# Analysis of Middle School Math Systems

## Leveraging Classroom Observation to Foster Ambitious and Inclusive Middle School Math Instruction

### 2024 NCTM Research Conference

### Study Overview

The Analysis of Middle School Math Systems (AMS) study aimed to understand the extent to which teachers in four urban school districts planned and executed ***ambitious*** and ***inclusive*** mathematics lessons while using one of six different middle school mathematics curricula.

### Ambitious Instruction

- Students engage in ***cognitively demanding*** tasks
- Teachers' curriculum and instruction is ***standards-based***

We measured ambitious instruction using the Mathematics Scan (Walkowiak et al. 2014) classroom observation tool which is a validated instrument designed to assess the degree to which teachers create opportunities for students to engage in ambitious instruction.

### Inclusive instruction

- ***Culturally and linguistically responsive:*** promotes mathematical thinking, the use of students' funds of knowledge, and math as a tool for social justice
- ***Equitable:*** personalizes learning for specific subgroups of students, such as miltilingual learners, so students have equal access and opportunity to engage in the learning process

We measured inclusive instruction using our Culturally Responsive Mathematicas Teaching (CRMT) classroom observation tool, that draws on a professional learning tool developed by Aguirre and del Rosario Zavala (2013). This tool is in a pilot phase and has undergone preliminary validation and refinement.

### Leveraging classroom observation in professional learning

We are developing a peer observation tool and discussion guide to support professional learning and create more ambitious and inclusive learning environments. The tool will help teachers identify opportunities for and strengthen implementation of the following instructional practices:

- Ambitious and inclusive instructional practices
- Classroom procedures, organization, and resources
- Relational interactions

## References


Aguirre, J. M., & del Rosario Zavala, M. (2013). Making culturally responsive mathematics teaching explicit: A lesson analysis tool. *Pedagogies: An International Journal, 8*(2), 163–190.

Walkowiak, T. A., Berry, R. Q., Meyer, J. P., Rimm-Kaufman, S. E., & Ottmar, E. R. (2014). Introducing an observational measure of standards-based mathematics teaching practices: Evidence of validity and score reliability. *Educational Studies in Mathematics*, *85*(1), 109–128.


## Evidence & insights from this project


Amos, L., Gorang, E., Halderlein, S., Hallgren, K., Hartog, J., Johnson, A., Pace, S., Smith, E., Stone, R., Wood, M. (2022). Analysis of Middle School Math Systems (AMS) Interim Report: Preliminary Exploration of Curriculum Characteristics, Professional Learning, and Instructional Adaptation.

Amos, L., Gorang, E., Halderlein, S., Hallgren, K., Hartog, J., Johnson, A., Pace, S., Tiwari, N., Venezia, F. (2023). Analysis of Middle School Math Systems (AMS): Further Investigation into Student Experiences, Instruction, and Context.

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Harris, B., Herring, W., Stone, R. (2024). Making Math More Accessible and Engaging Through Culturally Responsive Teaching.

McCullough, M., Shiferaw, M. (2024). Navigating the gray spaces in research-to-action: Engaging partners in a cross-district study of middle school math curricula/

Stone, R., Rosendahl, L., Johnson, A., Harris, B. (2023). Analyzing Middle School Mathematics Curricula A Comparative Study Using Three Measurement Tools.


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# Leveraging Classroom Observation to Foster Ambitious and Inclusive Middle School Math Instruction

## 2024 NCTM Research Conference

**Lauren Amos, Micah Wood, and Katie Gleason**
Mathematica

# Today’s Mathematica presenters

**Lauren Amos, Ph.D.**

Principal Researcher

**Micah Wood, M.P.A.**

Researcher

**Katie Gleason, M.P.P., M.S.T**

Researcher

# Agenda

## / Background and introduction

- Analysis of Middle School Math Systems (AMS) study overview
- Motivation and purpose of this session
- Measuring ambitious and inclusive math instruction
- Using classroom observations to foster ambitious and inclusive math instruction

## / Interactive activities

- Practice using the professional learning (PL) tool
- Small group discussion and feedback
- Gallery walk

