Critical Conditions for Students' and Teachers' Learning: Identifying High-Quality Teaching and Teacher Education Practices

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Agenda

1. Investigating what it takes to improve mathematics teaching and learning at scale
   - Share background information on the MIST Project
2. Focus on the importance of specifying in sufficient detail:
   - Ambitious, conceptually-oriented student learning goals
   - High-quality teaching practices
3. A coherent system of supports for teachers' learning:
   - High-quality instructional materials
   - High-quality teacher education practices

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Background: US Educational System

Decentralized education system

- Local control of schooling

Each US state divided into a number of independent school *districts*

- Rural districts with less than 1,000 students
- Urban districts with 100,000 students or more

State standards and assessments

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US Context: Ambitious and Equitable Teaching Practices

Major change in student learning goals:

- Conceptual understanding and procedural fluency
- Problem solving
- Mathematical communication

Implication: Significant change in what counts as high-quality teaching

- Ambitious and equitable teaching practices

Implication: Substantial teacher learning

- Teachers require sustained support

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Partnering to Improve Mathematics Teaching & Learning at Scale

MIST Project

2007-2011: 4 large urban districts – 360,000 students

2011-2015: 2 large urban districts – 180,000 students

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Partner Districts

- Districts aimed to support teachers' development of ambitious and equitable teaching practices
- Add value to districts' improvement efforts
  - Interventionist study
  - Yearly reports that specified how each district could adjust its improvement strategies
  - 162 specific recommendations – district leaders acted on about 2/3 of these recommendations
    - Evidence-based

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Participants

- 6-10 schools - 30 **middle-grades** mathematics teachers in each district - students 12-14 years old
- Mathematics coaches
- School leaders
  - Principals, assistant principals
- District leaders
  - Across five central office units that have a stake in mathematics teaching and learning

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Longitudinal Data Set

- **Audio-recorded interviews** with focal teachers, coaches, school and district leaders (n = 1,700 interviews)
- **Surveys** of focal teachers, coaches, school leaders (n = 1,600 surveys)
- **Video-recordings of lessons** of focal teachers (n = 1,920 lessons)
- **Mathematical Knowledge for Teaching Assessment** of focal teachers and coaches (n = 360 assessments)
- **Survey of *all* teachers' advice networks**, starting in Year 3; ~ 300 teachers per year, years 3 - 8
- **Audio- and/or video-recordings of professional development** (e.g., teacher collaborative meetings, district-wide PD)
- **Student achievement data** for each of the focal teachers, each year

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Research Team

PI and co-PIs:

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- Kara Jackson (University of Washington)
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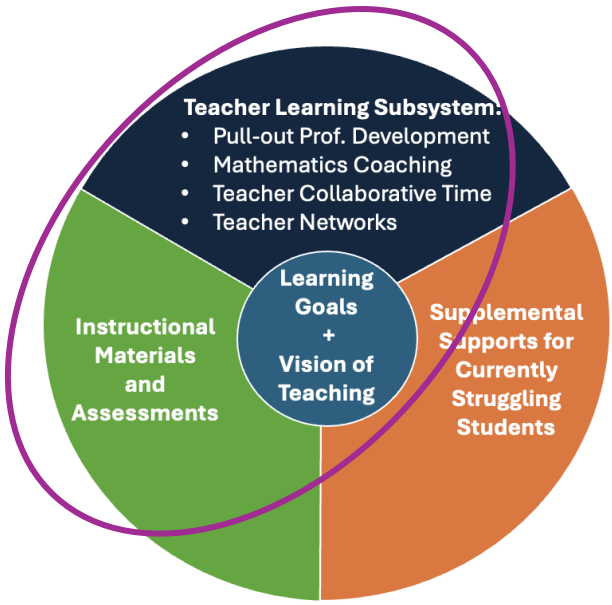
Critical Conditions for Improving Mathematics Teaching and Learning at Scale

- A **coherent instructional system** at the school level, to enable high-quality, equitable mathematics teaching and learning



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Critical Conditions for Improving Mathematics Teaching and Learning at Scale

