Improving the Quality of Mathematics Teaching and Learning on a Large Scale: Challenges and Opportunities

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What Does It Take to Improve the Quality of Mathematics Teaching on a Large Scale?

- Overview of the MIST project
  - Goal: Identify potentially productive instructional improvement strategies

- Share some of the findings concerning potentially productive strategies

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
  - No Child Left Behind (NCLB)
  - Common Core State Standards for Mathematics (CCSSM)
    - Reorganization rather than mere extension or elaboration of current practices

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-led PD for principals and coaches
- Research practice partnership
  - Do research with rather than on schools and districts

Partner Districts

- Limited financial resources
- High proportion of students from traditionally underserved groups
  - Achievement/opportunity gaps
- High teacher turn over
- High proportion of novice teachers

Partner Districts

- Recruited districts that were:
  - Aiming at rigorous learning goals for *all* students' mathematical learning
  - Attempting to improve the *quality* of instruction
  - Implementing reasonably coherent sets of improvement strategies
    - Forge a common improvement agenda with district leaders

Partner Districts

- Adopted instructional materials consistent with rigorous learning goals
- Lesson Structure:
  - Introduce or launch rigorous mathematical task(s)
  - Small group or individual work
  - Whole class discussion
    - Teacher presses students to:
    - Explain and justify their reasoning
    - Make connections between different solutions

Project Goals

- Pragmatic goal
  - Add value to the districts' instructional improvement efforts

- Research goal:
  - Develop an empirically grounded theory *of action* for instructional improvement in mathematics at scale
    - A set of policies or strategies for supporting teachers' (and others') learning
    - A rationale that explains why it is reasonable to expect that these strategies will be effective

(Argyris & Schön, 1974, 1978)

Initial Conjectures

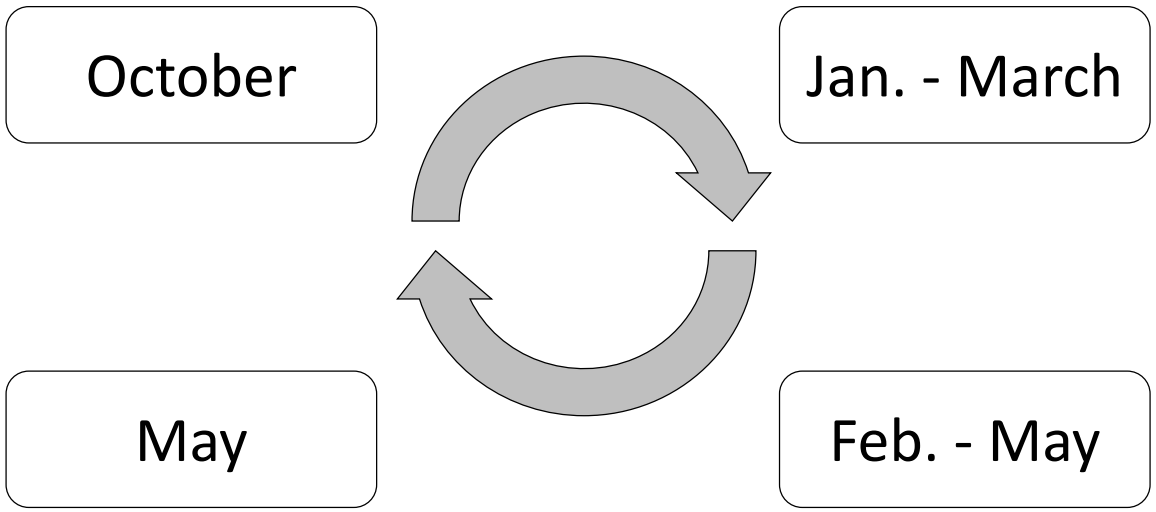
- Mathematics education, teacher education, educational policy and leadership
  - Instructional materials and associated resources
  - Teacher professional development
    - Teacher collaborative groups
  - School instructional leadership
  - District leadership