## / Wrap up

# Study Overview

- Analysis of Middle School Math Systems (AMS) study funded by the Gates Foundation
- SY2021-22 and SY2022-23
- Explored the enabling and disabling conditions under which teachers:
  - Adopt and adapt six different middle school mathematics curricula in four urban school districts
  - Employ **ambitious** (cognitively demanding and standards-based) and **inclusive** (culturally responsive, linguistically responsive, and equitable) instructional practices
  - Positively influence student math identity, persistence, enjoyment, self-efficacy, engagement, growth mindset, and performance

Use the QR code below to visit mathematica.org and learn more about this project

Partners:

- The University of Delaware
- Teaching Lab
- Houghton-Mifflin-Harcourt
- The Center for Curriculum Analysis

# Study Overview (Cont'd)

## Data sources:

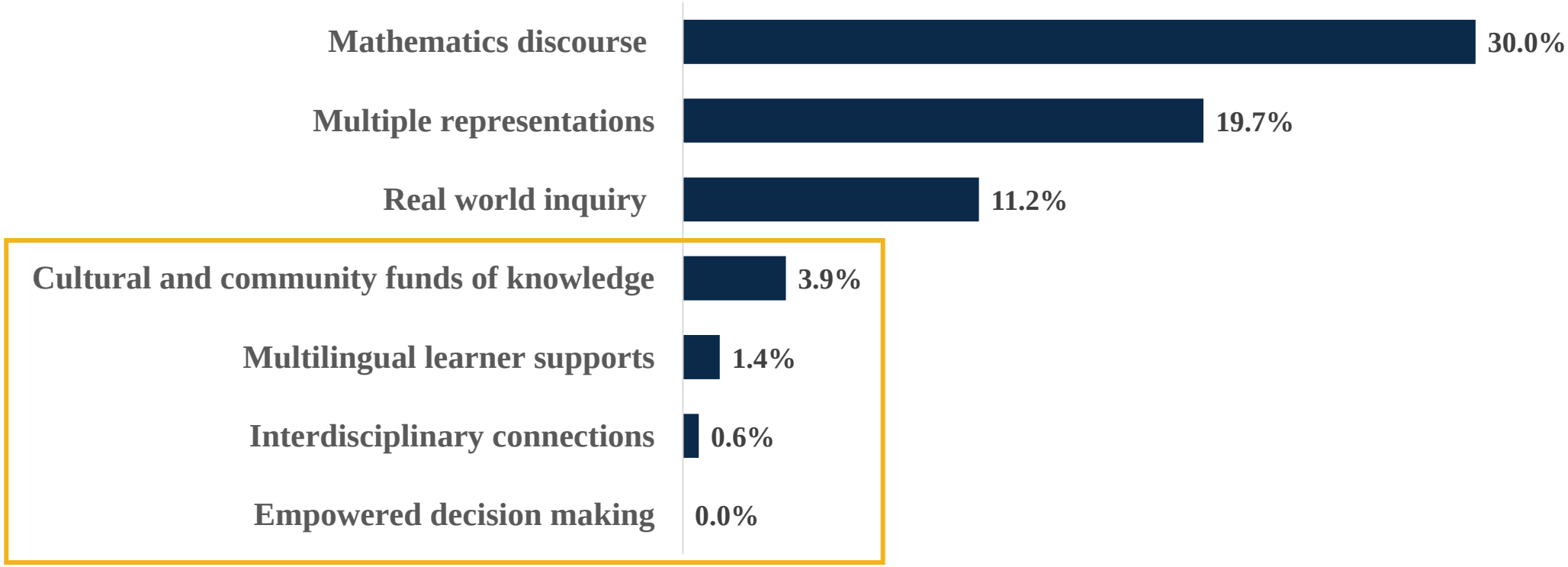
- Administrator, PL provider, math coach interviews
- Teacher and student surveys
- Professional learning and coaching observations
- Classroom observations
- Post-observation teacher interviews
- Post-observation student focus groups
- Lessons, instructional materials, and samples of student work

