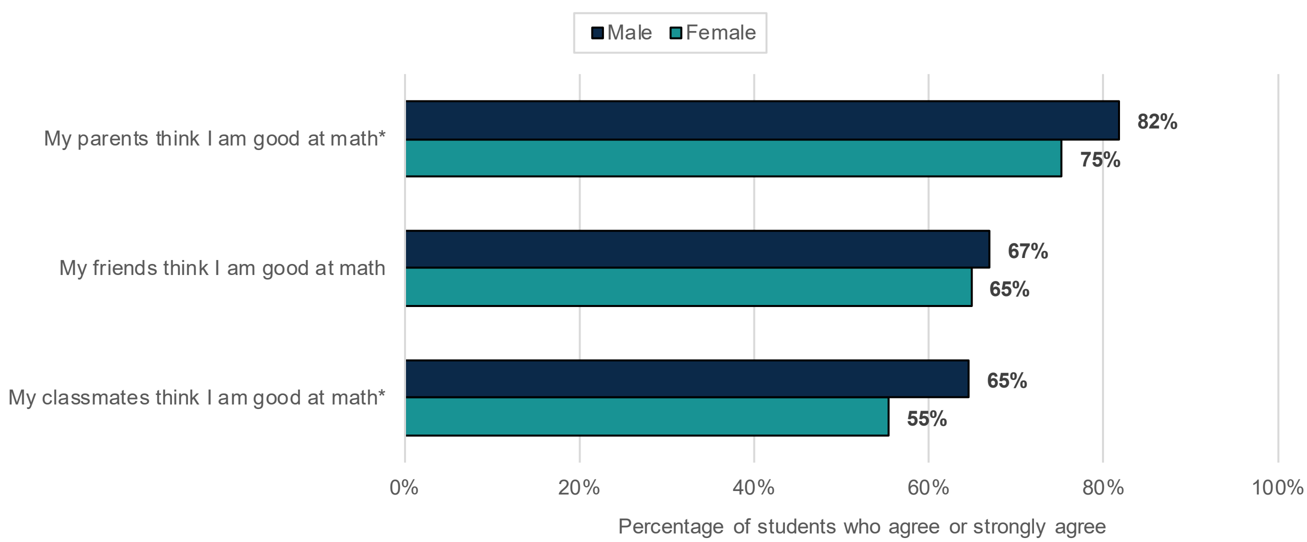
Exhibit 7. Students' plans to continue taking math coursework, by race and ethnicity



Source: AMS Spring 2022 Student Survey, question 7.

Findings by gender. We see significant differences between male and female students in their math achievement identity and their enjoyment of math, in keeping with historical disparities between male and female students in math. Male students in our sample were significantly more likely than female students to say that their parents and their classmates think they are good at math (Exhibit 8).

Exhibit 8. Students' math achievement identity, by gender

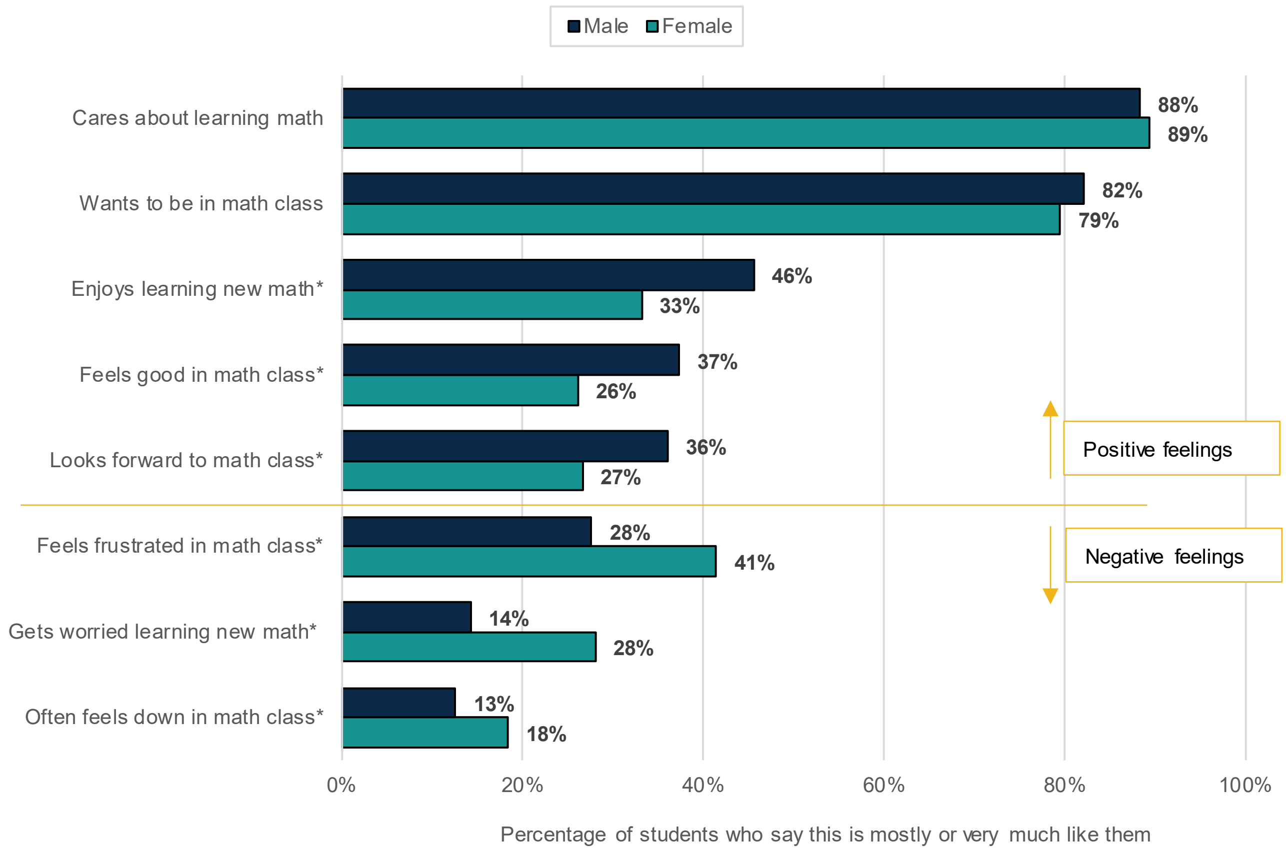


Source: AMS Spring 2022 Student Survey, question 6.

* $p < 0.05$.

We found no significant differences between male and female students on two core dimensions of student enjoyment of math: female students were equally likely as male students to say that they care about learning math and want to be in math class (Exhibit 9). Other than this, however, the remaining dimensions of student enjoyment show significant differences by gender confirming historical patterns: female students were less likely to report enjoying, feeling good in, or looking forward to math class, and were significantly more likely to report feeling frustrated, worrying about learning new things in math, or feeling down in math class.

Exhibit 9. Student math enjoyment, by gender

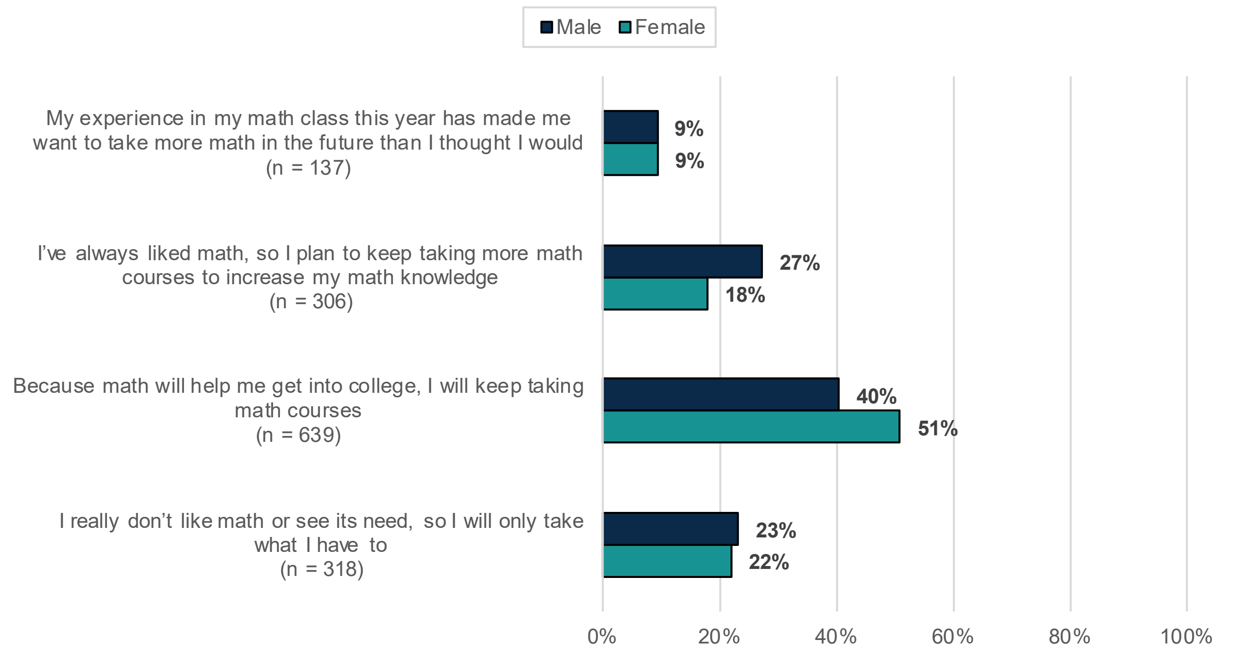


Source: AMS Spring 2022 Student Survey, question 5.

* $p < 0.05$.

More encouragingly, female students' plans for future math coursework do not suggest they are likely to leave the subject at a higher rate than male students at this point in their academic careers. Although there is a significant difference in the distribution of responses between male and female students on their thoughts about persevering in math coursework, it is because female students were more likely to say they will keep taking math classes because of the subject's importance to college enrollment. Male students, on the other hand, were more likely to say they will keep taking math classes because they like math (Exhibit 10).

Exhibit 10. Students' plans to continue taking math coursework, by gender*



Source: AMS Spring 2022 Student Survey, question 7.

* $p < 0.05$.

Note: Chi-square test of the distribution of responses, not responses to individual items.

It is clear that students' experiences in math class shape their views of themselves as math learners, their enjoyment of their classroom experience, and their plans for continuing in the subject. The role of teachers in shaping and influencing these experiences is also indicated by comments from students during focus groups:

> *He [the teacher] tells us it's okay to make mistakes, he doesn't want us to feel like it's not okay to make mistakes or be pressured and have all that weight on our shoulders just because we made a little mistake." Student,* District 1

> *"I feel like for some of us when the teacher chooses someone else [to explain an answer or solution], we feel like some sort of feeling as to like 'Oh, I made a mistake, they had to choose someone else.'" Student,* District 3

> *"If math would've been more fun, it would be more interesting because it's always like, for example, 'Fernando had two apples,' and it's always so boring." Student, District 3*

In the next section, we look at the instructional practices teachers use in the classroom.