- Test, revise, and elaborate initial conjectures
  - *Theory of action* for large scale instructional improvement in mathematics

Participants

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

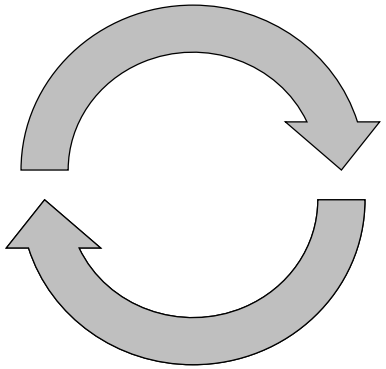
Annual Cycles of Data Collection, Analysis, and Feedback



Annual Cycles of Data Collection, Analysis, and Feedback

October:

- Interviewed district leaders to document their current strategies for improving **middle-school mathematics**

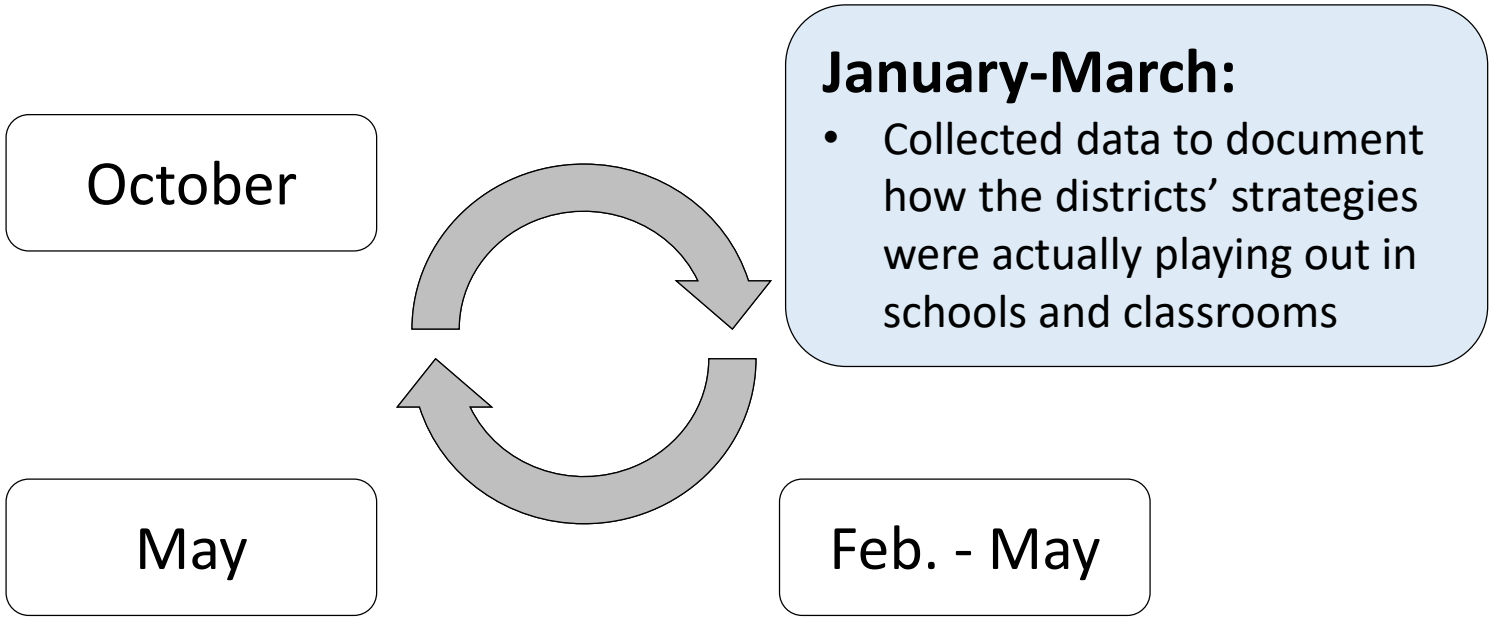


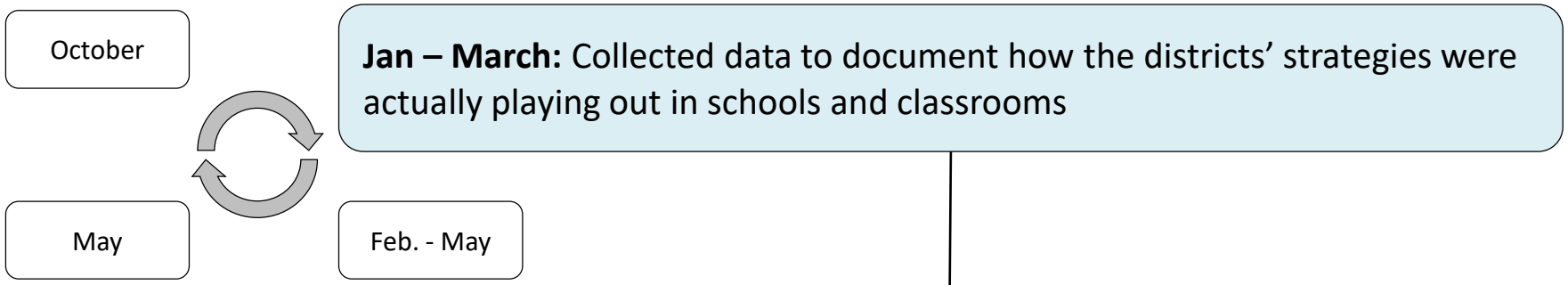
Jan. - March

Feb. - May

May

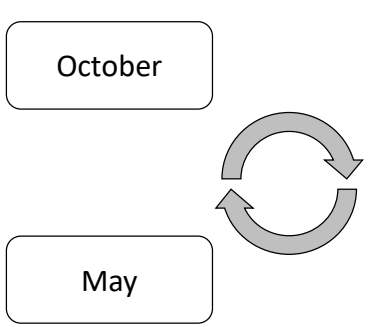
Annual Cycles of Data Collection, Analysis, and Feedback