# Study Overview (Cont'd)

- We developed a classroom observation tool to measure inclusive practice:
  - Research on culturally responsive mathematics teaching (CRMT) is inspirational but largely qualitative and theoretical
  - There's a dearth of:
    - Actionable, scalable, and causal research illustrating effective implementation of CRMT
    - Evidence that the use of CRMT contributes to improved student outcomes
    - Valid and reliable classroom observation tools designed to assess both CRMT and equitable instruction

# Motivation

/ Although **96 percent** of teacher survey respondents reported receiving PL on culturally responsive pedagogy, we rarely observed the use of CRMT practices



# Purpose of this Session

- **Early stages of adapting our classroom observation tool as a peer observation tool and discussion guide for use by teams of classroom teachers as an in-service professional learning intervention**
- **Why peer observation?**
  - Classroom observation as a PL intervention is a promising strategy (Cantrell et al, 2014)
  - Majority of our teacher survey respondents reported that their PL is:
    - **Not aligned** with their individual professional growth needs or feedback on their teaching
    - **Not connected** to their daily lessons
  - Teachers who employed CRMT practices the most were more likely to report a high sense of collective efficacy, the extent to which teachers believe in their communal ability to positively influence student learning (Goddard et al., 2000; Goddard, 2002; Goddard & Skrla, 2006)
    - Collective efficacy is a predictor of student performance (Goddard et al., 2004; Hancock & Scherff, 2010)
- **Your role: Practice using the adapted tool and provide feedback on its design**

# Measuring Ambitious and Inclusive Math Instruction

# What is Ambitious and Inclusive Math Instruction?

| Ambitious instruction | Inclusive instruction |
| --- | --- |
| • **Cognitively demanding:** performance tasks that require students to demonstrate understanding, conjecture, generalize or prove, make connections, or solve non-routine problems<br>• **Standards-based** | • **Culturally and linguistically responsive:** promotes mathematical thinking, the use of student's funds of knowledge, and math as a tool for social justice<br>• **Equitable:** personalizes learning for specific subgroups of students, such as multilingual learners, so students have equal access and opportunity to engage in the learning process |
| • Mathematics Scan (Walkowiak et al. 2018) | • Culturally Responsive Mathematics Teaching (CRMT) classroom observation tool |

# AMS study CRMT classroom observation tool

## Tool design and development process:

- Derived initial domains and codes from a literature review, AMS Math Advisory Committee recommendations, and feedback from AMS co-PIs
- Formatted as a simple Excel tool that documents and quantifies the occurrence/non-occurrence of given practices in five-minute intervals
- Findings are reported as a percent of class time
- Iteratively pilot tested and refined the tool's usability, codes, code descriptions, and inclusion/exclusion criteria over the course of 3 years
- Assessed the tool's reliability and validity to finalize the tool's design

## Domains observed:

- The use of ambitious and inclusive practices
- Student–teacher relationships
- Procedural activities
- Resource use
- Student grouping strategies
- Performance tasks

# Leveraging Classroom Observation to Foster Ambitious and Inclusive Math Instruction

# Professional learning overview

/ **Build teacher capacity** to create more ambitious and inclusive learning environments by participating in peer observation using an **observation checklist** and discussion guide

# Tool organization and content

- **Part 1: AIM Practices**
  - Real world mathematical inquiry and problem solving
  - Multiple representations of mathematics
  - Mathematical discourse
  - Multilingual learner support and scaffolding
  - Engaged student and community funds of knowledge
  - Interdisciplinary connections
  - Empowered mathematical inquiry and decision making
- **Part 2: Classroom procedures, organization, and resources**
- **Part 3: Relational interaction**

# Major differences in design (Option A vs. B)

| Component | Tool A | Tool B |
|---|---|---|
| **CRMT practices** | Space to take open-ended notes on *three levels of practice* for each CRMT domain:<br>• Teacher-led,<br>• Teacher-facilitated,<br>• Student-led. | Definition of practices in each domain with space to record *when and how* the practices were observed and additional opportunities to incorporate them. |
| **Classroom procedures, organization, and resources** | Checklist to record occurrence and space for *how they advanced student learning*. | Checklist to record occurrence and space for *low-inference notes* on their use. |
| **Relational interactions** | The *desired* relational interactions observed and their *distribution* across students. | Space to record both *positive and negative* interactions that occurred during the lesson. |