- Ambitious mathematical learning goals for students

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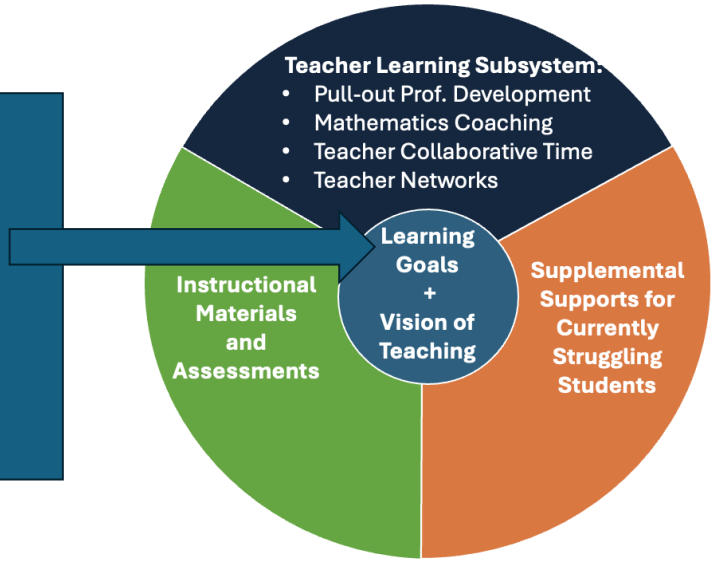
- Vision of ambitious and equitable mathematics teaching
  - Evidence-based
  - Sufficiently detailed



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Ambitious, Domain-Specific Learning Goals for Students

- Develop procedural fluency and conceptual understanding of key mathematical ideas in a range of domains
- Make sense of problem situations, know *why* particular solution strategies make sense in certain situations
- Develop the ability to communicate effectively about mathematics

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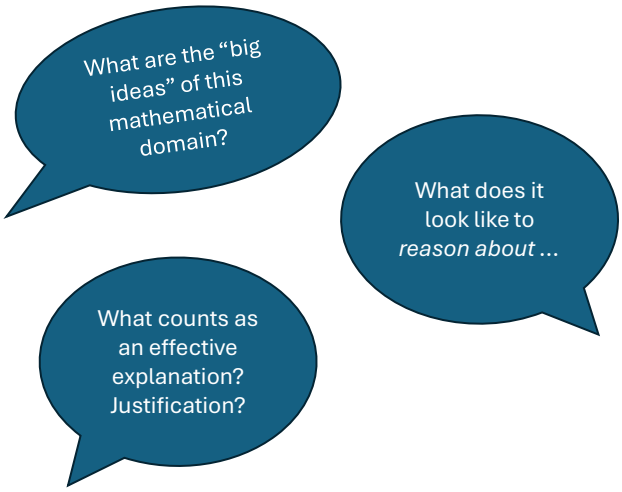
Ambitious, Domain-Specific Learning Goals for Students



Support students' development of specific ways of reasoning and communicating

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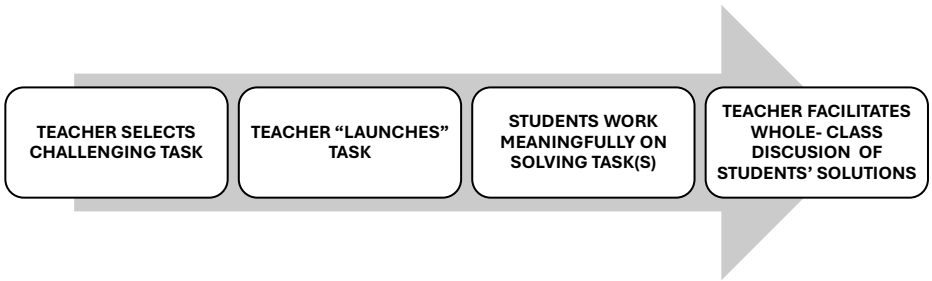
Vision of Ambitious and Equitable Mathematics Teaching



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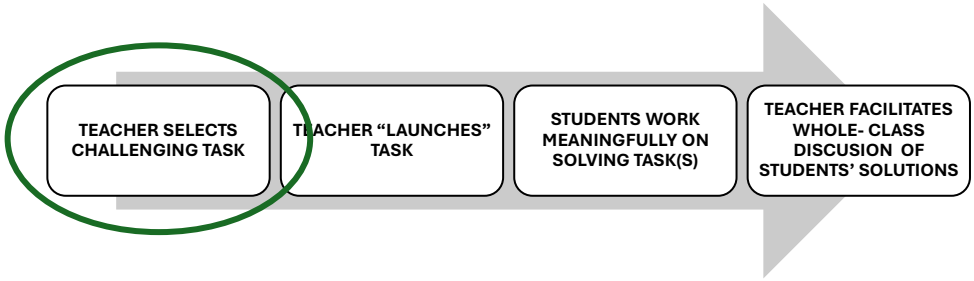
Vision of Ambitious and Equitable Mathematics Teaching



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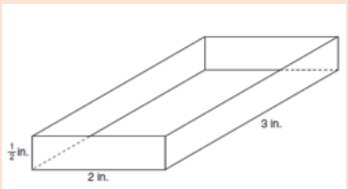
Routine Task

(A) Mr. Muñoz drew a box in the shape of a rectangular prism, as shown below. What is the volume of the box?



