Investigating What It Takes to Improve Mathematics Teaching and Learning on a Large Scale

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Overview

Clarify the problem of improving mathematics teaching on large scale

Background to project

- Long-term *partnerships* with US school districts

Findings

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

Clarifying the Problem

Supporting the learning of groups of teachers

- Necessary, essential, critical
- But not sufficient

Influence of teacher professional development on classroom practice is mediated by *school and district contexts* in which teachers work

Clarifying the Problem

Challenge: (Re)organizing school and district contexts in which teachers' work to support their ongoing improvement of their instructional practices

Implicates:

- Practices of mathematics coaches, school leaders, and district leaders
- Tools they use
- Organizational routines

MIST Project

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

- Analyses to inform revision of district instructional improvement strategies

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

- Co-designed and co-leaded PD for principals and for mathematics coaches

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Partner Districts

Recruited districts that were responding to high-stakes accountability by:

- Aiming at rigorous goals for students' mathematical learning
  - Conceptual understanding of central mathematical ideas
  - Procedural *fluency*
- Attempting to improve the *quality* of instruction

Ambitious (Inquiry Oriented) Mathematics Instruction

- Challenging mathematical tasks
  - Students have to analyze tasks to figure out solution steps
- Introduce or launch tasks
  - All students can begin to work productively on tasks
  - Maintain the level of rigor
- Small group or individual work
- Whole class discussion of students' solutions
  - Teacher presses students to explain and justify their reasoning and to make connections between different solutions

Ambitious (Inquiry Oriented) Mathematics Instruction

Major change in instructional practice for most US mathematics teachers

- Rethink what is worth knowing mathematically, how students learn mathematics, and how that learning can be supported

Substantial teacher learning – requires sustained support

Participants

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

Data Collection: October

Interviewed district leaders to document their current strategies for improving **middle-grades** mathematics teaching and learning

- Member checked our conclusions

Data Collection: January

Audio-recorded interviews with the 200 participants

- The school and district settings in which the teachers and instructional leaders work
  - Sources of support
  - To whom and for what they are held accountable
  - Tools they used in their work

Data Collection: January - March

- On-line surveys for teachers, coaches, and school leaders
- Video-recordings of two consecutive lessons in the 120 participating teachers' classrooms
  - Coded using the *Instructional Quality Assessment* (IQA)
- Assessments of teachers' and coaches' *Mathematical Knowledge for Teaching* (MKT)

Data Collection: Data Collection: January - March

- Video-recordings of professional development sessions
- Audio/video-recordings of teacher collaborative meetings
- On-line assessment of teacher advice networks
  - All 300 mathematics teachers in the participating schools
- Access to district student achievement data

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Research Team

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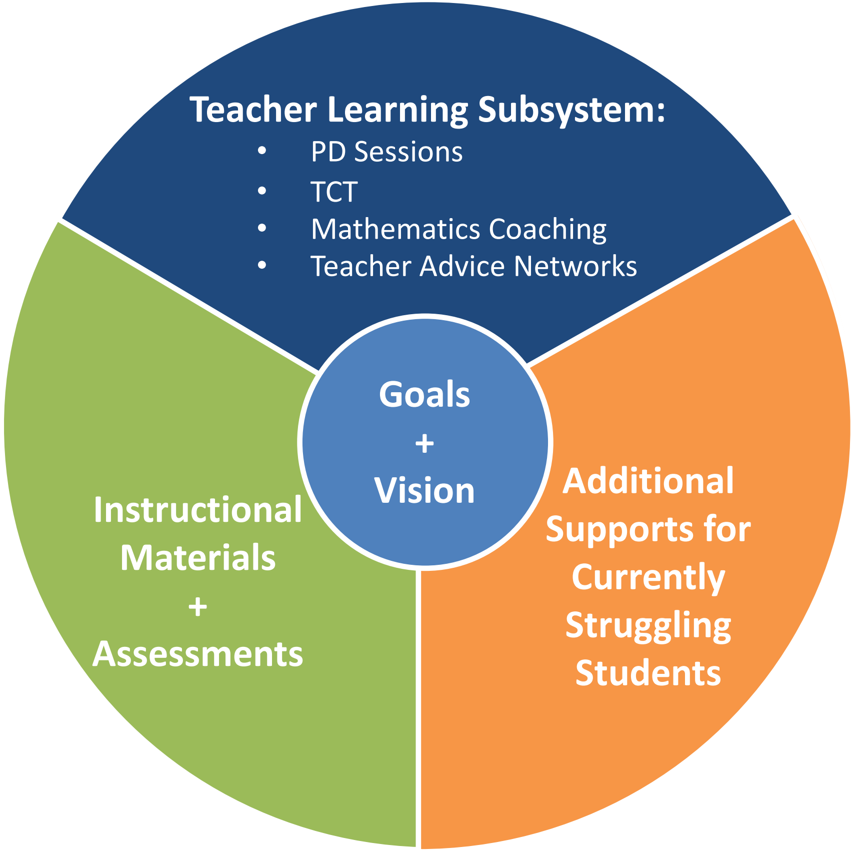
Coherent Instructional System