# Get ready to practice observing

- **Review the version of the tool that you've received, consider…**
  - content
  - design
- **Do you have any questions about how to use the tool?**

# Practice using the observation tool

# Practice observing

## Conduct the observation

- We will play the video clip twice, pausing after each viewing to give you time to take notes in your tool

## Debrief the observation

- What ambitious and inclusive practices did you notice?
- What missed opportunities did you notice?

https://www.youtube.com/watch?v=TdmoWC4meBw

# Small group discussion

## / Annotate your tool by…

- Putting a ✓ by elements you like
- Putting an X by elements you don't like
- Putting a ? by elements that confuse you

## / Discuss and provide feedback on the tools

- What worked well about your tool in terms of its content?
- What worked well about your tool in terms of its design?
- Where did you get stuck with your tool?
- What questions do you have about your version?
- What revisions would you recommend?

Please put notes from your group's discussion on your chart paper.

# Gallery Walk

- Move through the room to review the notes from other groups' discussions
- As we move forward with our revision of the tool, which suggestions should we prioritize?
  - Put a ★ next to comments that strike you as particularly important to address

# Wrap up discussion

- What are key revisions to the tool’s design or content?
- What would make it more useful or accessible to educators?
- How might you structure a professional learning session to use this tool productively?

# Contact Information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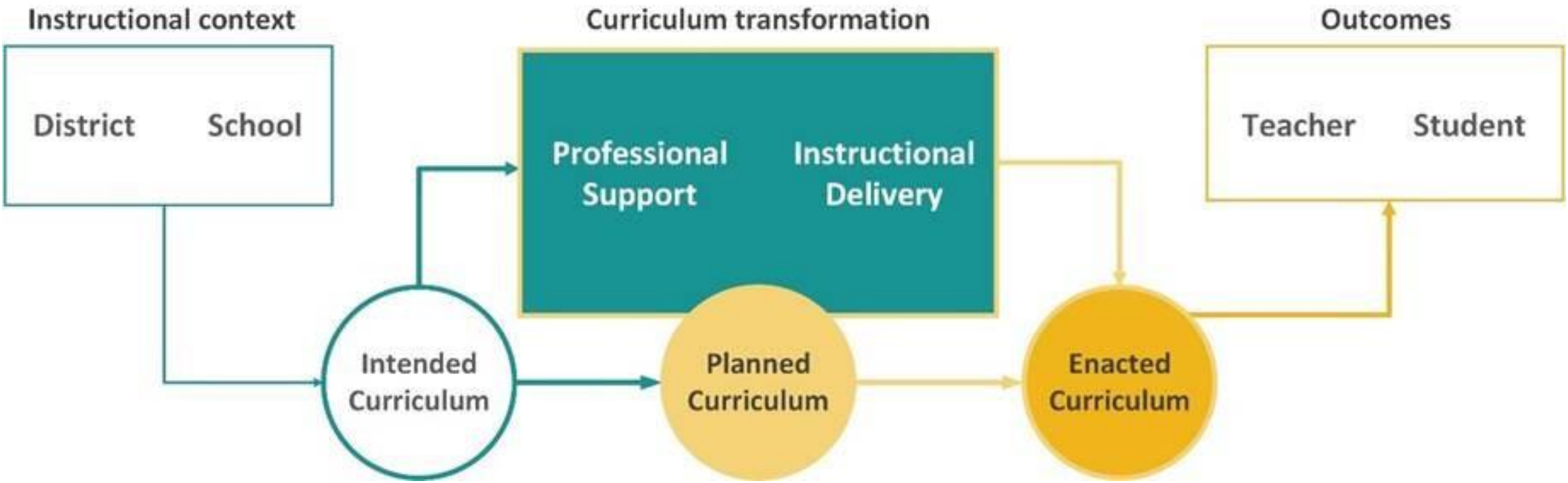
# Thank you!

# References


- Cantrell et al, 2014
- Goddard & Skrla, 2006
- Goddard et al., 2000
- Goddard et al., 2004
- Goddard, 2002
- Hancock & Scherff, 2010
- Walkowiak, T. A., Berry, R. Q., Pinter, H. H., & Jacobson, E. D. (2018). Utilizing the M-Scan to measure standards-based mathematics teaching practices: Affordances and limitations. ZDM, 50(3), 461–474.