- Students have to apply a procedure to solve a task
- Little ambiguity as to what to do

Challenging Task

(B) An 80-gallon bathtub is being filled at a rate of 15 gallons every 2 minutes. At this rate, how many minutes will it take to fill this bathtub ¾ full?

- Students have to analyze the problem in order to figure out a strategy to use
- Students have to explain why their strategy makes sense

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Critical Shift in the Purpose of Implementing Tasks

Enable students to solve specific types of tasks

“What do students need to do solve this task?”

Support students’ development of specific ways of reasoning and communicating

“What significant mathematics can students learn by working on this task?”

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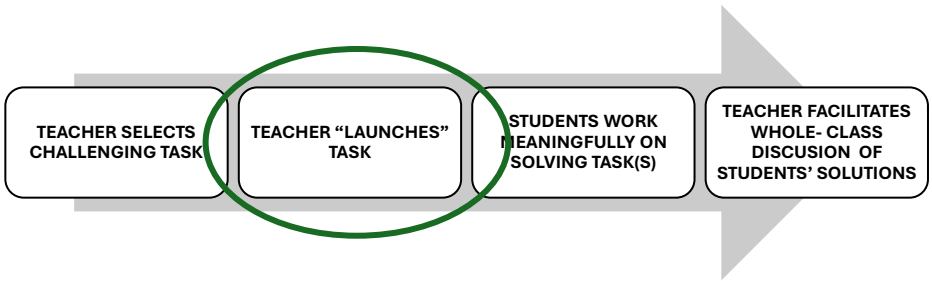
Vision of Ambitious and Equitable Mathematics Teaching



Introduce or launch tasks

- All students can imagine what is happening in the task situation
- All students understand what the problem is asking
- Maintain the level of challenge

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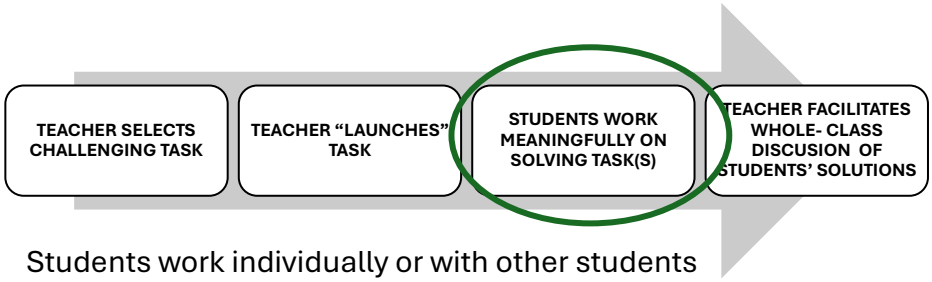
Vision of Ambitious and Equitable Mathematics Teaching



Students work individually or with other students

- Norms and routines have been established such that …
  - Students see value in sharing tentative and exploratory ideas with one another
  - Students ask each other to explain their reasoning
- Teacher monitors how students are attempting to solve task(s) in order to plan for the whole-class discussion

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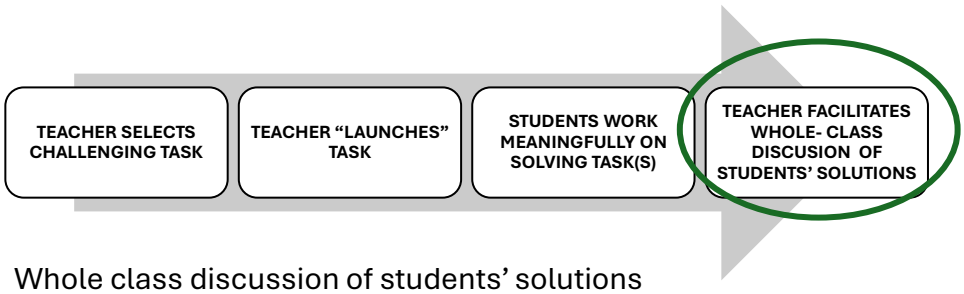
Vision of Ambitious and Equitable Mathematics Teaching



Whole class discussion of students' solutions

- Teacher presses students to
  - explain and justify their reasoning
  - make connections between different solution strategies
- Teacher ensures that key mathematical ideas are the focus of discussion

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Critical Conditions for Improving Mathematics Teaching and Learning at Scale

- Ambitious mathematical learning goals for students

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- Vision of ambitious and equitable mathematics teaching
  - Evidence-based
  - Sufficiently detailed