B. Are teachers employing ambitious, culturally responsive, and equitable instructional practices?

Our study hypothesizes that when teachers use high-quality middle school math curricula—curricula that are aligned with standards, are cognitively demanding, and are culturally responsive and that support equitable instruction—they will have the tools to implement curricula with integrity and make productive adaptations that effectively differentiate learning for students according to their individual needs, and, consequently, deliver higher-quality math instruction. By "integrity," we mean the implementation of a curriculum as intended by its curriculum developer but with the flexibility to make appropriate adaptations that do not compromise intended learning outcomes.

In our first interim report (August 2022), we found that the majority of teachers self-reported the routine adaptation of curricula. Our teacher survey respondents perceived their adaptations as productive. Most commonly, they reported that they differentiated instruction not only to meet the needs of students performing above or below grade level but also to ensure a more culturally responsive and equitable experience for their students.

In this report, we look beyond self-reported data to better understand what teachers are doing in the classroom. We analyzed classroom observation and teacher interview data to explore three questions:

1. To what extent do teachers employ ambitious (high cognitive demand) instructional practices?
2. To what extent do teachers employ culturally responsive instructional practices?
3. To what extent do teachers employ equitable instructional practices?

We corroborated the available teacher interview data with student focus group data to determine whether students experienced lessons as intended by their teachers.

Overall, we found:

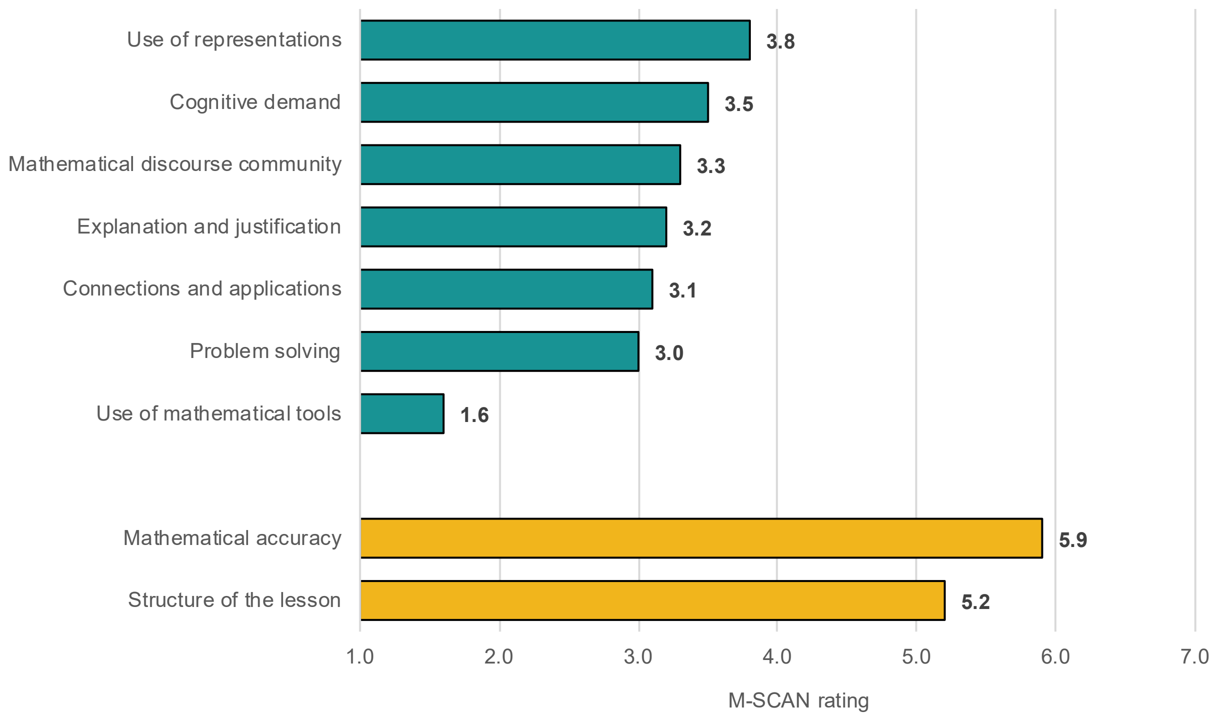
- **Ambitious instruction.** Across the lessons we observed, teachers on average earned moderate ratings for their use of ambitious instructional practices. Teachers commonly designed lessons that were aligned with standards and earned high ratings for presenting mathematical concepts accurately. They were least likely to create opportunities for students to engage in problem solving or use manipulatives.
- **Culturally responsive instruction.** Teachers infrequently employed strategies most commonly associated with culturally responsive teaching, including engaging students' cultural and community funds of knowledge and making interdisciplinary connections. We observed no instances of teachers empowering students to use math as a tool for social justice. However, teachers created ample opportunities for students to engage in mathematical discourse.
- **Equitable instruction.** Teachers predominantly delivered whole-class instruction, suggesting limited efforts to create equitable learning environments. In addition, teachers commonly tasked students with individual work.

We discuss these findings in detail below.

1. To what extent do teachers employ ambitious (high cognitive demand) instructional practices?

To better understand teachers' use of ambitious instructional practices, we examined M-Scan scores for the 41 lessons we observed in the deep dive schools. The M-Scan rates instructional delivery for a given lesson on a scale from 1–7, with 1–2 representing a low rating (or "rarely" observed), 3–5 representing a moderate rating (or "sometimes" observed), and 6–7 representing a high rating (or "often" observed). Generally, we observed lessons that earned low to moderate M-Scan ratings. As illustrated in Exhibit 11, teachers on average earned the highest ratings for presenting mathematical ideas clearly and accurately (5.93) and for structuring coherent lessons that aligned with standards (5.24). Teachers earned the lowest ratings for the infrequent use of manipulatives (1.56) and for rarely creating opportunities for students to engage in problem solving (2.95). These findings were consistent with a finding we presented in our first interim report that the majority of teachers in our full sample perceived their curriculum as too rigorous for their students.

Exhibit 11. Use of ambitious instructional practices (M-Scan ratings)



Source: 2021–2022 school year M-Scan scores (*n* = 22 teachers, 41 classroom observations, 1 to 3 observations per teacher).

To better understand why teachers did not use ambitious instructional practices to a high degree and rarely engaged students in problem solving or the use of manipulatives, we analyzed teacher interview data. After each classroom observation, we interviewed teachers to collect additional information about the observed lesson, including teachers' key considerations (1) when planning the lesson, (2) when selecting the instructional materials used during the lesson, (3) when adapting curriculum content and tasks, (4) when and if modifying their original lesson plan, and (5) when adopting CRMT practices. To investigate teachers' decisions to employ ambitious practices, we identified the top five teachers who earned the highest M-Scan scores and reviewed their interview responses. We limited this initial analysis to these five teachers given the absence of wide variation in M-Scan scores among the deep dive sample. Even among the highest-scoring teachers, only two teachers earned consistently high ratings for most M-Scan domains. The remaining three teachers earned consistently moderate ratings. Nearly half of the sample earned consistently low scores in each M-Scan domain. Presumably, we can learn more about why and how teachers employ ambitious practice from those teachers who in fact engage in such practice.

That said, the teachers earning the highest M-Scan scores held the same perception as those who earned the lowest M-Scan scores, noting that their curriculum is too rigorous for their students. In fact, one of the higher-scoring teachers reported that they decided not to use their curriculum at all when preparing an observed lesson on dividing fractions. The teacher reported that their students did not yet understand fractions but did not indicate whether they made that determination based on student performance data or personal belief:

> *"I'm not even going to be teaching [my curriculum] because it is dividing fractions and they don't even know what a fraction is. So I'm going back to the beginning and teaching them fractions. I'm kind of doing my own thing." — Teacher, District 4*

However, generally speaking, the teachers with the highest M-Scan scores employed several practices in common. They chose to adapt, rather than abandon, their curricula and differentiate their instruction by selecting performance tasks that helped students:

- Bridge existing knowledge with new knowledge
- Think more deeply about mathematics concepts and practice by breaking down new or complex procedures involving those concepts into more manageable parts (such as breaking down ratios by using a double number line)
- Practice a procedure modeled by the teacher during the lesson by solving problems of increasing difficulty

"I tried to pick purposeful questions that I thought would get them to think because I can't choose every question to use. So it was also about which questions that I think would force them to think deeper."

— Teacher, District 4

- Develop their ability to recognize the numeric and operational meanings of specific words and phrases in math—a skill that one of the teachers views as inadequately supported by the curriculum

"Because [when] you're dealing with word problems, it's not just the straight numbers and it's set up for them so they can see, oh, there's the word 'of,' or the word 'is.' It really helps them to see the language and to put the mathematical expression and equations together to be able to get your right answer. Even if [the word problems] aren't laid out perfectly, just by looking at those key coded words…it helps them understand."

— Teacher, District 4

- Explicitly articulate their thinking to one another with the aim of developing their mathematical discourse skills and procedural fluency as they engage in higher-level math

"I think it's important to give them opportunities to speak to other students, other peers, and being able to articulate, 'How did I solve this problem?'; 'What was my thought process?' And [then], 'Now let me listen to somebody else who maybe did the same thing as I did…but maybe they [didn't].' Then maybe, for the next question, they're more open, or have, maybe, another tool in their toolbox that they can then implement to answer another question."

— Teacher, District 3

Notably, student focus group responses indicate high comfort with participating in more cognitively demanding discussions about mathematics.

"I feel comfortable trying different ways of solving problems if you do it and if you need help. Because you can always ask [math teacher] and she'll like, help you out with the way you're doing and give you a correction if you're doing something wrong. But in like a nice way where it doesn't make you feel like you've made a mistake. It doesn't make you feel like you're bad at math."