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Teachers' Knowledge, Perspectives, and Instructional Practices

- Instructional Quality Assessment (IQA)
  - Video-recordings of lessons
    - Assess the potential of the task(s)
    - Assess the quality of task implementation
  - Coding scheme:

Score	Description
4	Doing genuine mathematics: Exploring, justifying, explaining, generalizing, etc.
3	Using procedures with connections to underlying mathematical concepts
2	Using specified procedures
1	Memorizing or reproducing facts, rules, formulae, or definitions

Measures of Teachers' Knowledge and Perspectives

- *Mathematical Knowledge for Teaching (MKT)*
  - Multiple choice instrument
    - Mathematical knowledge that is specific to the practice of teaching

- *Vision of High-Quality Mathematics Instruction (VHQMI)*
  - Interviews
    - Nature of the tasks
    - Nature of whole class discussions
    - Role of the teacher

(Munter, 2014, 2015; Munter & Correnti, 2017)

Findings: Vision of High-Quality Mathematics Instruction

- Teachers' visions of high-quality mathematics instruction (VHQMI) improved in all 4 districts

- Instruction (IQA) of teachers who had higher VHQMI scores was more likely to improve

(Munter & Correnti, 2017)

- Teachers' VHQMI related to
  - Selecting cognitively demanding tasks
  - Maintaining level of challenge throughout lessons

(Wilhelm, 2014)

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Teachers' Perspectives on Their Students' Current Mathematical Capabilities (VSMC)

- Interviews
  - *Diagnostic dimension*: Explanations of the source of students' success or failure
  - *Prognostic dimension*: Descriptions of the supports provided to students perceived to be struggling

(Jackson, Gibbons, & Sharpe, 2017)

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Finding: Teachers' Perspectives on Students' Current Mathematical Capabilities

- Teachers' attributions of students' difficulties:
  - Less that 20% attributed students' difficulties primarily to limited instructional or schooling opportunities
  - Almost 30% attributed difficulties *solely* to deficits of students, their families, or their communities

- Less than 20% described making productive adjustments to their instruction

Finding: Teachers' Perspectives on Students' Current Mathematical Capabilities

- Controlling for Mathematical Knowledge for Teaching (MKT) and instructional vision (VHQMI), teachers with productive VSMC are more likely to:
  - Maintain the cognitive demand of tasks (IQA)
  - Conduct higher quality WC discussions in which students have opportunities to explain their reasoning (IQA)
    - Influenced by the racial, ethnic, and linguistic composition of the classes they taught

(Wilhelm, Munter, & Jackson, 2017)

Finding: Teachers' Perspectives on Students' Current Mathematical Capabilities

- Teachers' instruction unlikely to improve unless they have developed both:
  - Relatively sophisticated VHQMI
  - Productive VSMC