# Appendix

# AMS theory of action



# Analyzing CRMT data

- **Code** observed practice in five-minute intervals
- **Calculate** CRMT subdomain scores as a percentage of intervals during which a teacher exhibited a particular strategy or behavior at least once during the class period
- **Aggregate** teacher subdomain scores to calculate average scores for each CRMT domain
- **Report** domain scores as a "percentage of class time":
  - 25 percent or less of class time suggests *nonroutine, rare, or no* use of a strategy or behavior over the course of a lesson
  - 26–49 percent of class time suggests *occasional but inconsistent* use of a strategy or behavior over the course of a lesson
  - 50 percent or higher of class time suggests *routine or consistent* use of a strategy or behavior over the course of a lesson

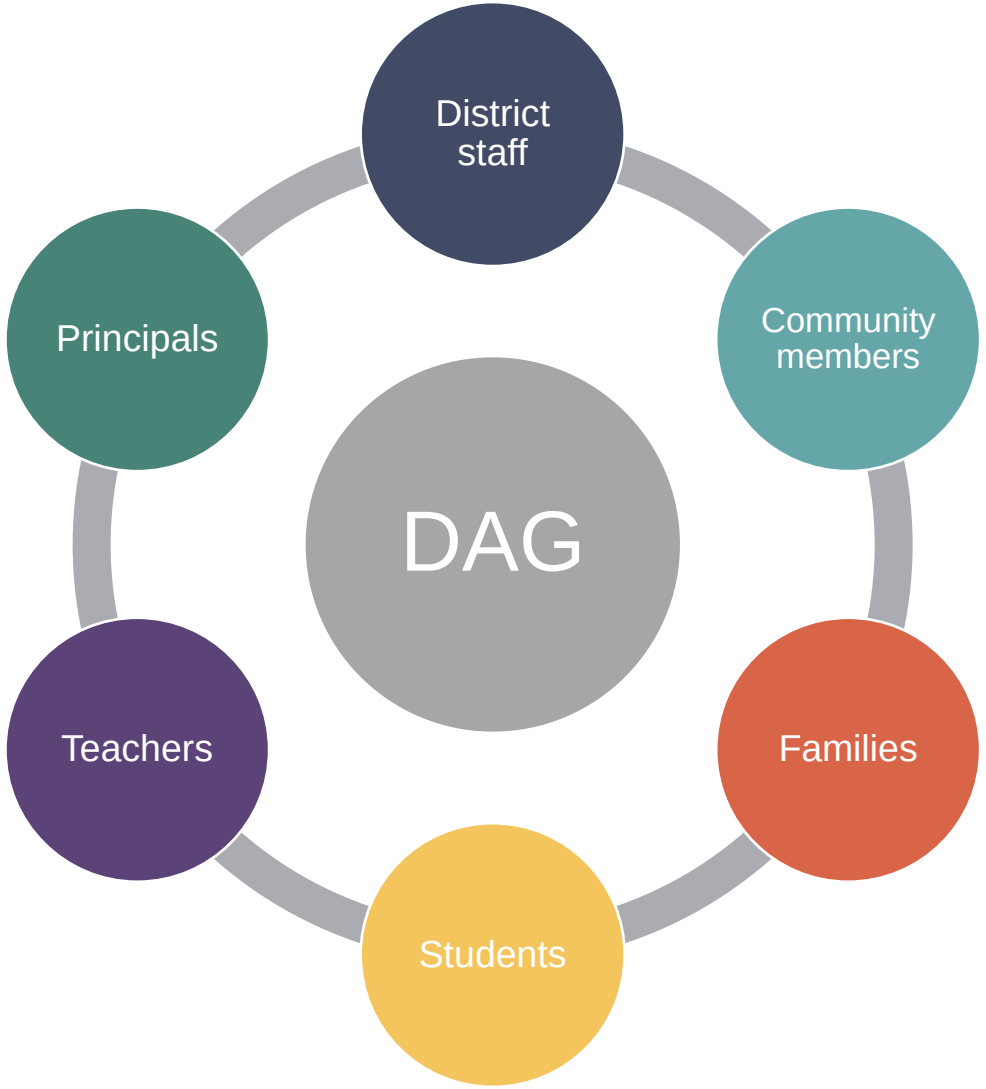
# Characteristics of “High Quality” PL

- ☑ Engages teachers in **reflective practice** to identify and address their individual learning needs and implicit biases
- ☑ Advances teachers’ **mathematical knowledge for teaching**, capacity to employ **CRMT practices**, and understanding of **how students learn**
- ☑ Provides ample opportunity for teachers to engage in **active learning** through such interactive activities as discussion and analyzing student data, student work, student inquiry, instructional materials, and lessons
- ☑ Is **aligned** with their curriculum, state or district standards, and their district and school’s vision and goals for teaching and learning in math
- ☑ Is offered on an **ongoing** basis throughout the school year with at least 20 hours of contact time
- ❑ Is **differentiated** in response to teachers’ individual learning needs
- ☑ Is **championed** by district and school leaders who encourage teachers to apply knowledge and skills in their classrooms

(Aguirre and del Rosario Zavala 2013; Akiba et al. 2019; Civitillo et al. 2019; Desimone 2009; Desimone and Garet 2015; Hill et al. 2008; Hozebin 2018; Monet and Etkina 2008; Murata et al. 2012; Weber et al. 2018)

# District Advisory Groups (DAGs)

- Provide feedback on research questions, study design, and findings—including preliminary and interim analyses—to inform reporting and dissemination



# Detialed findings from teacher surveys

- **96 percent** of teachers reported that they had received professional learning in culturally responsive teaching
- **89 percent** of teachers reported participating in professional learning that asked them to engage in reflective practice to address biases
- **Culturally responsive teaching** was the most reported topical focus of professional learning among respondents
- **Most teachers report adapting curricula** to make it more culturally responsive for their students