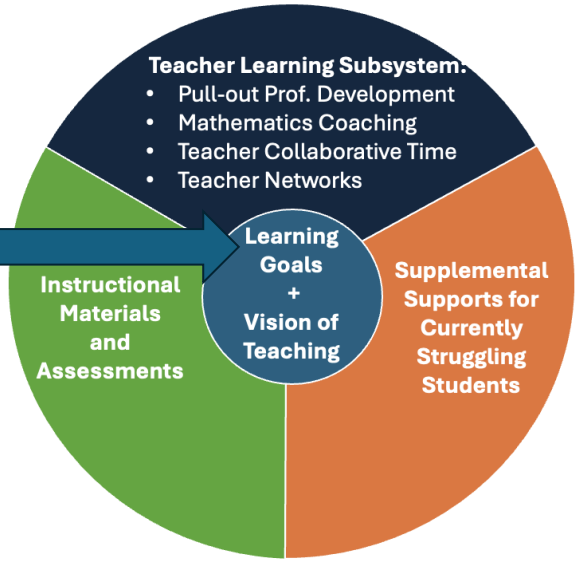

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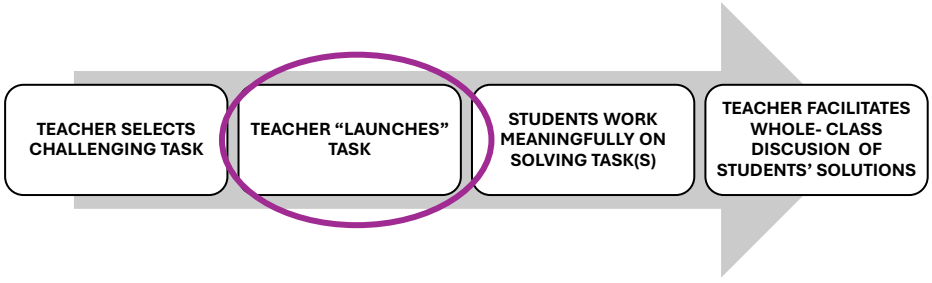
Illustration of what we mean by a *sufficiently detailed, evidence-based vision of high-quality mathematics teaching:* **Launching challenging tasks**



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Why the Launch Matters

- Data Source: Video-recordings of two consecutive days of classroom teaching, 40 lessons, year 1
  - Teachers conducted a problem-solving lesson, with a concluding whole-class discussion
- Impacts the work of students
  - Engaging in solving the task meaningfully
  - Participating in and learning from the concluding whole-class discussion
- Impacts the work of teachers
  - Planning for the concluding whole-class discussion

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Planning for and Analyzing the Launch of a Task

bit.ly/ImproveMath
"2a. Elem - Monkeys Tree Task"
"2b. Sec – Dollars Dancing Task"

Choose a task to focus on.

- Elementary: Five Monkeys in Two Trees Task
- Secondary: Dollars for Dancing Task

With 1-2 colleagues:

(1) Anticipate at least 2-3 ways students might approach/ solve the task, given the long-term learning goal.

(2) Discuss: What would students need to understand in order to begin to work meaningfully on this task?

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Elementary Task

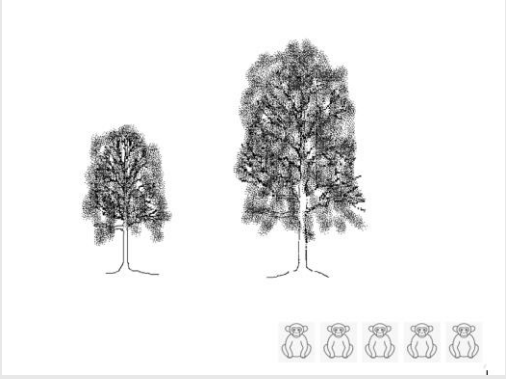
Students: Grade 1 (6-7 years old)

Long-term learning goal: Flexible partitioning of small quantities (e.g., five as four and one, three and two, etc.)

Task: Five Monkeys in Two Trees

What are all the different ways that five monkeys could be in the two trees?

How do you know that you found all of the ways?



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Secondary Task

Students: Grade 7 (12-13 year olds)

Long-term learning goal: Investigate and compare linear relationships (rate of change, initial value), using equations, tables, and graphs as tools

**This is the students' first encounter with a linear relationship with nonzero y-intercepts.*

Task: Dollars for Dancing

Three students at a school are raising dollars for the school's Valentines Dance. All three decide to raise their money by having a dance marathon in the cafeteria the week before the real dance. They will collect pledges for the number of hours that they dance, and then they will give the money to the student council to get a good DJ for the Valentines Dance.

- Rosalba's plan is to ask teachers to pledge $3 per hour that she dances.
- Nathan's plan is to ask teachers to give $5 plus $1 for every hour he dances.
- James's plan is to ask teachers to give $8 plus $0.50 for every hour he dances.

Part A. Create at least three different ways to show how to compare the amounts of money that the students can earn from their plans if they each get one teacher to pledge.