Jan – March: Collected data to document how the districts' strategies were actually playing out in schools and classrooms

- 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

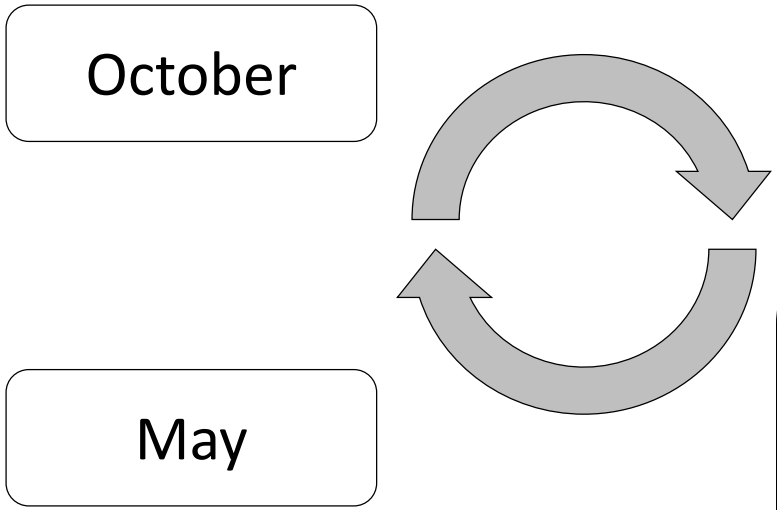


Jan – March: Collected data to document how the districts' strategies were actually playing out in schools and classrooms

Feb. - May

- 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)
- Video-recordings of district professional development
- Audio/video-recordings of teacher collaborative time
- On-line assessment of teacher networks completed by all 300 mathematics teachers in the participating schools
- Access to district student achievement data