# Observation tool A

- **CRMT practices:** Space to take open-ended notes on three levels of practice for each CRMT domain (teacher-led, teacher-facilitated, student-led).
- **Classroom procedures, organization, and resources:** Checklist to record occurrence and space for how they advanced student learning
- **Relational interactions:** The desired relational interactions observed and their distribution across students

# Observation tool B

- **CRMT practices:** Definition of practices in each domain with space to record when and how the practices were observed and additional opportunities to incorporate them
- **Classroom procedures, organization, and resources:** Checklist to record occurrence and space for low-inference notes on their use
- **Relational interactions:** Space to record both positive and negative interactions that occurred during the lesson

# AMBITIOUS & INCLUSIVE MATH (AIM) CLASSROOM OBSERVATION WORKSHEET: OPTION A

| **Teacher name:**<br>**Observer name:** | **Grade:**<br>**Class:** | **Unit/lesson:**<br>**Learning standard:** | **Which practices does the teacher intend to implement during this lesson?** |
|---|---|---|---|

## Part 1: AIM practices

| **Practice** | **Level 1: Teacher-led**<br>*Teachers demonstrate the practices and/or behaviors in this domain.* | **Level 2: Teacher-facilitated**<br>*Teachers engage students in tasks that promote use of the practices and behaviors.* | **Level 3: Student-led**<br>*Students independently use the practices and behaviors as they explore, solve and develop a shared understanding of mathematics and make sense of mathematical tasks.* |
|---|---|---|---|
| **Real-world mathematical inquiry and problem solving**<br>Engage in real-world inquiry and problem solving using authentic data or information. | *In each cell, take note of examples of when and how the teacher and the students partook in each practice.* | | |
| **Multiple representations of mathematics**<br>Explore multiple representations of mathematical concepts and alternative solutions to problems. | | | |
| **Mathematical discourse**<br>Discuss mathematics in meaningful and rigorous ways (such as debating or critiquing ideas or solution strategies, using mathematics terminology, developing explanations, communicating reasoning, and making generalizations). | | | |
| **Multilingual learner support and scaffolding**<br>Develop math content knowledge and competencies as a multilingual learner. | | | |
| **Engaged student and community funds of knowledge**<br>Draw on students' cultural and community funds of knowledge as a learning asset. | | | |
| **Interdisciplinary connections**<br>Make interdisciplinary connections. | | | |
| **Empowered mathematical inquiry and decision making**<br>Explore social justice issues of relevance to students using math as a tool. | | | |