Part B. Explain how the hourly pledge amount is represented in each of your ways from Part A.

Part C. For each of your ways in Part A explain how the fixed amount in Nathan's plan and in James's plans is represented.

Part D. For each of the ways in Part A show how you could find the amount of money collected by each student if they could dance for 24 hours.

Part E. Who has the best plan? Justify your answer.

Adapted from *Connected Mathematics Project 2* (Lappan et al., 2009)

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Launching the task: What is the teacher doing to enable all students to meaningfully start on solving the task?

- Read the transcript of how the teacher launched the task.
  - Elementary: Five Monkeys in Two Trees Task
  - Secondary: Dollars for Dancing Task
- Make notes for yourself: **What is the teacher doing to enable all students to begin to work meaningfully on the task?**
- Discuss with a partner.

bit.ly/ImproveMath
"3a. Launch – Elem-Monkey Trees Task"
"3b. Launch – Sec-Dollars Dancing Task"

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"Sufficiently Detailed": Four Aspects of High-Quality Launches

1. Ensure students are familiar with key **contextual features** of scenario.
   - *monkeys, they play in trees*
   - *dance marathons*
2. Support students to **imagine what is happening in the task situation** (what is being **mathematized**).
   - *different ways that five monkeys can be distributed among two trees (part-part-whole)*
   - *different ways of accumulating money over time: starting with a fixed amount and/or earning a fixed amount per every hour of dancing*
3. Support students to **develop common language** to describe key aspects.
4. Maintain the challenge of the task (i.e., **do not suggest a solution strategy**).

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Research Evidence that the Launch Matters for Students' Learning Opportunities

- Data Source: Video-recordings of two consecutive days of classroom instruction
- Sample: 165 teachers across 4 districts, 460 lessons, Years 3 & 4
- Coded
  - level of challenge of the task – both before and during the lesson
  - quality of the launch (4 aspects)
  - quality of the concluding whole-class discussion

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Research Evidence that the Launch Matters for Students' Learning Opportunities

- The quality of the launch was positively related to students' learning opportunities in the concluding whole-class discussion.
- However, teachers lowered the challenge of the task in about 2/3 of the lessons we observed.

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Stepping Back: Specifying Ambitious Learning Goals + Vision of Teaching

- Evidence-based
  - empirical evidence that enacting the practice makes a real difference in students' learning opportunities
- Sufficiently detailed
  - description of a teaching practice attends explicitly to aspects that are consequential for students' learning
    - → learnable in the context of professional development

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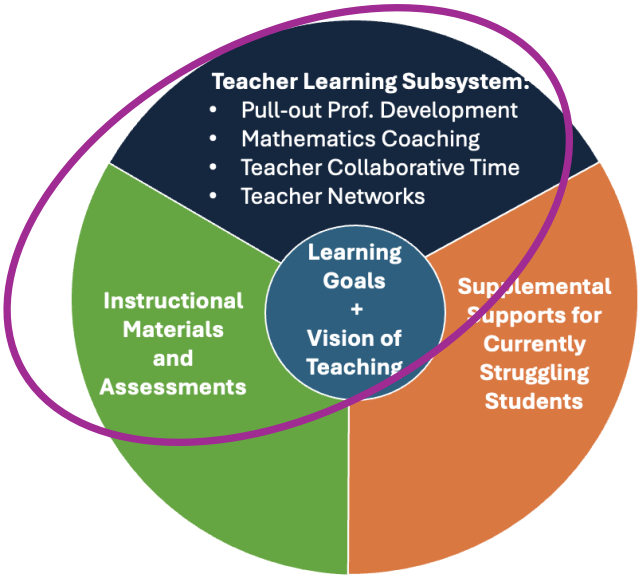
Critical Conditions for Improving Mathematics Teaching and Learning at Scale

High-quality supports for teachers' ongoing improvements of their teaching



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High-Quality Instructional Materials

- Coherent sequences of lessons that target ambitious student learning goals
- Multiple entry points
- Range of student solution strategies
  - Enable teachers to lead discussions that focus of significant mathematical ideas
- Necessary, but not sufficient

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Sustained Opportunities to Work with an Accomplished Colleague

- Developing complex practices (e.g., teaching)
- Working **closely** with someone who is **already accomplished in the intended forms of practice**
- Professional learning leaders (PLLs):
  - Design and lead sequences of PD sessions
  - Facilitate school-based mathematics teacher collaborative meetings
  - Work one-on-one with mathematics teachers in their classrooms

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Professional Learning Leaders (PLLs)

- What knowledge, skills, and capabilities do PLLs need to support teachers' development of ambitious and equitable instructional practices?
- What knowledge, skills, and capabilities would you look for if you were hiring a PLL for your school?