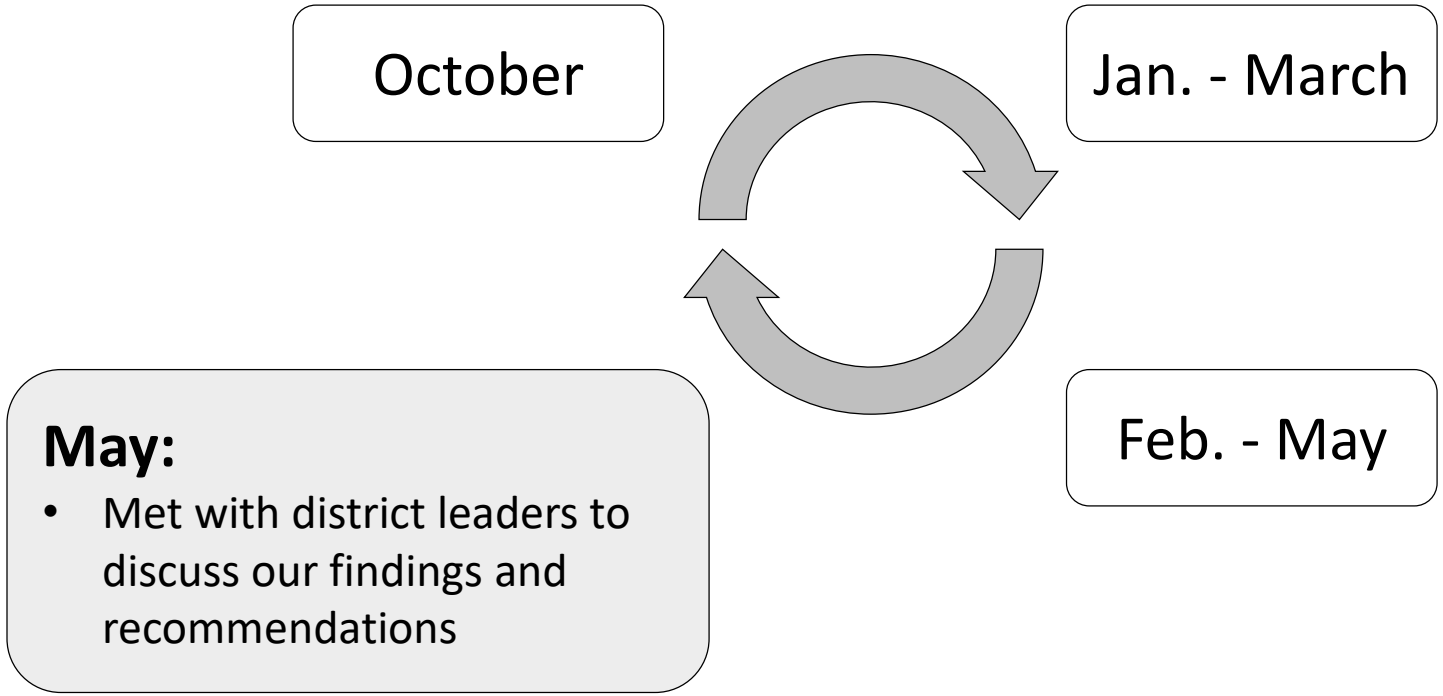
Annual Cycles of Data Collection, Analysis, and Feedback