## Part 2: Classroom procedures, organization, and resources

| | | |
|---|---|---|
| What types of **performance tasks** did students complete during this lesson? *(check all that apply)* | ❑ Memorize or recall<br>❑ Perform procedures<br>❑ Demonstrate understanding<br>❑ Conjecture, generalize, or prove<br>❑ Solve non-routine problems or making connections | *How did these tasks advance or support student learning?* |
| What **classroom procedures** did the teacher engage in throughout the lesson? *(check all that apply)* | ❑ Giving instructions and/or clarifying instructions<br>❑ Handing out or collecting materials<br>❑ Establishing or reinforcing classroom norms<br>❑ Redirecting or addressing student behavior<br>❑ Lecturing or demonstrating<br>❑ Initiation-Response-Evaluation (IRE) questioning | *What was the impact of these procedures on student learning?* |
| What **grouping strategies** did the teacher use throughout the lesson? *(check all that apply)* | ❑ Whole class<br>❑ Small group<br>❑ Pair<br>❑ Individual | *When and how did the teacher deploy grouping strategies? What was the impact on student learning?* |

## Part 3: Relational interactions

| **Relational interaction** | | **A small number of students** | **About half of the students** | **Most or all of the students** |
|---|---|---|---|---|
| **Setting the emotional tone** | Teacher sets ***positive*** expectations for the classroom culture/climate by **preempting behavioral issues with compassion and empathy** or creating a safe emotional space for students. | | | |
| **Framing mathematics ability** | Teacher makes a comment that ***positively*** **frames** one or more students' **general capabilities in mathematics** or ability to complete an upcoming math task. Instances must include broad statements rather than a specific assessment of a contribution during the lesson. | | | |
| **Valuing math persistence and a growth mindset** | Teacher encourages students to work through cognitively demanding tasks by ***praising*** **mistakes as opportunities to learn or encouraging productive struggle.** | | | |
| **Giving Affirming Feedback** | Teacher gives a student **positive, supportive, or constructive** feedback on their math-related work or contributions--**but does not elaborate or explore as to why the work is good.** | | | |
| **Interpersonal connection** | Teacher forges or reinforces a **personal or relational connection** with one or more students via a shared interest, expressing curiosity or appreciation for a student's interest, or engaging with a student in their home language. | | | |
| **Addressing student behavior** | TEACHER **praises** student(s) positive non-math-related or on-task behavior. | | | |

# AMBITIOUS & INCLUSIVE MATH (AIM) CLASSROOM OBSERVATION WORKSHEET: OPTION A

# AMBITIOUS & INCLUSIVE MATH (AIM) CLASSROOM OBSERVATION WORKSHEET: OPTION B

| | | | |
|---|---|---|---|
| **Teacher name:**<br>**Observer name:** | **Grade:**<br>**Class:** | **Unit/lesson:**<br>**Learning standard:** | **Which practices does the teacher intend to implement during this lesson?** |

## Part 1: AIM practices

| Practice | Description | When or how did you observe this practice? | What additional opportunities to include this practice did you notice during the lesson? |
|---|---|---|---|
| **Real-world mathematical inquiry and problem solving** | • Teacher poses a mathematical question, problem, or task with explicit real-world implications.<br>• Teacher poses a mathematical question, problem, or task that requires applying real-world data or information to solve. | | |
| **Multiple representations of mathematics** | Teacher encourages students to share, discuss or demonstrate<br>• their reasoning and sense making about different symbolic, textual, or graphical representations of mathematical concepts or relationships<br>• connections or relationships of the mathematical concepts, procedures or tasks at hand with other mathematical ideas (e.g., presented in a different lesson)<br>• alternative solution paths. | | |
| **Mathematical discourse** | Teacher probes or asks purposeful questions, or provides instructions to engage more than one student to<br>• evaluate or compare each others' representations, solutions, approaches, or arguments,<br>• debate math ideas and strategies<br>• co-construct strategies or explanations in response to a mathematical task. | | |
| **Multilingual learner support and scaffolding** | • Teacher uses an English language scaffolding strategy or provides translation support to make a math-related conversation or task more accessible. | | |
| **Engaged student and community funds of knowledge** | • Teacher connects or employs students' community, cultural or linguistic knowledge that is specific to their individual lived experience or local context with a math-related discussion or task. | | |