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Professional Learning Leaders (PLLs)

- Accomplished teachers
  - Developed ambitious and equitable teaching practices
- Deep mathematical knowledge for teaching
- Social/interpersonal skills
  - Establish relationships grounded in trust with teachers

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Mathematics Coaching

- Research-practice partnership with a large urban school district
  - 100,000 students
  - Worked closely with the Director of Mathematics and three lead mathematics coaches
- Sequence of eight coach PD sessions across a school year – monthly – two hours long
  - 15 mathematics coaches
    - Middle grades – 12-to-14 years old students

Dr. Nicholas Kochmanski
University of North Carolina, Greensboro

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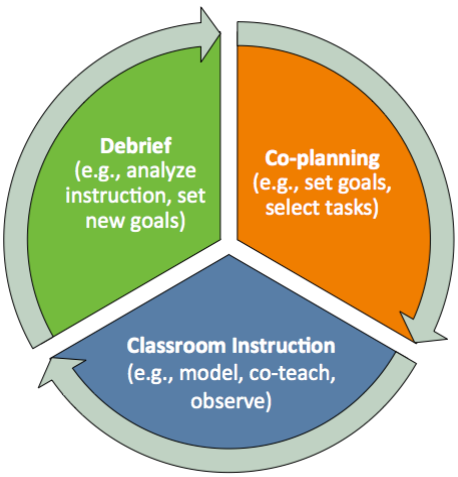
One-on-One Coaching Cycles



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First and Second Coach PD Sessions

- First session: overview of the one-on-one coaching cycle
- Second session: Identifying *productive* goals for individual teachers' learning
  - Two criteria:
    - Making the change will likely enhance students' learning *immediately*
    - Feasible – the teacher can actually make the identified change
- An unexpected challenge

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Second Coach PD Session: The Focal Case

What do you think would be an appropriate improvement goal for this teacher?

- Teacher selected a task that would be challenging for her students:
  - Figure out the volume of this rectangular prism

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Second Coach PD Session: The Focal Case

(1) Read how the teacher launched the task.

(2) With 1-2 colleagues, anticipate how the students worked on the task, given this launch.
What do you think the students did?

bit.ly/ImproveMath
"4a. Rectangular Prism Task - Launch"

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Second Coach PD Session: The Focal Case

(3) Look at the handout with students' solutions.

With 1-2 colleagues, discuss: Which of these solutions would you focus on in the whole-class discussion to further their understanding of volume?

bit.ly/ImproveMath
"4b. Rectangular Prism Task – Student Work"

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Identifying Productive Teacher Learning Goals: The Focal Case

- Conditions for productive whole class discussions
  - All students were able to work meaningfully on the task(s)
  - Students have used a range of different solution strategies
- Implicates the level of challenge of tasks, the launch, and norms for small group work

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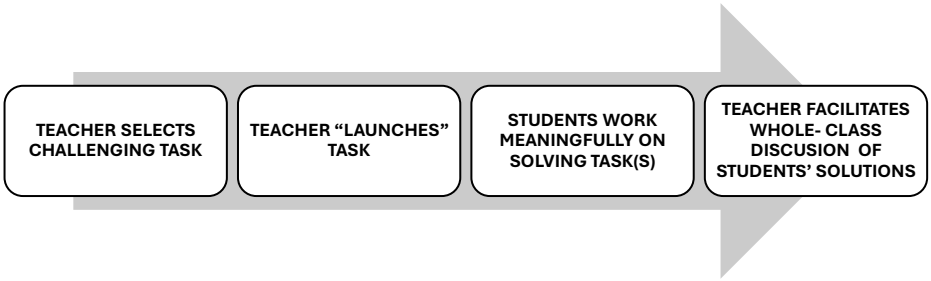
Identifying Productive Teacher Learning Goals



Identifying where student learning opportunities first break down in the focal lesson

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Investigating High-Quality Coaching

How can mathematics coaches identify *productive* goals for individual teachers' improvement of their teaching (and thus their students' learning)?

- Video-recorded all 8 PD sessions
- 7 focal coaches:
  - Documented the coaching cycles they conducted across the school year
  - Complete data on 28 coaching cycles