— Student, District 3

2. To what extent do teachers employ culturally responsive practices?

To investigate culturally responsive practice, we analyzed classroom observation data by using our CRMT tool to compare the extent to which teachers created opportunities for students to:

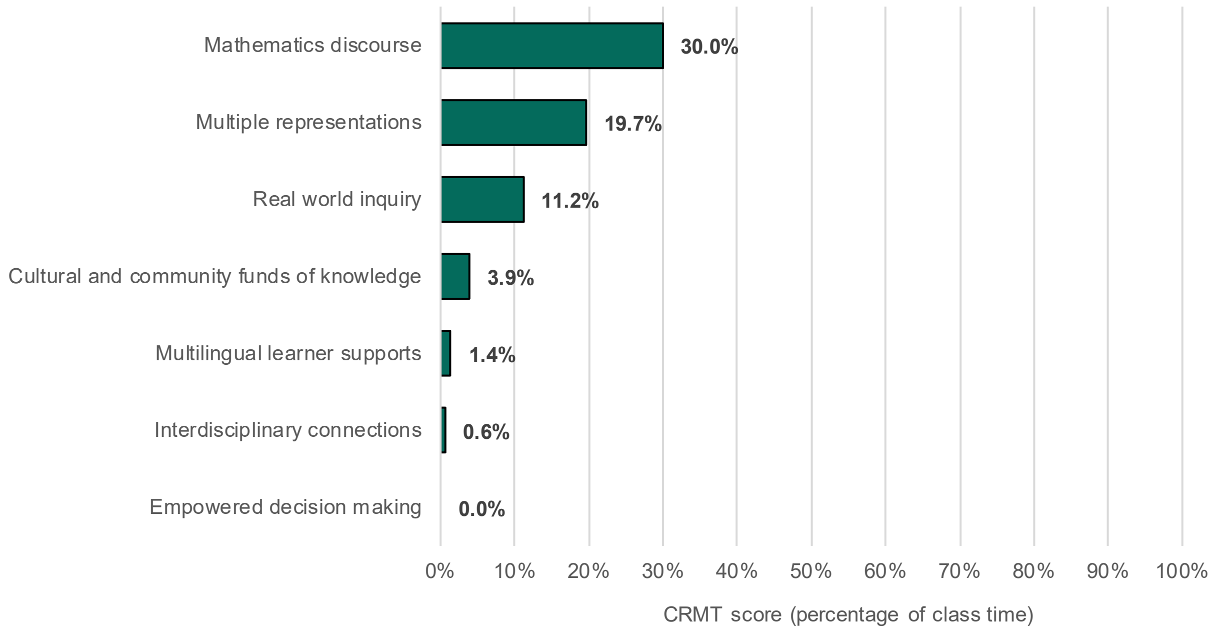
- Engage in real-world inquiry
- Explore a variety of representations of mathematics
- Develop mathematical discourse skills
- Develop math content knowledge and competencies as a multilingual learner
- Leverage their cultural and community funds of knowledge as a learning asset
- Make interdisciplinary connections
- Explore social justice issues relevant to them by using math as a tool for empowered decision making

We report domain scores as a percentage of class time. A domain score of:

- 25 percent or less suggests *nonroutine, rare, or no* use of a strategy or behavior over the course of a lesson
- 26–49 percent represents *occasional but inconsistent* use of a strategy or behavior over the course of a lesson
- 50 percent or higher suggests *routine or consistent* use of a strategy or behavior over the course of a lesson

Overall, study teachers rarely employed the strategies that are most commonly associated with culturally responsive teaching, including engaging students' cultural and community funds of knowledge (3.9 percent of class time) and making interdisciplinary connections (0.6 percent). We observed no instances of teachers empowering students to use math as a tool for social justice. In addition, we infrequently observed teachers employing scaffolds for multilingual learners (1.4 percent), perhaps because observed classrooms had few, if any, multilingual learners in need of targeted support (Exhibit 12).

Exhibit 12. Use of CRMT domain scores (percentage of class time)

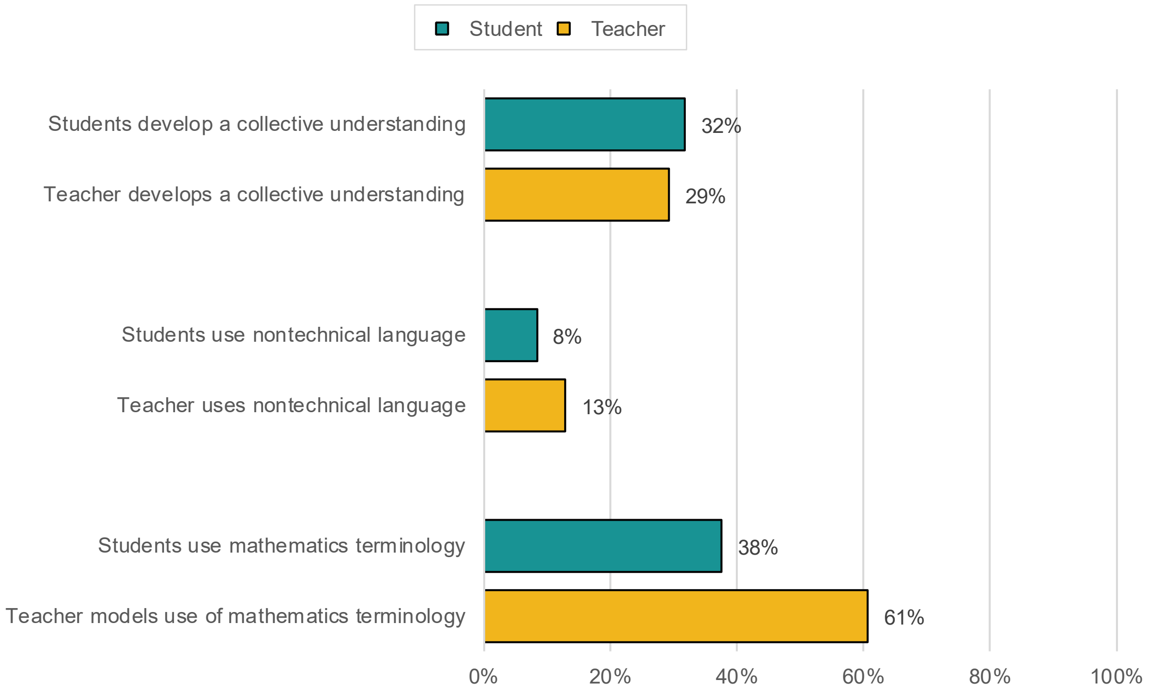


Source: 2021–2022 school year CRMT scores (n = 25 teachers, 48 classroom observations, 1 to 3 observations per teacher).

Note: Domain scores reflect the average percentage of total 5-minute intervals during which a practice was observed at least once over the course of a lesson. Domain scores do not add up to 100 percent as the use of specific practices can overlap during a lesson. The chart does not reflect a distribution of how a teacher used the available time during a lesson.

However, teachers created occasional opportunities for students to engage in mathematical discourse (30 percent). As illustrated in Exhibit 13, which outlines the six subdomains comprising the mathematical discourse domain, mathematical discourse typically involved teachers frequently modeling the use of math terminology throughout a lesson (60 percent of class time). Students were occasionally observed using math terminology (37.5 percent) and developing a collective understanding about a mathematical fact, concept, or procedure for the larger portion of the lesson (31.7 percent). Developing a collective understanding refers to instances when more than one student (in large, small, or peer-pair groups) (1) evaluates or compares another student' representations, solutions, approaches, or arguments; (2) debates math ideas and strategies; or (3) co-constructs strategies and explanations in response to a mathematical task.

Exhibit 13. Mathematics discourse sub-domain scores (percentage of class time)



Source: 2021–2022 school year CRMT scores (*n* = 25 teachers, 48 classroom observations, 1 to 3 observations per teacher).

Note: Domain scores reflect the average percentage of total 5-minute intervals during which a practice was observed at least once over the course of a lesson. Domain scores do not add up to 100 percent as the use of specific practices can overlap during a lesson. The chart does not reflect a distribution of how a teacher used the available time during a lesson.

To better understand teachers' use of culturally responsive practices and why teachers rarely employed a number of these practices, we identified the teachers who earned the highest CRMT domain scores and reviewed their interview responses. Ironically, most of the teachers who earned the highest scores did not indicate in their interview that they explicitly or consciously adapted their curricula to make them more culturally responsive. Moreover, those who did not make any adaptations did not offer an explanation. This finding resonates with the teacher survey data we presented in our first interim report. Of the teachers who self-reported modifying their curriculum to promote CRMT, only a small percentage reported employing strategies explicitly intended to leverage students' cultural and community funds of knowledge as an asset for learning. One of those teachers provided an example during their interview of how they *engage students' funds of knowledge*:

> *"We have many kids who have their own little snack businesses on campus. So that's another thing—just like talking about like dealing with money and dealing with percentages and when things are off, like on sale, so it gets them to interact. That's real-life stuff." — Teacher, District 4*

Another teacher provided an example of how they create opportunities for students to *engage in real-world inquiry*:

> *"We were learning about volume and space and we watched, we actually watched [a] video from* Shark Tank*, I don't know if you know that show? Yeah, we were watching*

> *[one] where the girl was selling her product and after we watched the video we took notes on volume and spheres and cones." — Student, District 2*

Although rare, these opportunities appear to be well-received by students:

> *The whole lesson was talking about measurements, and that really helps because sometimes me and my sister start baking like cookies and all that stuff, and like, we need to figure out, how much ingredients, but exact measurements." – Student, District 3*

> *"Sometimes my family goes and makes, like, colored eggs [for Easter]. So then we need to know how much vinegar and, like, food coloring we need. So the measurements also do help." – Student, District 3*

> *"I do kind of, you know, use math [when it comes to money] so I can count [it] and stuff, or when I go to buy at the grocery store to count how many quarters you have or how many pennies." – Student, District 2*

3. To what extent do teachers employ equitable instructional practices?

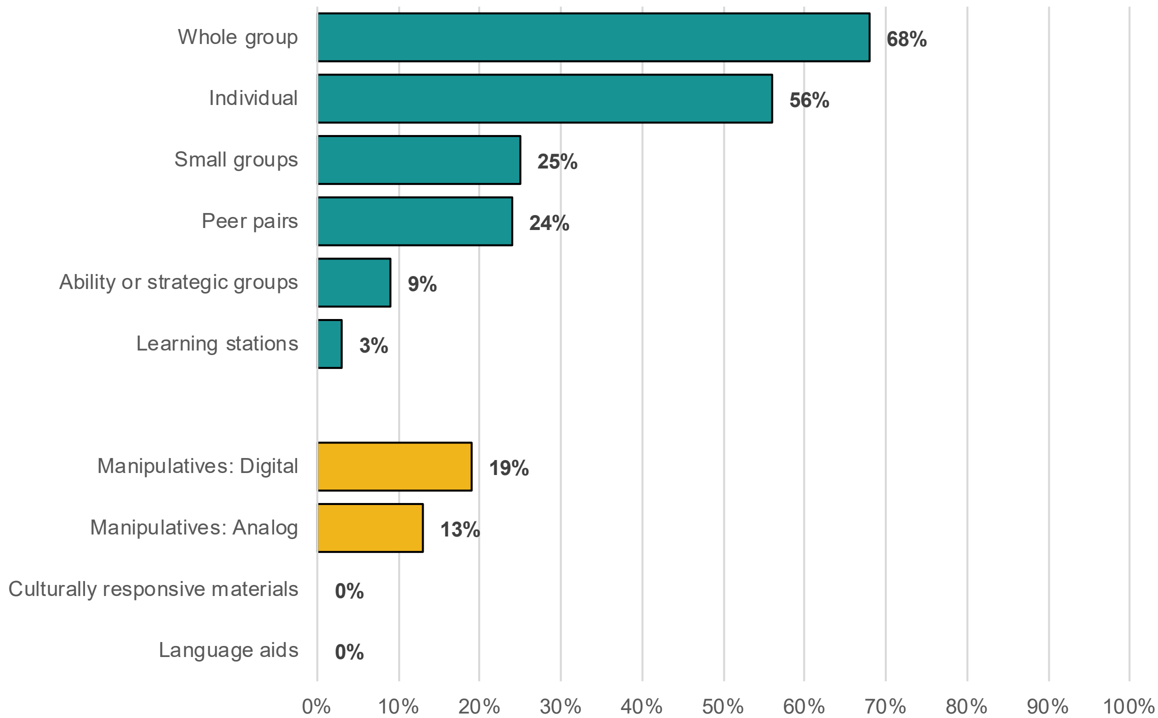
We define equitable instruction as instructional protocols, tasks, or content that personalizes or differentiates the learning experience for specific subgroups of students, such as multilingual learners, to ensure that all students have equal access and opportunity to engage in the learning process. Teachers commonly design more accessible learning environments by (1) varying the ways in which they facilitate instructional activities to support students who may learn better in small groups or individually, and (2) providing students with a range of materials that exemplify mathematical ideas and procedures in different graphic, tabular, or narrative formats.