| | | | |
|---|---|---|---|
| **Interdisciplinary connections** | • Teacher explicitly connects a math-related discussion or task to another academic discipline or content area (e.g., science, social studies, art) as a tool to broaden students' understanding and application of a mathematical fact, concept, or procedure beyond the lesson. | | |
| **Empowered mathematical inquiry and decision making** | • Teacher poses a question, initiates a discussion, or assigns an instructional task that requires students to use math to investigate or critique a societal challenge or a social justice issue of direct relevance to them or of their own choosing. | | |

## Part 2: Classroom procedures, organization, and resources

| | **Check all that apply** | **Low-inference notes on where, when, how, and for whom these practices were used.** |
|---|---|---|
| What types of **performance tasks** did students complete during this lesson? *(check all that apply)* | ❑ Memorize or recall<br>❑ Perform procedures<br>❑ Demonstrate understanding<br>❑ Conjecture, generalize, or prove<br>❑ Solve non-routine problems or making connections | |
| What **classroom procedures** did the teacher engage in throughout the lesson? *(check all that apply)* | ❑ Giving instructions and/or clarifying instructions<br>❑ Handing out or collecting materials<br>❑ Establishing or reinforcing classroom norms<br>❑ Redirecting or addressing student behavior<br>❑ Lecturing or demonstrating<br>❑ Initiation-Response-Evaluation (IRE) questioning | |
| What **grouping strategies** did the teacher use throughout the lesson? *(check all that apply)* | ❑ Whole class<br>❑ Small group<br>❑ Pair<br>❑ Individual | |

## Part 3: Relational interactions

| | | |
|---|---|---|
| **Setting the emotional tone** | TEACHER sets ***positive*** expectations for the classroom culture/climate by **preempting behavioral issues with compassion and empathy** or creating a safe emotional space for students. | TEACHER sets ***negative*** expectations for the classroom culture/climate by **preempting behavioral issues** with threats, warnings or other **statements of *negative* consequences**. |
| | *Notes:* | |
| **Framing mathematics ability** | TEACHER makes a comment that ***positively* frames** one or more students' **general capabilities in mathematics** or ability to complete an upcoming math task. Instances must include broad statements rather than a specific assessment of a contribution during the lesson. | TEACHER makes a comment that ***negatively* frames** one or more students' **general capabilities in mathematics** or ability to complete an upcoming math task. Instances must include broad statements rather than a specific assessment of a contribution during the lesson. |
| | *Notes:* | |
| **Valuing math persistence and a growth mindset** | TEACHER encourages students to work through cognitively demanding tasks by ***praising* confusion and mistakes or encouraging productive struggle.** | TEACHER discourages working through cognitively demanding tasks by ***reprimanding or ridiculing* struggle, confusion, and mistakes**. |
| | *Notes:* | |
| **Giving Affirming Feedback** | Teacher gives a student **positive, supportive, or constructive** feedback on their math-related work or contributions--**but does not elaborate or explore as to why the work is good.** | Teacher gives a student **negative, unconstructive, or unsupportive** feedback on their math-related work or contributions--**but does not explain why the work is poor**. |
| | *Notes:* | |
| **Interpersonal connection** | Teacher forges or reinforces a **personal or relational connection** with one or more students via a shared interest, expressing curiosity or appreciation for a student's interest, or engaging with a student in their home language. | TEACHER makes an instructional decision that **could be perceived as unrelatable, problematic, or inappropriate by one or more students** in the classroom. |
| | *Notes:* | |
| **Addressing student behavior** | TEACHER praises student(s) ***positive* non math-related or on-task** behavior**.** | TEACHER redirects or reprimands student(s) ***negative, noncompliant, or off-task*** non-math student behavior. |
| | *Notes:* | |