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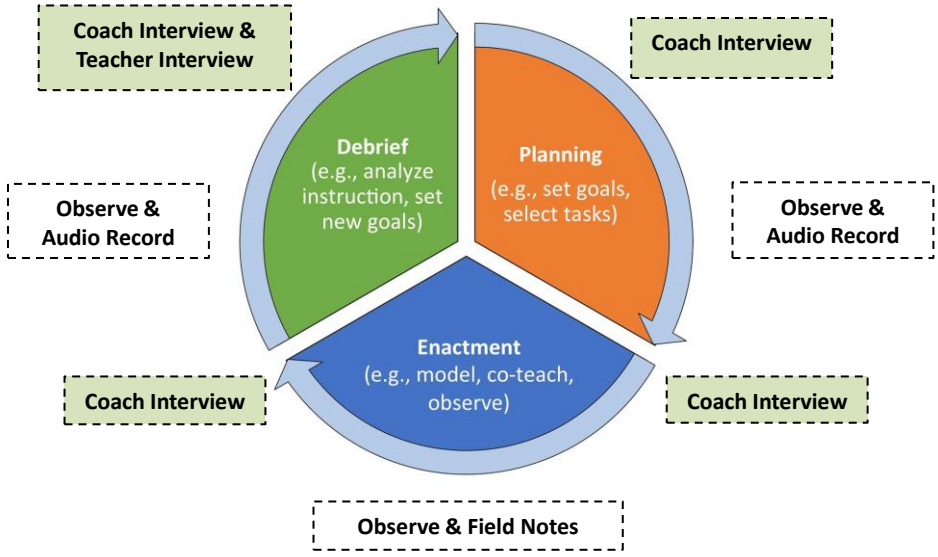
Data Collection: Focal Coaches



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Data Analysis: Identifying Productive Goals

- For each of the 28 coaching cycles with complete data:
  - Determined how the coach identified an improvement goal for the partner teacher
    - Interviews with coaches in which they identified goals
  - Determined whether the improvement goal was productive
    - Analyzed structured field notes of lessons to identify productive improvement goals

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Findings: Identifying Productive Goals

- Three approaches for identifying improvement goals:
- Based on
  - school/district priorities or the teacher's preferences
  - coach's analysis of the lesson – focused only on teacher's instruction
  - coach's analysis of the lesson – linked teacher's instruction to students' learning
    - Identified where students' learning opportunities broke down

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Findings: Identifying Productive Goals

	Approach		
Result	District's priorities or Teacher's preferences	Focus *only* on teacher's instruction	Link teacher's instruction and students' learning
Productive Goal	0	0	14
Unproductive Goal	4	10	0

Essential for coaches to link instruction and students' learning when analyzing lessons

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Significance of the Findings

- Coaches typically identify improvement goals based on
  - Teacher's preferences or district's priority
  - Analysis of the lesson – focused only on teacher's instruction
- Investment in coaching is not paying off in terms of improved student learning

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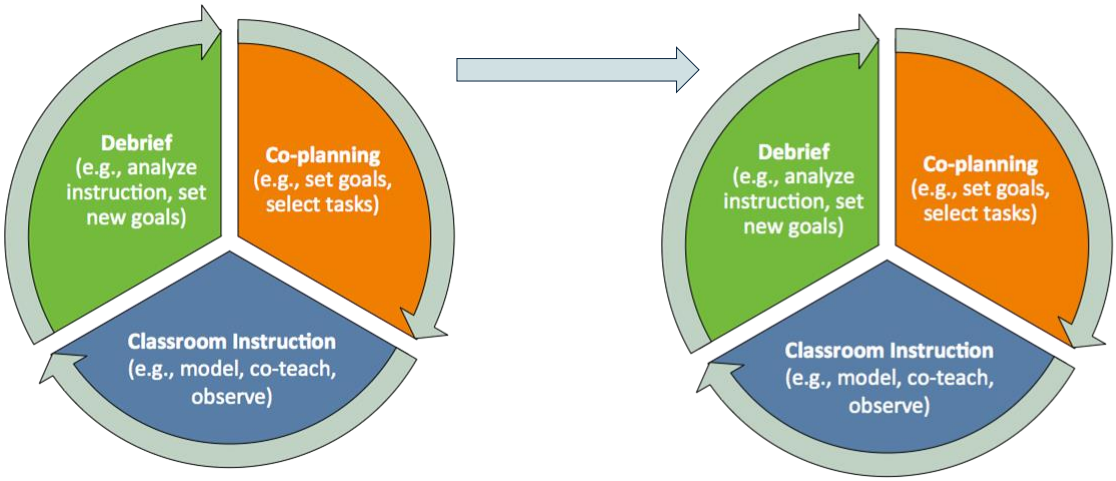
Implications for Coaching Practice: Productive Debriefing Meetings



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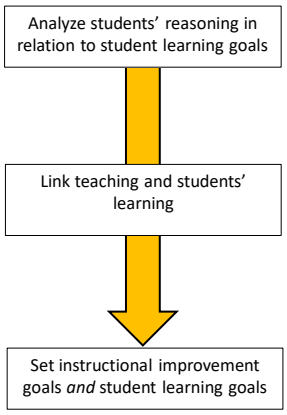
Implications for Coaching Practice: Productive Debriefing Meetings