To understand equitable practice, we analyzed classroom observation data with our CRMT tool to compare the frequency with which teachers use the following instructional practices or resources:

- Student grouping strategies, including *whole-class* activities, *small-group* activities, *peer pairs*, *individual* or independent work, *ability* or strategic grouping (for example, to review content that some students may have missed because of absence), or *learning stations*
- *Culturally responsive* instructional materials (for example, an abacus to support a lesson on decimal place values)
- *Language aids* for multilingual learners (for example, a math glossary printed in English and Spanish)
- Analog (for example, poster on order of operations) or digital (for example, graphing calculator) *manipulatives*

On average, teachers most often relied on whole-class instruction (68 percent of class time) and assigning students individual work (56 percent) (Exhibit 14).

Exhibit 14. Use of equitable teaching strategies (percentage of class time)



Source: 2021–2022 school year CRMT scores (n = 25 teachers, 48 classroom observations, 1 to 3 observations per teacher).

Note: Domain scores reflect the average percentage of total 5-minute intervals during which a practice was observed at least once over the course of a lesson. Domain scores will not add up to 100 percent as the use of specific practices can overlap during a lesson. The chart does not reflect a distribution of how a teacher used the available time during a lesson.

To better understand teachers' use of equitable practices, we used CRMT domain and subdomain scores to identify the teachers who used the greatest variety of student grouping strategies and instructional materials and whose students reported the highest positive experiences on the spring student survey. We identified these teachers by averaging and ranking students' engagement and math enjoyment scale scores at the teacher level from highest to lowest. We reviewed interview data for the top five highest-ranked teachers. Teachers who met these ranking criteria reported that they created more equitable lessons by:

- Translating materials from English to multilingual learners' home language
- Seating multilingual learners next to other learners able to provide English translation support
- Forming ability groups or working with students independently in response to formative assessment data

Some of these teachers' students confirmed that their teachers:

- Adjusted how they delivered instruction to accommodate students performing on different levels
- Helped individual students privately, as needed

- Designed a range of learning activities, including fishbowl- and gallery-walk-style activities, to engage in mathematical discourse and explore several representations of mathematical concepts such as discussing alternative solutions to a problem with classmates.

"Sometimes we have different arguments about if the question is right or not. And we have to base it [on] how we got the answers and show how they're right. We also do this thing in class called Facing Off where we get in a group where there's four people and we just basically move the chairs together and we all discuss how we got different answers and how we were able to get the answer."

"Sometimes we'll all walk around the classroom and just compare our answers to everybody else to see if we got a close answer or the same answer, or maybe even a completely different answer. Sometimes [the math teacher] spins a wheel and whoever it lands on has to answer her."

— Students, District 2

In the next section, we explore teachers' underlying beliefs that may influence their decisions and capacity to employ ambitious, culturally responsive, and equitable instructional practices.

C. Do teachers possess beliefs that positively influence students' experiences in math class?

Teachers bring unique experiences and beliefs to the classroom, and these beliefs may meaningfully influence instructional enactment and, in turn, the classroom experiences of their students, such as those we explored earlier. Research suggests that students underperform when they have teachers who do not believe they can achieve at high levels in mathematics or whose teachers are not confident in their knowledge and ability to teach mathematics effectively (particularly to struggling or historically underperforming students) (Busi & Jacobbe, 2018; Lopez, 2017). In this section, we explore how teacher beliefs influence student outcomes. Specifically, we examined the relationship between the following teacher beliefs and student outcomes (Exhibit 15):

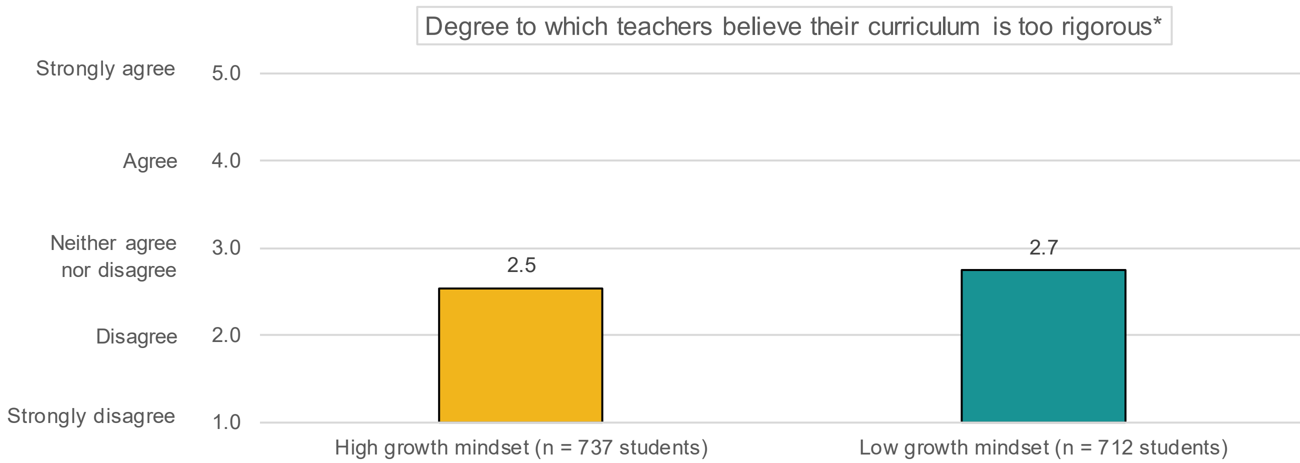
Exhibit 15. Teacher beliefs and student outcomes

Teacher beliefs	Student outcomes
• **Self-efficacy:** The belief that they have the instructional capacity to teach their students effectively • **CRMT confidence:** The belief that they have the instructional capacity to use culturally responsive mathematics teaching strategies effectively • **Supportive leadership:** The perception that they are encouraged by district and school leadership to implement knowledge and competencies gained through professional learning in their classrooms • **Curriculum normative authority:** The perception that a curriculum is appropriate for their students' needs	• **Growth mindset:** The belief that the ability to learn and be successful academically is not fixed and can be developed over time • **Achievement identity:** The belief that they can perform well in math (such as, on tests and by earning good grades) • **Math enjoyment**: The belief that doing math and being in math class is fun • **Math self-efficacy:** The confidence to solve mathematics problems and perform mathematics-related tasks successfully • **Engagement:** Positive and active participation in math class including the desire to meet academic expectations (such as, earning good grades and test scores), comply with social and behavioral classroom norms (such as, being a good small group partner), engage cognitively (such as, the personal drive or commitment to improve conceptual understanding of a particular math topic), and engage emotionally (such as, being excited when playing math games) • **Proficiency:** Demonstrated mastery of grade-level math learning standards on a 6th, 7th, or 8th grade end-of-grade test

Overall, our survey data do not support a strong relationship between most of the teacher beliefs and student outcomes we measured. We found no statistically significant relationships between the teacher beliefs and student outcomes we investigated with one exception: the relationship between teachers' perceptions of the normative authority of their curricula and students' growth mindset.

The belief that our ability to learn is not fixed but can be developed over time is a mindset that can be nurtured in instructional settings (Burgoyne et al., 2018; Hochanadel & Finamore, 2015; Yeager et al., 2019). Among the students in out sample who reported a low growth mindset—students who believe that academic ability is innate and not the product of hard work—were significantly more likely to be taught by teachers who believe that their curriculum is too rigorous for their students (Exhibit 16).

Exhibit 16. Relationship between students' growth mindset and teacher beliefs about the rigor of their curriculum (curriculum normative authority)

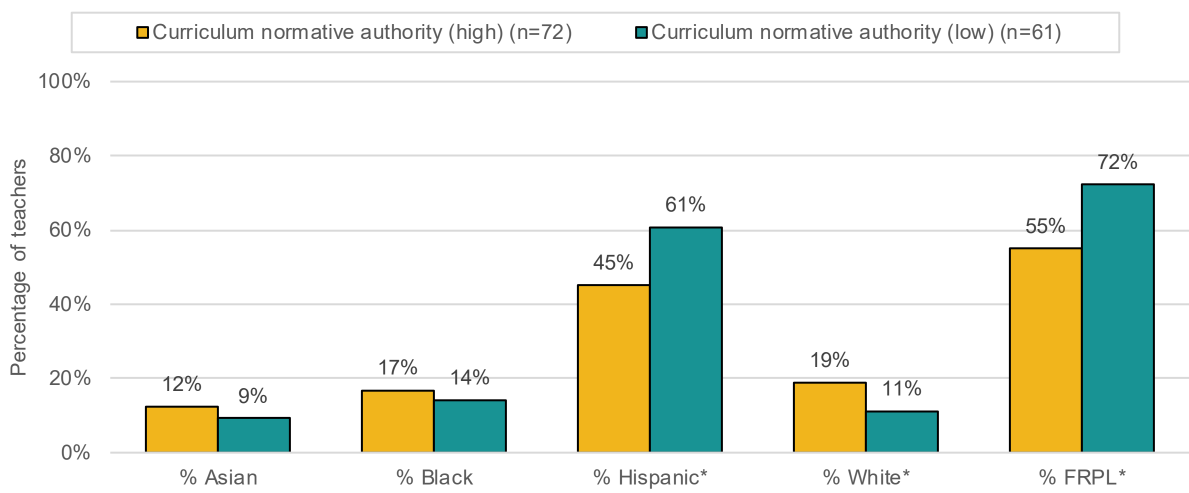


Source: AMS Fall 2021 Teacher Survey, question 11, and AMS Spring 2022 Student Survey, question 1.

* $p < 0.05$.

Teacher beliefs about the normative authority of their curricula appear related to the demographic profile of students in their schools. As illustrated in Exhibit 17, teachers who believe their curriculum is too rigorous for their students (low score on the curriculum normative authority scale), are significantly more likely to teach in schools with a greater percentage of Latino students (61 percent) and students eligible for free and reduced-price lunch (72 percent) than teachers who believe their curriculum is appropriate for their students' needs (high score on the curriculum normative authority scale) (45 percent and 55 percent, respectively).