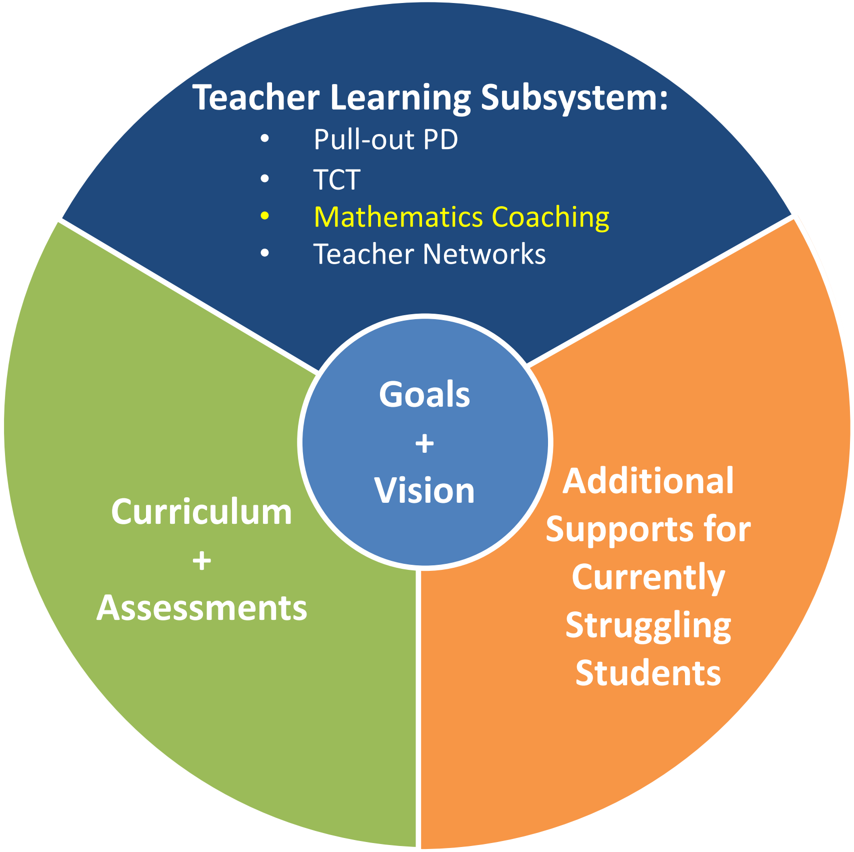
(Dunlap, 2016)

Stepping Back

- MKT clearly matters, but supporting the development of teachers' MKT is not sufficient

- It is also important to support teachers' development of sophisticated VHQMI and productive VSMC
  - Reason and motivation to work to improve the quality of their instruction
    - Level of challenge of tasks teacher select
    - Extent to which they maintain that level of challenge
    - Extent to which they elicit and build on their students' thinking

Coherent Instructional System



Mathematics Coaching

- *Rationale*: Coaches who have developed ambitious instructional practices can be more accomplished colleagues

- Co-participate with teachers in activities close to instructional practice
  - One-on-one in teachers' classroom
  - Teacher collaborative meetings

Working One-on-One with Teachers in their Classrooms

Modeling instruction

- Support teachers in developing a vision of specific instructional practices
- Support teachers in developing productive views of their students' current mathematical capabilities (VSMC)

Co-teaching

- Support teachers' initial enactment of specific instructional practices

Observing instruction and providing feedback

- Support teachers in improving their enactment of specific instructional practices

(Gibbons & Cobb, 2017; Kochmanksi & Cobb, in press)

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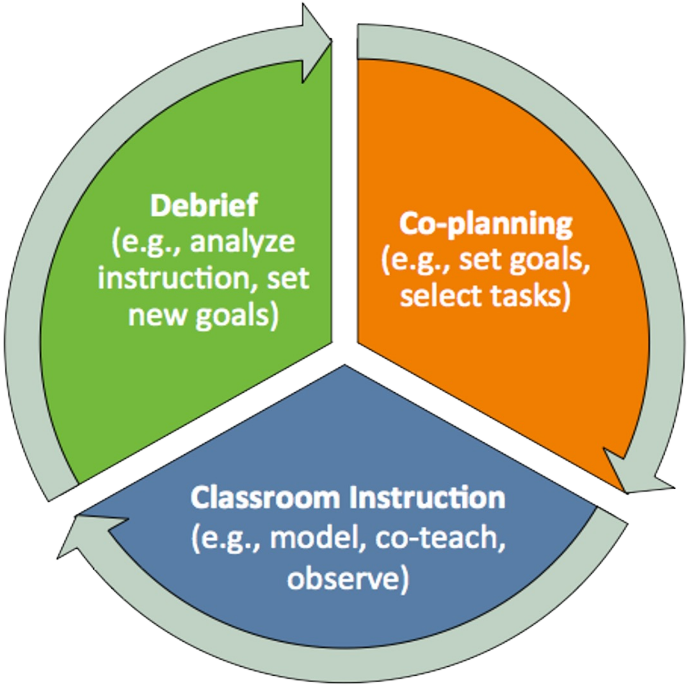
One-on-One Coaching Cycles