- Understand what students actually learned in the lesson
- Understand the extent to which students made progress toward student learning goals

- Understand how teaching influenced students' learning
- Explain *why* students learned what they learned

- Determine what went well in the lesson and what the teacher might work to improve
- Discuss improvement goals

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Negotiating Productive Improvement Goals

- How can mathematics coaches *negotiate* productive instructional improvement goals with teachers?
  - Teacher has a voice in the decision
  - Teacher and coach agree on a *productive* goal
  - Teacher considers this productive goal to be worthwhile

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Findings: Negotiating Productive Goals

- 14 cycles in which the coach identified a *productive* goal
- 4 cycles in which the coach and teacher agreed to a goals with minimal negotiation
- 10 cycles in which the teacher proposed an *unproductive* goal
  - 7 successful negotiations, 3 unsuccessful

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Unsuccessful Negotiations

- **Coach**: Elicits the improvement goal the teacher wants to work on
- **Teacher**: Proposes an unproductive improvement goal
- **Coach**: Proposes an alternative productive improvement goal

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Successful Negotiations

- **Coach**: Asks the teacher what s/he wants to work on
- **Teacher**: Proposes an unproductive improvement goal
- **Coach**: Asks the teacher for her rationale – why?
- **Teacher**: Justifies the improvement goal in terms of a *desired student development*
- **Coach**: *1)* Agrees that this *student development* is important
  2) proposes an alternate instructional change to support this development

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Stepping Back: What Coaches Need to Know and Be Able to Do

- Identify productive improvement goals
- Conduct productive debriefing conversations
  - Negotiate productive improvement goals
- Evidence-based + Sufficiently detailed:
  - Differences that make a difference for students' mathematical learning
  - Learnable coaching practices

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Stepping Back: What PLLs Need to Know and Be Able to Do

- Relevance of findings is not limited to coaching:
  - Teacher collaborative meetings
  - Teacher professional development sessions – lesson study
- Expertise of PLLs is critical if teachers are to develop ambitious and equitable instructional practices
- Essential that school systems dedicate significant resources to "growing" a cadre of accomplished PLLs

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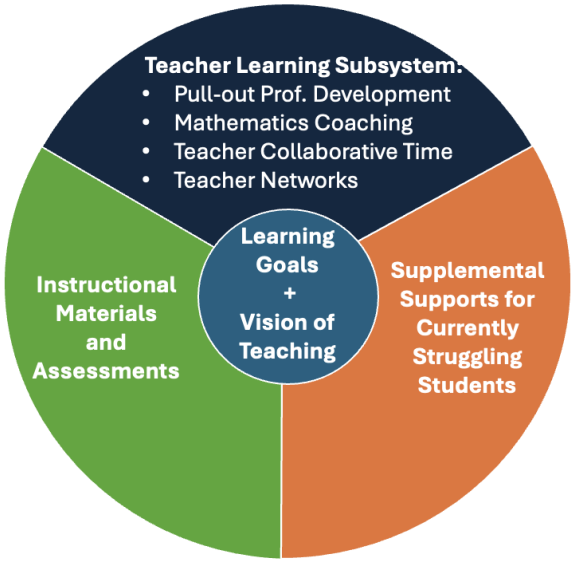
Critical Conditions for Improving Mathematics Teaching and Learning at Scale

- A **coherent instructional system** at the school level, to enable high-quality, equitable mathematics teaching and learning
- Implications for **system leaders**
  - Supporting the development of school- wide capacity for instructional improvement



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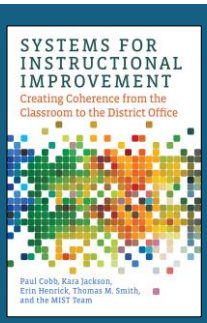

Thank you!

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Middle-School Mathematics & the Institutional Setting of Teaching
https://peabody.vanderbilt.edu/academics/departments/teaching-learning/mist/

Practical Measures, Routines, and Representations
https://www.pmr2.org

Link for resources from today's session: **https://bit.ly/ImproveMath**

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To access materials in Drive, type the following into your browser:
bit.ly/ImproveMath

(There are also paper copies of select handouts.)

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Characteristics of a Profession

Specialized knowledge
Professionals have a unique body of specialized knowledge that's often theoretical.

Code of ethics
Professionals have a code of ethics that outlines the minimum standards of conduct they are expected to follow.

Accountability
Professionals take responsibility for their actions, admit mistakes, and take steps to fix them.

Integrity
Professionals are honest, ethical, and keep their commitments.

Respect
Professionals treat everyone in the workplace with respect, including superiors, colleagues, and subordinates.

Organization
Professionals are organized and use their organization to define priorities, focus on tasks, and increase productivity

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