Exhibit 17. Teacher scores on the curriculum normative authority scale, by student demographics



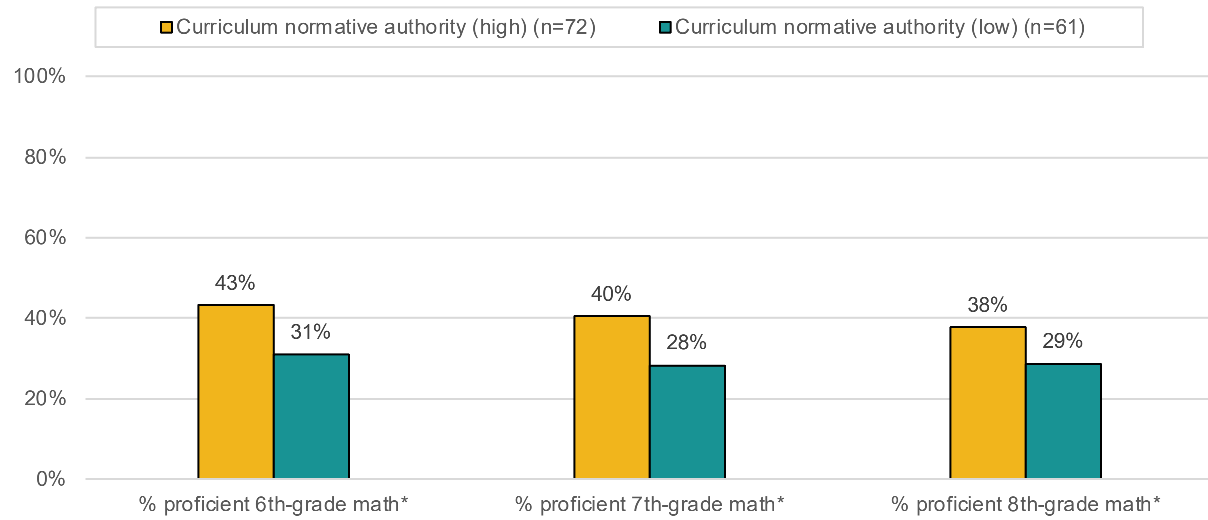
Source: AMS Fall 2021 Teacher Survey, questions 9 and 11. School demographic data from the 2020–2021 Common Core of Data.

* $p < 0.05$.

FRPL = students who are income-eligible for free or reduced-price lunch.

Teachers who believe their curriculum is appropriate for their students' needs are also significantly more likely than teachers who believe their curriculum is too rigorous to teach in schools with a larger percentage of students performing at or above proficiency in 6th-, 7th-, and 8th-grade math (Exhibit 18).

Exhibit 18. Teacher scores on the curriculum normative authority scale, by student proficiency in math



Source: AMS fall teacher survey question 11. 2018–2019 EDFacts data on state assessments in math.

* $p < 0.05$.

Our study hypothesizes that when teachers use high-quality middle school math curricula—curricula that are aligned with standards, cognitively demanding, culturally responsive, and equitable—they will have the tools to implement curricula with integrity and make productive adaptations that effectively differentiate learning for students according to their individual needs. These findings suggest that teachers who work in schools serving students in greatest need may need additional professional learning to productively adapt their curricula *without compromising intended learning outcomes*. In the next section, we take a preliminary look at whether teachers are operating in a coherent instructional context that helps them make productive adaptations.

D. Do district and school administrators share a clear and coherent vision for high-quality middle school math instruction that can help teachers create and sustain positive learning environments?

Ultimately, teachers do not teach in isolation. Our study hypothesizes that teachers can enact curricula with integrity and make productive adaptations when they work in a coherent instructional context. A context is coherent when district and school leadership mutually embrace a vision for high-quality instruction, that the vision is aligned with standards, that leadership enables implementation of that vision through the provision of high-quality curricula and professional learning supports, and teachers perceive this coherence (Desimone, 2009; Desimone & Garet, 2015).

To begin to dig into this, we analyzed data from interviews with district and school administrators (in most cases the principal was the school administrator interviewed) to understand their perspectives on the district and school's vision and goals for math instruction. In line with our theory of action, we define a vision for high-quality math instruction as one where (1) learning goals are sufficiently well-specified and shared among stakeholders (Jansen et al., 2009) and (2) concrete instructional practices that have the potential to lead to the attainment of the learning goals are articulated (Cobb & Jackson, 2011). We use this definition to address the following questions:

1. In our four partner districts, what are the district administrator and school principal's visions for high-quality math instruction?
2. Are these visions aligned?

We begin our focus here given commonly held views on effective leadership. According to Kotter (1988), effective leadership is:

> *"The process of creating a vision of the future that takes into account the legitimate long-term interests of the parties involved in that activity; of developing a rational strategy for moving forward that vision; of enlisting the support of the key power centers whose cooperation, compliance, or teamwork is necessary to produce that movement; and of motivating highly that core group of people whose actions are central to implementing the strategy" (pp. 25–26).*

The analysis that follows is based on interviews conducted with district staff and school principals in the first year of the study in each of the four partner districts. At this stage, we share what we heard from staff but recognize this is still preliminary. We do not yet have as complete information as we plan to collect in order to look more comprehensively at the coherence of the instructional context.

1. District 1

The **district administrator** at District 1 who we interviewed shared that although they did not have a vision specifically for high-quality math instruction, they had recently developed districtwide profiles for students, in which they envisioned students would engage in ambitious and culturally responsive learning. This includes learning math logic rather than memorizing procedures, reasoning and communicating their reasoning every day, working collaboratively to learn math, and solving problems relevant to real-world situations. The district administrator also shared that the district directs schools to implement the National Council of Teachers of Mathematics (NCTM) Principles to Actions, a list of eight effective math instructional practices (see text box).

NCTM principles to actions

1. Establish mathematics goals to focus learning
2. Implement tasks that promote reasoning and problem solving
3. Use and connect mathematical representations
4. Facilitate meaningful mathematical discourse
5. Pose purposeful questions
6. Build procedural fluency from conceptual understanding
7. Support productive struggle in learning mathematics
8. Elicit and use evidence of student thinking

Despite the district administrator's view that the district did not have a vision for high-quality math instruction, their vision for math is a strong one when viewed in the context of the criteria articulated by Cobb and Jackson (2011), as the NCTM's principles not only articulate clear and specific learning goals, but concrete, ambitious, and culturally responsive instructional practices as well. However, we were unable to note any explicit focus on equitable instruction in either the district's articulation of its math priorities or the NCTM's principles.

"One of our main disconnects is that the educators and the people here in the building, we're on the front lines; we know the consumers; we know the people that we're working with. And the disconnect is the people who come up with our curriculum…have never set foot in our building. So they may have astronomical expectations that we, on the front line, know cannot be met."

"Our school's vision [is] appreciating the diversity that is in our building and ensuring that it's seen through everything that kids do. The district's vision: Making sure everyone takes a learner's stance, grows using complex tasks…Our vision is the same, just more catered to our individual building."

— Principals, District 1

In **schools**, principals' visions of high-quality math instruction largely drew on the NCTM's list of effective math instructional practices, which include ambitious and culturally responsive practices. In their respective visions, principals were most likely to mention student participation in math discourse and engagement in critical thinking or problem solving. Other desired competencies principals noted, albeit less frequently, related to working collaboratively, engaging conceptually rather than procedurally with math, using real-world problem solving, and engaging in productive struggle.

Although we do not have data on district administrators' view on alignment, principals' perceptions of the **alignment** of their vision with the district's varied widely, with almost an equal number expressing beliefs of alignment, partial alignment, and misalignment. One principal was critical of the developers of the curriculum used in their school. Another shared that they did not feel that professional development was ready at the start of school, and the self-paced online and in-school training felt disjointed from daily realities. Yet another principal shared that their vision matched the district's in a general sense, but simply at a different scale.

We found that principals who perceived misalignment between district and school visions based their opinion exclusively on the absence of a district vision explicitly labeled as such. Although most did not comment further than expressing that rationale, one principal was especially critical of the district's historical handling of math:

> *"Math is the ugly stepchild that is very rarely addressed with any fidelity or depth. We have a rotating array of curriculum choices that are put in without the appropriate supports and then released when they can't be, for lack of a better term, dumbed down to meet the common denominator. So instead of being able to raise our teachers' instructional capacity, we just throw out the curriculum and we try the next new thing."*
> *— Principal, District 1*

Two topics principals raised that were notably absent in our interview with the district administrator related to (1) ensuring a diverse set of students can succeed and (2) differentiation. Principals variously referenced race, ethnicity, and gender as sociocultural factors affecting students and their experiences at school and made explicit connections to these in their articulation of their visions. A few principals referenced family economic backgrounds in the same context. Half of all principals identified differentiation and scaffolding to meet students' needs as important aspects of their vision.

District 1 principals on their visions for high-quality math instruction

"We want each of our learners, scholars, and teachers be individually and collectively presented with academically, intellectually complex tasks that are worthy of their productive struggle. And allow them an authentic opportunity to demonstrate their work and learning."

"[Our vision involves using] real-world math problems correlated to grade-level standards. Strategies learned in class or developed on their own. Mathematical discourse to debate, with teachers as moderators. We envision students solving problems on their own and in collaborative groups."

"As with literacy, math should be differentiated, hands-on…Students use different modalities [to express themselves in math]; instruction is scaffolded…Math should [involve] challenging scholars, allowing mathematic discourse, scaffolding conceptual understandings."

"We want students to be building conceptual understanding, rather than just memorization and algorithms."

2. District 2

District 2 consists of regional areas that are divided into communities of schools. Therefore, there can be a vision for math at multiple levels: district administrators at the central office level; the local district or regional areas level, each of which has a superintendent; the communities of school level, each with an administrator who supervises principals; and the school level. We conducted interviews with district administrators at the central office level and principals—the most and least centralized parts of this structure.

"The expectation that we get from our district leadership is that everything we do needs to be standards aligned. Everything we do, all of our activities should be standards-based activities. Meaning, you know, students should be talking and sharing and collaborating."

— Principal, District 2

District administrators reported learning goals with concrete, ambitious instructional practices as their vision for a high-quality math instruction. Their vision is grounded in board goals[5], which include four areas for improvement that apply across content areas. With regard to math, they pointed to a numeracy goal, which focuses on improving the Algebra I pass rate and is to be measured by state assessments as well as formative assessments throughout the year. District administrators try to "connect conversations and problem solving" back to the board goals. They have seen leaders reference the board goals when speaking about strategic support and developing a professional development plan, which the district administrator views as "an attempt to make this [board goals] coherent." The district also has a theory of action that it sees as important for coherence across levels. The theory of action shows what each level is doing regarding data collection, professional development, and implementing the curriculum with fidelity.

One district administrator shared their goals focused on ambitious and equitable instruction, including developing positive attitudes toward math and providing additional supports for lower-achieving students. They hoped to change the mindset of students and teachers and close the gap and make student achievement a reality:

[5] We assume by "board goals" that the administrator was referring to goals set by the District 2 School Board.