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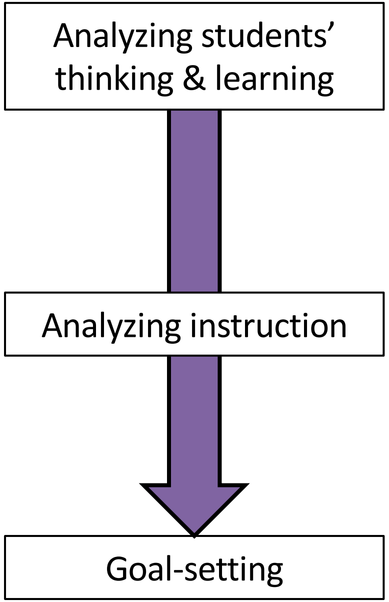
Productive Instructional Improvement Goals

- Feasible next step for a particular teacher
- Will likely result in *immediate improvement* in students' learning if attained

Effective Debrief Conversations



- What were our mathematical goals for the students' learning?
- What did students learn in this lesson?

- Why did the students learn what they did in the lesson?
- Why did instruction result in this learning?

- Did we make progress on our instructional improvement goal(s)?
- What additional improvements can we make to instruction?

Working with Groups of Teachers

- Engaging teachers in mathematics
  - Identify the big mathematical ideas in tasks/instructional units
  - Anticipate student solution strategies and how can build on them

- Analyzing student work
  - Analyze students' thinking and connect to instruction

- Analyzing classroom video
  - Analyze instruction and connect to student thinking

- Engaging in Lesson Study
  - Analogous to one-on-one coaching cycle

Teacher Collaborative Meetings

- Productive teacher collaborative groups connect:
  - Content – mathematical learning goals
  - Students' thinking
  - Instruction

(Horn, Kane, & Garner, 2018)

- Requires expert facilitation
  - *Negotiate* feasible instructional improvement goals with teachers
  - Select activities in light of those goals

Teacher Advice Networks

- Interactions with colleagues with more sophisticated instructional practices support the development of teachers' own instructional practices
  - The *quality* but not the amount of teacher collaborative time influences whether teachers seek advice from each other
  - Those advice-seeking relationships tend to last

(Horn, Garner, Chen, & Frank, 2020)

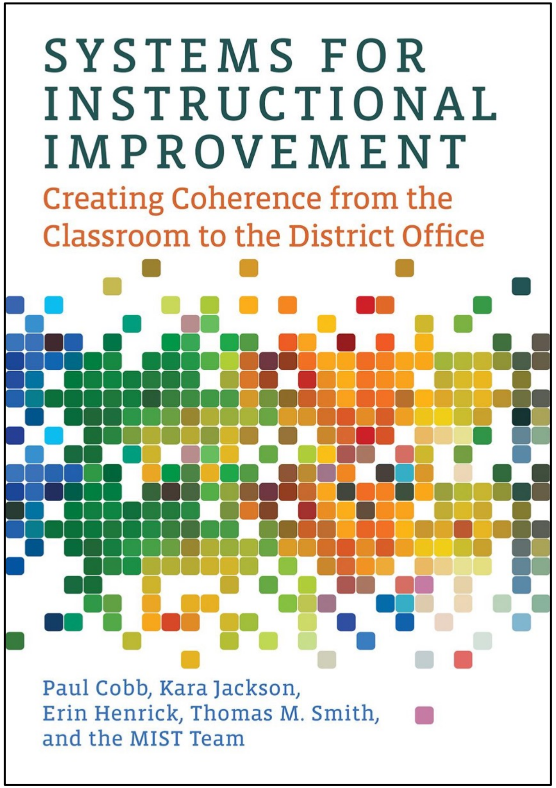
Teacher Learning Subsystem

- Coaches can play a key role in coordinating the various elements:
  - Participate in PD sessions that focus on particular aspects of instruction
  - Facilitate teacher collaborative meetings that focus on the same aspects of instruction
  - Support the teachers in enacting those aspects of instruction in their classrooms

What it makes sense to implement

- A set potentially productive instructional improvement strategies
- What high-quality enactments of those strategies look like

http://vanderbi.lt/mist



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