> *"We're also trying to change the culture of math so that students see themselves as mathematicians, as math students, and to have high expectations and really try to change the mindset not only of student outcomes, but of the expectations in our schools around culture, with teachers believing that our students can indeed achieve." — District administrator, District 2*

At the **school level**, principals shared visions that suggest attention to ambitious and culturally responsive instruction. One principal said their vision was standards-aligned instruction. Principals also shared a vision for students' conceptual understanding of math that involves "understand[ing] the logic behind" solutions and goes beyond "memorizing an algorithm" as well as preparing students to be independent critical thinkers and problem solvers. Principals also shared visions related to seeing real-life application of mathematical concepts:

> *"I would like all students to love math and see how it actually relates to their lives. So as far as instruction in the classroom, kids, you know, teachers being able to make it culturally relevant, have some real-world applications." — Principal, District 2*

In terms of **alignment** of visions, it is important to note that we do not have data on district administrators' perception of alignment. Some principals (though not the majority) reported alignment of school and district visions around standards-aligned instruction. These principals seemed to have a vision for math centered around standards-aligned instruction specifically because they believed that would be "in alignment with what the districts wants." For the most part, however, principals did not report strong alignment of school and district visions. Principals mentioned that math has been a struggle for District 2 and not addressed explicitly in their vision in the past, which may contribute to this finding. Some principals seemed to suggest that District 2's size and limited continuity of programs played a role in the lack of vision alignment. One principal expressed "an absence of vision and hope." They referenced how District 2's large size negatively affects their ability to provide professional development; the large size also means that the principals' math visions have more of an impact on what happens at the school level than would a district vision. Another principal discussed how coherence appears to be the goal, but constant programmatic changes pose a challenge to the feasibility:

> *"I know that there's a push to kind of get everybody on the same page. And my feeling is either we all need to be on the same page and there needs to be one systematic approach to it, or schools need to sort of figure out what's going to work…. But sometimes it's a lot of like, we're going to try this program and then we stop that program or try this program, and then we stop that program." — Principal, District 2*

When discussing alignment between district and school visions, principals named ambitious and culturally responsive practices they understood to be part of the district vision. However, none of these aspects was reported by the district administrators interviewed. Aspects principals named included a push for standards alignment across curricula, use of a framework, and a focus on culturally relevant materials and resources.

3. District 3

The District 3 **administrator** reported shared learning goals with concrete, ambitious instructional practices indicating a vision for a high-quality math instruction. In their vision, students are active participants in math and teachers create space for students' own meaning making. The vision is organized around pillars that connect professional learning and curriculum. Additionally, District 3's vision for math includes a focus on empowering teachers, developing a multi-tiered system of support for math, and implementing culturally responsive instruction.[6] The vision includes creating learning experiences where:

"Our vision is that students will see themselves as doers of mathematics as opposed to observants of mathematics. Teachers see themselves as building the conditions where students can construct their own meaning instead of just sharing knowledge."

— Administrator, District 3

- Students develop mathematical thinking, collaborate, and engage in math discourse;
- Teachers deliver instruction with high expectations that is student-centered and inquiry-based, and helps students feel a sense of belonging; and
- The material gives students opportunities to productively engage with cognitively demanding math concepts that are relevant to them and draw connections to their broader environment.

"I would say, if you want me to have a district vision for mathematics instruction, I would need to have fewer schools... I don't really have an articulated sort of mission that I share and expect to be shared by principals on math. And I think that we probably all share the same vision; that is coming from the Department of Education on mathematics."

— Superintendent, District 3

At the **school level**, principals reported visions that included ambitious and culturally relevant instructional practices. For example, one principal discussed making math understandable and relevant to the students they serve and to meet students where they are. They also wanted students to not be "afraid to try at math" and to "go after math in many different facets." Another principal discussed pedagogical practice that supports having students engage with multiple representations of math:

> *"I think…the big transition in teaching math from the way that we learned it so that it's not so much procedural and skills based to be a subject in which, like a lot of thinking happens, a lot of modeling happens… To have multiple representations of the math. And expect kids to be able to arrive in different ways, but also to have a cohesiveness of pedagogical practice that supports that thinking." — Principal, District 3*

Principals perceived alignment of their vision and their district's vision varied. One principal saw their vision as different from their superintendent's, who approached math as more of a procedural subject. However, the principal felt that the superintendent trusted principals to create their own visions. Another principal reported that the district and school visions were very aligned. To support this conclusion, the principal pointed to a new program introduced at a district meeting that their school was already implementing.

The superintendent's vision for middle school math included differentiated instruction, fluency with foundational skills, and making math fun using games and technology. However, when asked about their

[6] District 3 shared its vision for math document with us in Year 2 of the study, after interviews were conducted.

vision alignment with principals' visions, the superintendent then seemed to contradict this and suggested that they did not have a specific vision and would want responsibility for fewer schools in order to have a math vision. They also said that they thought principals shared the district's vision.

A principal we interviewed had been struggling with challenging staffing issues and was unable to articulate much of a clear vision for math during our interview. When asked about district and school vision alignment, the principal shared they did not know what the vision was.

> *"I'm not sure what the vision of the city is. I mean, I know the standards and…stuff like that, but…I guess we're all connected, but it's not something that people talk about on a daily or weekly basis."*
>
> — Principal, District 3

4. District 4

District administrators articulated the vision for math as follows:

> *"We define mathematics as what we do, how we feel, and what we believe. If these three components are in action in a classroom, you would both see an increase in student sense of belonging and welcoming, but also an increase in student participation as active collaborators who are making sense of learning in a community where all learning is seen as valued and as part of my [students'] learning journeys." — District administrator, District 4*

The district enacts its vision for math through a centralized program focused on instruction; high-quality curriculum; equitable assessment practices and grading; and developing administrator and leadership networks. They are working to reframe math as multidimensional; honoring and validating students' diverse mathematical thinking; and moving away from predominantly teacher-led models of instruction. District administrators shared a vision of walking into classrooms and seeing students being confident about and enjoying math, feeling a sense of belonging, and being active collaborators in learning.

> *"[That] everyone in District 4 sees themselves as mathematicians who are knowledgeable, can apply their thinking when making sense of the world, and can communicate their reasoning as active critical thinkers and problem solvers."*

At the **school level**, ambitious instruction was a key component of visions for high-quality math instruction. Principals variously referenced the value of math practice standards, assessment for learning, rich and challenging discussions, engagement in math discourse, and the prioritization of conceptual over procedural understanding in their visions.

Another common theme at the school level was creating opportunities for students to experience and develop positive feelings and attitudes toward math. One principal expressed that their school's vision for math involved "developing a passion and a love for mathematics," adding that their personal vision was that teachers "demonstrate passion in math during their teaching, [because] that communicates nonverbally to students how safe, fun, and wonderful math is." A principal at another school shared that their vision involved implementing "a culture of a healthy math mindset," and yet others variously described visions of students "enjoying themselves," "having fun," "feeling empathy," and "being engaged."

A handful of principals shared a vision of math instruction that referenced concepts of culturally responsive math teaching beyond applying math to real-world situations. One principal shared that "ensuring access and equity for all students" was a priority in their vision for high-quality math instruction, specifying "culturally responsive teaching practices… including how [they] organize students in the classrooms so that every student [can] collaborate" as a means to implement their vision.

In terms of **alignment of visions**, district administrators reported perceptions of misalignment with schools' visions of high-quality math instruction. District administrators shared that they are working on improving alignment by "calibrating" and defining the centralized math approach to inform and norm with district leaders what math means within the context of their goals. They added that they are also engaging in conversations to identify alignments and misalignments with math standards, testing, student placement in math courses, and teacher coaching to determine the direction professional support can take. One district administrator shared perceptions of teachers harboring "deficit minded approach[es] to mathematics and placement," adding that they believed teachers continue to "rank, sort, and categorize students in the class that they belong in, and the math that they can or cannot have access to."

Most principals, however, expressed the belief that their visions were mostly well-aligned with the district's. Although a few principals were unequivocal in expressing their perception of alignment, adding praise for the math department at District 4 in the process, most also expressed some caveats.

"It's uncomfortable to lump all teachers in the one spot. But in general, we're actually seeing this predominantly showing up in our data. We're seeing that, for example, on the same item, students in our call-to-action—which are Black youth, multilingual students, and students receiving special services—those students have far less achievement in some of areas where it's very clear they're in a classroom with other students who fall into different groups. So those students in those classes are receiving different instruction, have different expectations for success. And it shows within our system. And that is only possible if it isn't solely resting on the shoulders of teachers who are denying that access. But they are certainly part of that. So there is definitely a malalignment."

— District administrator, District 4

"I think I'm pretty much in line with how our district feels from what I can tell. But it's just the implementation and the ways to go about it. I don't know. I just have the different people pulling me in different directions on how it should be done."

"I don't think there is necessarily a disconnect between the school and district vision. I think the level of training and time that's needed for teachers to shift…instructional practices is a limitation."

"[The district's] goal is really to get more engagement from their students in math again and stop having students be afraid of math and say, 'I can't do it.' Yeah, we're getting away from that. Having more math games, more math workshops, more fun stuff with math…"

"I think that I am on the same page ***philosophically*** *with the district at the middle school level." (emphasis theirs)*

— Principals, District 4

Principals who felt there was school–district misalignment in vision were generally critical of the district's vision, but none disagreed with the district's stated goals. In one instance, the principal shared that they found the district's vision to be too restrictive. In another, the principal's response referred to taking different approaches based on students' needs to get them on grade level.

This initial look at how districts and principals describe their respective visions for math education—and the alignment between the two—suggests room for greater cohesion around a common vision. This, in turn, may help districts and schools target their investments in productive and efficient ways to support clear and shared teaching and learning goals.

District 4 principals' criticism of the district's vision for high-quality math instruction

"They haven't addressed the human element to learning and teaching. You know, exploration and that kind of thing…I've seen when we have our trainings, they're so much focused on the 'above the green line,' the technical pieces of math instruction, that there's not a lot of time spent on the relational, or 'below the green line' aspects."

"The district has backed away from the single lane of acceleration…if [students] are ready for more challenging things, we want to honor that. And if they're not ready, we also want to fill those holes. One point further: Whatever current grade-level standards they should be at, it's our goal."

IV. Implications, Limitations, and Next Steps

This report takes a preliminary look at student survey data and at educator interview and student focus group data to reflect on both proximal (teacher practices) and distal factors (district and school visions for math) that influence students' experiences in middle school math classrooms. We first highlighted some of what we have learned thus far about students' beliefs—achievement identity, math enjoyment, and desire to continue studying math in the future—and then described what we have learned about the factors that may influence these beliefs. Specifically, we characterized the instructional practices we observed, teacher beliefs, and district and school visions for math. Below, we summarize implications from our findings.

A. Implications

The real and discouraging racial and gender differences between students' reported math achievement identity and enjoyment of math suggest the need for continued attention to improving these outcomes. Decades of research have indicated that students' mathematical beliefs are a predictor of math performance, whereby students who do not believe that they can perform well in math tend to perform at lower levels than students who believe that they can excel in math (for example, Chen, 2003; Cleary & Chen, 2009; Mason & Scrivani, 2004; Schommer-Aikins et al., 2005). Encouragingly, students responding to our surveys did not report differences in caring about learning math and the desire to attend math class. If teachers are able to harness students' intrinsic desire to engage in math class more effectively, it is possible that the disparities revealed by our study can be remedied. For example, studies have demonstrated that improving female students' achievement identity and self-efficacy can positively influence their pursuit of math coursework and math-related careers (Halpern et al., 2007). Such studies may further support the idea that culturally responsive pedagogical practices—those that attend to, for example, valuing productive struggle, providing affirming feedback, empowering mathematical inquiry—are critical to how students experience math and, in turn, their likelihood of math success.

There is a considerable need to strengthen professional learning in ambitious, culturally-responsive, and equitable teaching to align pedagogical practice with district and school visions for improved academic outcomes for all students. Even though our first interim report noted that the large share of teachers in our full sample reported participating in professional learning that improved their capacity to teach in ambitious, culturally responsive, and equitable ways, the deep dive sample has not yet revealed consistent improvements in these capacities. Overall, we observed few instances of teachers engaging students in problem solving and promoting the use of mathematical tools to improve conceptual understanding. In addition, of the teachers who self-reported modifying their curriculum to promote CRMT, only a small percentage reported that they employed strategies explicitly intended to leverage students' cultural and community funds of knowledge as an asset for learning. Moreover, there was wide variation in teachers' use of equitable teaching practices such as the use of ability grouping to differentiate learning. These findings suggest that all teachers could potentially benefit from professional learning on:

- **Ambitious teaching practices.** Engaging students in problem solving, scaffolding learning for multilingual learners
- **Culturally responsive teaching practices.** Drawing on students' cultural and community funds of knowledge, helping students make interdisciplinary connections in math, and using math as a tool for social justice

- **Equitable teaching practices.** To make their classrooms more equitable, teachers could generally benefit from professional learning in differentiating the learning experience with manipulatives, language aids for multilingual learners, and a variety of student grouping strategies that engage all students

We do not yet understand from our data why teachers did not routinely employ these practices. They could have been receiving training in these practices as reported, but the learning opportunities may not have helped them understand how to implement the practices with students performing below grade level or in large classrooms with a great need for differentiation. Coaching and teacher planning could support teachers in using these various practices. In upcoming reports, we will explore how both training and coaching build teacher capacity.

Teacher beliefs appear related to schools' historical student performance and demographic characteristics, which may contribute to persistent racial and gender disparities in math. Research has demonstrated that student and teacher demographic and socioeconomic characteristics can be determinants of student achievement in math (for example, LaCour & Tissington, 2011; McCoy, 2005). Teacher beliefs, knowledge, and self-efficacy in instructional content areas influence instructional practice (Desimone et al., 2016). In particular, research has suggested that students underperform when their teachers do not believe that they can achieve at high levels in math or when teachers lack confidence in their knowledge and ability to teach math effectively (particularly to struggling or historically underperforming students) (Busi & Jacobbe, 2018; Lopez, 2017). We found that teachers in schools with historically low-performing students believed that their curricula were too rigorous. Even if curricula are too challenging, our findings underscore the need to align investments in curricula and professional learning to build teachers' instructional capacity. Research has indicated that effective professional learning can improve teachers' innate beliefs about math as a discipline, how people learn math, and beliefs about instructional strategies designed to support culturally diverse learners (Busi & Jacobbe, 2018; Lopez, 2017). As teachers' confidence in their ability to meet their students' needs change (Cornett & Knight, 2009), so, too, do their expectations about their students' academic performance. Teacher expectations are implicit or explicit inferences about their students' academic abilities or performance potential. Empirical studies have shown that low expectations can adversely influence student achievement and that high expectations can promote high achievement (Friedrich et al., 2015; Lopez, 2017). Furthermore, teachers can develop the capacity to employ more ambitious instructional strategies in lieu of more procedural practices (Jackson & Cobb, 2010; Kazemi et al., 2009; Stroupe, 2016). However, it appears that the teachers in our study need much better tools and support than currently provided if they are to teach all students in an ambitious, culturally responsive, and equitable way—particularly students who were struggling to meet grade-level learning standards. Where relevant, it was not clear that teachers had access to explicit guidance on how to move students up a steeper learning trajectory to close achievement gaps.

As organizations, districts and schools might prioritize establishing a coherent and shared vision for math instruction, and one that provides more concrete guidance on instructional practices to support this vision. A high level of consensus in the public domain points to an organization's vision as a critical guide for progress. The same should hold for educational institutions. A district vision that clearly articulates the importance of equity can and should ultimately spread to and affect teacher practices in the classroom. Our interviews, albeit only a preliminary investigation into questions of vision, alignment, and resources to support a vision's goals, indicated that there is more that districts might do to harness the power of a vision– a vision that clearly places a high priority on equity, communicates the vision often and comprehensively to all district stakeholders, and uses the vision to guide investment decisions at every level. Indeed, harnessing a vision may be critical in helping address stubbornly persistent and historic equity issues.

B. Limitations

Several limitations associated with our survey data influenced the interpretations of our findings. First, given missing data (teachers and students who did not reply to a survey or opted out of specific questions), some findings might suffer from nonresponse bias. Nonresponse bias is particularly problematic for analyses that involve matching teacher and student data (that is, the analysis of student experiences), which requires survey data for both the student and the respective teacher. Second, our analysis was not causal. We therefore could not infer if teachers adapted *because* of the teacher and school characteristics of interest or whether variables are simply related or the relationship is caused by some other underlying factor. Nonetheless, understanding the relationship between these factors is a useful starting point for future qualitative and quantitative analysis. Finally, as noted in earlier reports, some analyses relied on self-reported survey data, which are subject to bias.

We relied on a small, purposive sample for our classroom observations, teacher interviews, and focus groups. We conducted only one to three observations per teacher over the course of a week. As a result, we observed instructional practices that may not have been representative of a teacher's typical practice. In addition, teacher and student reflections recounted during post-observation interviews and focus groups, respectively, reflected perceptions only at a given time point and did not reflect perspectives that may have shifted or evolved over the school year.

Some of our classroom observation data are difficult to reconcile and interpret. This may be in part because we analyzed teacher practices only in the aggregate and have not yet investigated and compared individual teacher practices during a lesson to explore how differences in instructional delivery may have influenced student beliefs and performance outcomes. In addition, we do not yet understand the relationship among teachers' use of ambitious, culturally responsive, and equitable practices. We have neither (1) validated our CRMT classroom observation tool against the M-Scan scoring rubric nor (2) conducted an integrated analysis of the data collected with these instruments. As a result, we should not generalize our classroom observation findings beyond the deep dive sample.

C. Next steps

As we dig into the rich data we have in hand on the AMS and begin to "peel back the onion" on questions related to relationships among curricula, professional investments, teacher classroom practices, and student experiences, we find more and sometimes new areas for exploration. We will conduct one more round of data collection (spring 2023) and add to our rich data set for analysis. We see some potential questions for future exploration based on the work completed to date, as summarized below:

- **To what extent do the study curricula support differentiation that is aligned with standards?** At this stage in the study, we do not know whether teachers were "dumbing down" curricula or strategically differentiating instructional content and tasks to help struggling students catch up to grade-level learning standards. Our findings suggest that teachers were adapting the curricula frequently to better meet the needs of their students. As we report above and in our first interim report, teachers were most likely to adapt their curriculum to accommodate the needs of students performing below grade level and to make their instructional materials more culturally or linguistically responsive to their students' interests and needs. As a next step, we would like to review differentiation supports provided by the study curricula. For example, we might explore the extent to which the curricula helped teachers identify prerequisite learning standards in order to address knowledge gaps.

- **How do teachers differentiate learning for students performing below grade level?** We would like to use CCSS math learning progressions as a benchmark to understand whether teachers were "dumbing down" rigorous curricula or scaffolding students to ultimately master grade-level content and competencies while maintaining a focus on rigor.
- **How do teachers who use ambitious, culturally responsive, or equitable practices structure their lessons? Do they design learning environments differently from teachers who did not use these practices routinely?** As a next step, we would like to analyze teacher-level patterns of practice over the course of a lesson with the aim of:
  - Providing illustrative examples of the instructional practices employed by teachers who earned particularly high or low classroom observation ratings
  - Characterizing or typifying the instructional decisions associated with improved student experiences
- **Is there evidence that districts and schools are making explicit investments in professional learning and other instructional resources needed to help teachers realize a common vision for high-quality math?** During our final round of data collection, we will interview district administrators and school principals to learn more about how they operationalized their respective visions for high-quality math instruction. We will investigate their efforts to align communication, resources, and accountability at the district, school, and classroom levels.
- **Is there a relationship between the quality of a curriculum and the quality of instructional delivery?** Does instructional practice differ by curriculum rating or curriculum? In our first year of data collection, we conducted fewer than 50 classroom observations. These observations represented 25 teachers, just one to three observations each, depending on whether teachers taught more than one grade level. Of these observations, we observed fewer than 25 lessons using green curricula and fewer than 20 observations using non-green curricula. Therefore, we observed only a handful of lessons for each of the six study curricula. With such small sample sizes, we have insufficient data to draw generalizable conclusions about differences in practice and student outcomes associated with the use of green or non-green curricula. Given that our final round of data collection will double the total number of observations, we will have more data with which to determine whether noteworthy differences between curricula are detectable.

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Appendix A.

Teacher and Student Survey Samples

To create the sample of schools for study participation and data collection activities, the team worked with each of the four participating districts to identify and recruit a set of schools with grades 6–8 that were using the curricula of interest and were willing to participate. This resulted in 10 participating schools in District 1, six schools in District 2, eight schools District 3, and 15 schools in District 4.

Within these schools, to identify the classrooms, teachers, and students for participation in our surveys, we then obtained a list of all middle school math classrooms from each study school. For each classroom, we received information such as grade (6, 7, or 8), teacher name, class level (for example, below grade level, general education, advanced), and number of students. We excluded classrooms designated as below grade level or advanced, as well as classrooms with fewer than 12 students. Among the remaining classrooms, we asked all math teachers to complete a survey. We randomly selected one classroom per grade per school, for a total of three classrooms per school, from which we collected student surveys. We also selected a set of classrooms for a deeper dive, which included more in-depth data collection activities such as classroom observations, teacher interviews, and student focus groups. For these more in-depth activities, we sought schools from within our larger sample described above that had demonstrated a willingness to make this additional investment. Our goal was to identify three schools in each of the four districts, and within those three schools to identify one math teacher in each of the three middle school grades. These nine classrooms and teachers per district (or 36 teachers across the four districts) became our "deep-dive" sample. The rich data collected in these deep-dive classrooms will be included in subsequent reporting.

To understand teachers' and students' experiences with math classrooms, we administered surveys to both teachers and students in fall and spring of the 2021–2022 school year. We administered the teacher survey to 207 teachers in the four districts. The fall survey had a 61 percent response rate, and the spring survey had a 42 percent response rate. The fall teacher survey collected information on teachers' teaching background and experience, perceptions and use of the math curriculum, and teaching practices. The spring teacher survey collected information about use of the math curriculum and teachers' experiences with professional learning. Each survey was administered via a web-based platform and took approximately 30 minutes to complete.

We administered the fall student survey to 1,908 students in District 1 and District 4 and the spring student survey to 2,941 students in all four districts. The study team did not administer fall student surveys in District 2 or 3. District 3 schools were delayed until January 2022 in providing the student roster information needed to select the student sample. This would have meant administering the fall survey in February and March 2022 and then administering the spring survey in April 2022, which we felt would create too much of a burden on schools. As a condition of its continued participation, District 2 would not allow the study team to conduct student surveys in the fall because the district needed to plan and prepare for in-person student learning for the 2021–2022 school year. The fall survey had a 70 percent response rate, and the spring survey had a 50 percent response rate (Exhibit A.1).

Exhibit A.1. Fall and spring teacher and student survey samples, completions, and response rates

	District 1			District 4			District 3[a]			District 2[b]			Total		
	Eligible sample	Completes	Response rate	Eligible sample	Completes	Response rate	Eligible sample	Completes	Response rate	Eligible sample	Completes	Response rate	Eligible sample	Completes	Response rate
Fall student survey	731	501	69%	1,177	830	71%	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1,908	1,331	70%
Spring student survey	731	306	42%	1,227	821	67%	522	163	31%	461	166	36%	2,941	1,456	50%
Fall teacher survey	21	14	67%	72	55	76%	48	27	56%	66	30	45%	207	126	61%
Spring teacher survey	21	12	57%	72	40	56%	48	15	31%	66	20	30%	207	87	42%

Source: AMS fall 2021 and spring 2022 teacher and student surveys.

[a] As a condition of study participation, District 2 would not allow the study team to conduct fall student data collection.

[b] District 3 schools did not provide the necessary student roster information until January 2022, which prevented the study team from administering the fall student surveys.

n.a. = not applicable.

The student survey included questions related to student beliefs (growth mindset, achievement identity, math persistence, math self-efficacy, and math enjoyment), student engagement, and student interest and persistence in math. Both fall and spring administrations used the same instrument. The student survey took approximately 10 minutes to complete. Schools were offered the option of administering the survey by web or a paper version, with the majority of schools selecting the latter.

Appendix B.

Survey Constructs

We constructed scales to calculate a respondent's aggregate score across items capturing a single construct. We constructed scales by taking the mean across all items on that scale. We calculated Cronbach's alpha to assess the reliability of each scale. First, we ensured that the alpha for each scale was equal to 0.70 or greater and that the alpha value would not be improved by removing any items. If either of these conditions was not met, we discussed as a group whether to remove any items from the scale. A list of all the scales we created for the student and teacher surveys and the items included in those scales are listed in Exhibit B.1.

Exhibit B.1. Items included in the teacher and student survey scales

Construct	Survey	Construct definition	Survey items included[7]
Self-efficacy scale	Spring teacher survey	Teachers' beliefs that they can improve their teaching and student learning (individual efficacy) can change	Please rate your confidence in the following areas on a scale of 0 (not confident at all) to 10 (extremely confident). a. Teaching math to students performing on grade level in math. b. Teaching math to students performing below grade level in math. c. Teaching math to students performing above grade level in math. d. Teaching math to students who are experiencing poverty (i.e., students who receive free or reduced-price lunch). e. Teaching math to students who have Individualized Education Programs (IEPs) or the equivalent. f. Teaching math to students who are designated as English learners (ELs). g. Teaching math to address unfinished learning related to COVID-19.
Culturally Responsive Mathematics Teaching confidence scale	Fall teacher survey	The extent to which teachers feel confident incorporating culturally responsive math teaching practices into their teaching	Please rate your confidence in the following areas on a scale of 0 (not confident at all) to 10 (extremely confident). a. Adapting instruction to meet the needs of my students. b. Using a variety of teaching methods. c. Using developmentally appropriate practices. d. Creating positive relationships in the classroom. e. Using my students' cultural backgrounds to help make learning meaningful. f. Adapting instructional materials to adequately and appropriately represent cultural groups. g. Helping my students feel like important members of the classroom. h. Explaining new concepts using examples that are taken from my students' everyday lives. i. Integrating social or political issues into class discussions or assignments. j. Uncovering my own implicit biases in my teaching practice. k. Supporting my students to be active in social or political causes.

[7] The letters in "Survey items included" represent the actual survey item letters from the student and teacher surveys.

Construct	Survey	Construct definition	Survey items included[7]
Supportive leadership scale	Spring teacher survey	The extent to which teachers feel encouraged by school leadership to implement learned knowledge and competencies in the classroom	Next, we would like to know more about your school's leadership. How much do you disagree or agree with each of the following statements? The leadership at this school… a. Makes clear to the staff expectations for meeting instructional goals. b. Communicates a clear vision for our school. c. Sets high standards for teaching. d. Understands how students learn. e. Sets high standards for student learning. f. Carefully tracks student academic progress. g. Knows what's going on in my classroom. h. Actively monitors the quality of teaching in this school. i. Actively encourages or supports me in implementing what I learned into my classroom practice.
Curriculum normative authority scale	Fall teacher survey	The extent to which teachers feel the curriculum is appropriate for their students	Please mark the extent to which you disagree or agree with each of the following statements. [Curriculum]: k. is culturally relevant. l. is engaging for students. Please mark the extent to which you disagree or agree with each of the following statements. [Curriculum]: a. Is too inflexible for teachers to effectively teach students. b. Includes more content than can be covered adequately in the school year. c. Is too rigorous for most students I work with. d. Helps prepare students for state standardized tests. e. Excludes important content that students should learn. f. Appropriately addresses the needs of students who are designated as dual language learners (DLLs). g. Appropriately addresses the needs of students who have Individualized Education Programs (IEPs) or the equivalent.
Student engagement scale	Fall and spring student surveys	Positive and active participation in math class including the desire to meet academic expectations (such as, earning good grades and test scores), comply with social and behavioral classroom norms (such as, being a good small group partner), engage cognitively (such as, the personal drive or commitment to improve conceptual understanding of a particular math topic), and engage	When reading the following statements, think about your current math class and decide how well the statements describe you. a. I don't think that hard when I am doing work for math class. b. I complete my math homework on time. c. I don't participate in math class. d. I do other things when I am supposed to be paying attention. e. I try to work with others who can help me in math. f. I build on others' ideas. g. I try to understand other people's ideas in math class. h. I don't care about other people's ideas.

Construct	Survey	Construct definition	Survey items included[7]
		emotionally (such as, being excited when playing math games)	When reading the following statements, think about your current math class and decide how well the statements describe you. a. I try to understand my mistakes when I get something wrong. b. I want to understand what is learned in math class. c. I try to help others who are struggling in math. d. I talk about math outside of class. e. I think that math class is boring. f. I don't like working with classmates.
Math enjoyment scale	Fall and spring student surveys	The belief that doing math and being in math class is fun	When reading the following statements, think about your current math class and decide how well the statements describe you. a. I look forward to math class. b. I enjoy learning new things about math. c. I feel good when I am in math class. d. I often feel frustrated in math class. e. I don't care about learning math. f. I don't want to be in math class. g. I often feel down when I am in math class. h. I get worried when I learn new things about math.
Math self-efficacy scale	Fall and spring student surveys	Students' confidence in solving math problems and performing math-related tasks. High self-efficacy is a predictor of math achievement.	When reading the following statements, think about your current math class and decide how well the statements describe you. How much do you disagree or agree with the statements below? b. I learn things quickly in math. c. I am good at working out difficult math problems. f. I believe that I can be successful in my math class. h. I am confident that I can understand the material in my math class. i. I know I can learn the materials in my math class.
Achievement identity scale	Fall and spring student surveys	Students identifying and holding a self-concept as someone who can achieve academically. This student belief can improve with intervention or is a strong predictor of future math achievement.	When reading the following statements, think about your current math class and decide how well the statements describe you. How much do you disagree or agree with the statements below? a. I usually do well in math. b. Math is harder for me than any other subject. c. My teacher tells me I am good at math. How much do you disagree or agree with the statements below? a. My classmates think I am good at math. b. My friends think I am good at math. c. My parents think I am good at math.

Construct	Survey	Construct definition	Survey items included[7]
Growth mindset scale	Fall and spring student surveys	Students' belief that their ability to learn is not fixed but can be developed over time. This is a mindset that can be nurtured in instructional settings.	When reading the following statements, think about your current math class and decide how well the statements describe you. How much do you disagree or agree with the statements below? a. Being a top math student requires a special talent that just can't be taught. b. If you want to succeed in math, hard work alone just won't cut it; you need to have a natural gift or talent. c. When you have to try really hard in math in school, it means you can't be good at math. d. Being a "math person" or not is something that you really can't change. Some people are good at math and other people aren't.

Appendix C.

Teacher Interview and Student Focus Group Coding Constructs for Adaptations

We coded and analyzed data from the teacher interviews and student focus groups on adaptations in the context of four constructs: (1) ambitiousness, (2) student engagement, (3) cultural responsiveness, and (4) equitable adaptations for multilingual learners.

3. **Ambitiousness**
   a. Students
      1. When you're in this math class, do you feel like you are learning things that you already know? Things that are too hard or too easy for you?
      2. Do you feel that your teacher supports your individual learning needs? Can you give me an example?
   b. Teachers
      1. What were your goals for this lesson?
      2. How did this lesson fit into your plan for the instructional unit as a whole?
      3. What are your key considerations when planning?
      4. Why did you select the materials that you ultimately used? What supplemental materials did you select, and why?
      5. Did you make any adjustments in the lesson? If so, why? If not, do you typically? If so, when and why?
      6. How, if at all, did this lesson create opportunities for students to discuss math in deep and meaningful ways?
      7. How, if it all, did you facilitate math discourse in this lesson?
4. **Student engagement**
   a. Students
      1. During this class, how did you feel? Were you happy to be there? Did you wish you were doing something different?
      2. Some students appear to be participating or paying attention more than others. Why do you think that is?
      3. What did you like about this lesson? What was fun or interesting about this lesson?
      4. When you're in this math class, do you feel like everyone is treated fairly? What makes you say that?
      5. Do you feel that some students are treated differently than others? What makes you say that?
      6. Did you connect math ideas or problems with what you're learning or have learned in other classes like history, science, or art?
      7. Did you use math to solve real-world problems or make-believe problems?

b. Teachers

1. Why did you select the materials that you ultimately used? What supplemental materials did you select, and why?
2. Did you make any adjustments in the lesson? If so, why? If not, do you typically? If so, when and why?
3. How, if at all, did this lesson create opportunities for students to discuss math in deep and meaningful ways?

5. Cultural responsiveness

a. Students

1. Did you discuss the ways math is used by other cultures or communities?
2. Did you use math to investigate an issue affecting your school, community, or your personal life, or a social justice issue that interests you?

b. Teachers

1. How, if at all, do you try to promote cultural responsiveness in your classroom?
2. How, if at all, did this lesson create opportunities for students to discuss math in deep and meaningful ways?
3. How, if at all, did this lesson help students connect math with their real-world experiences?

6. Equitable adaptations for multilingual learners

a. Students

1. If you speak more than one language, did this lesson give you the opportunity to explore math ideas and problems using a language other than English?

b. Teachers

1. Are there multilingual learners in this class? If so, how, if at all, did this lesson scaffold English language development for multilingual learners?

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