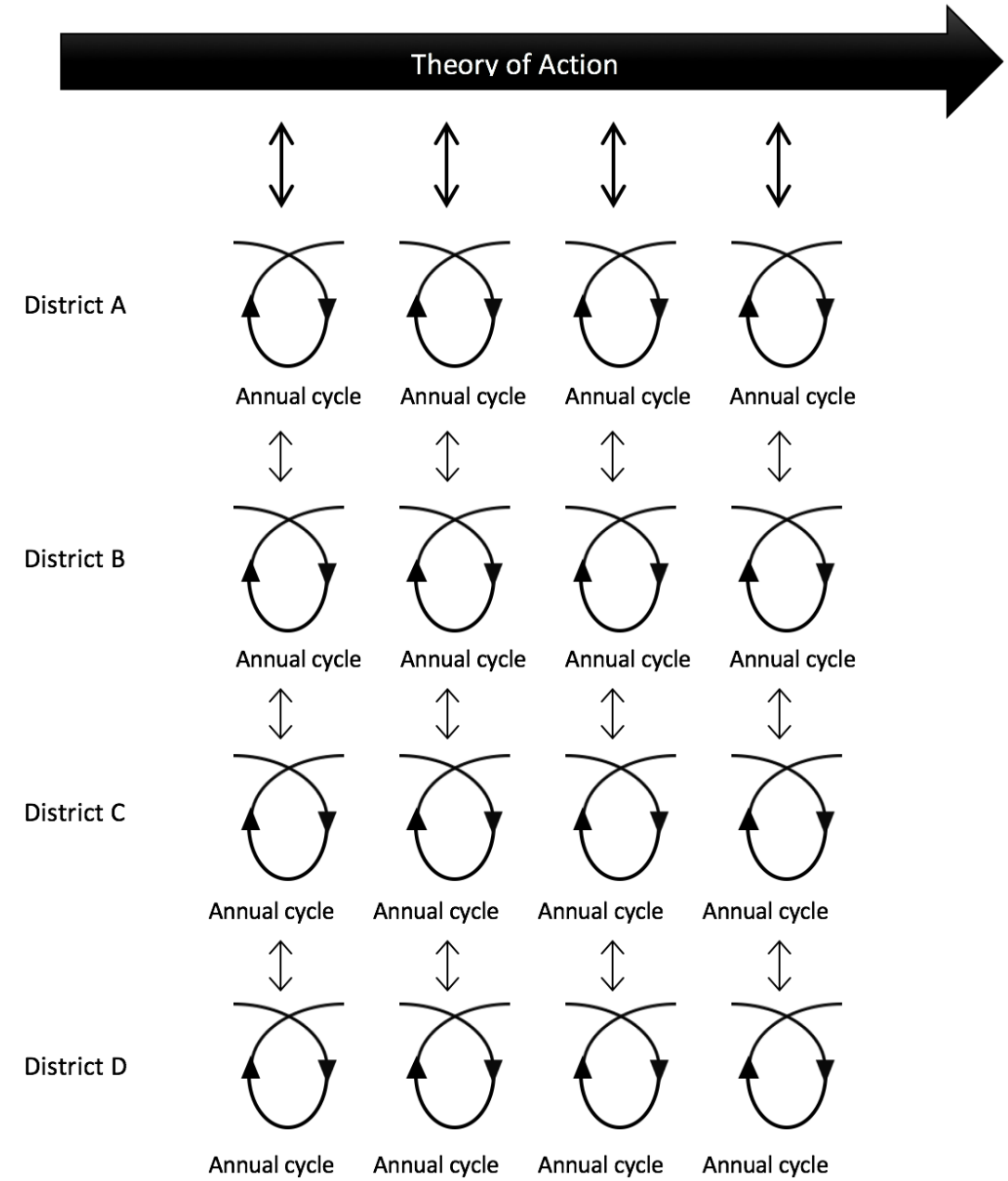


Feb. – May:

- Analyzed transcripts of the 200 interviews
- Identified and *explained* differences between each district's intended and implemented improvement strategies
- Developed a detailed report for leaders in each district
- Shared findings and made actionable recommendations

Annual Cycles of Data Collection, Analysis, and Feedback




Theory of Action
District A
Annual cycle
Annual cycle
Annual cycle
Annual cycle
District B
Annual cycle
Annual cycle
Annual cycle
Annual cycle
District C
Annual cycle
Annual cycle
Annual cycle
Annual cycle
District D
Annual cycle
Annual cycle
Annual cycle
Annual cycle

Research Team

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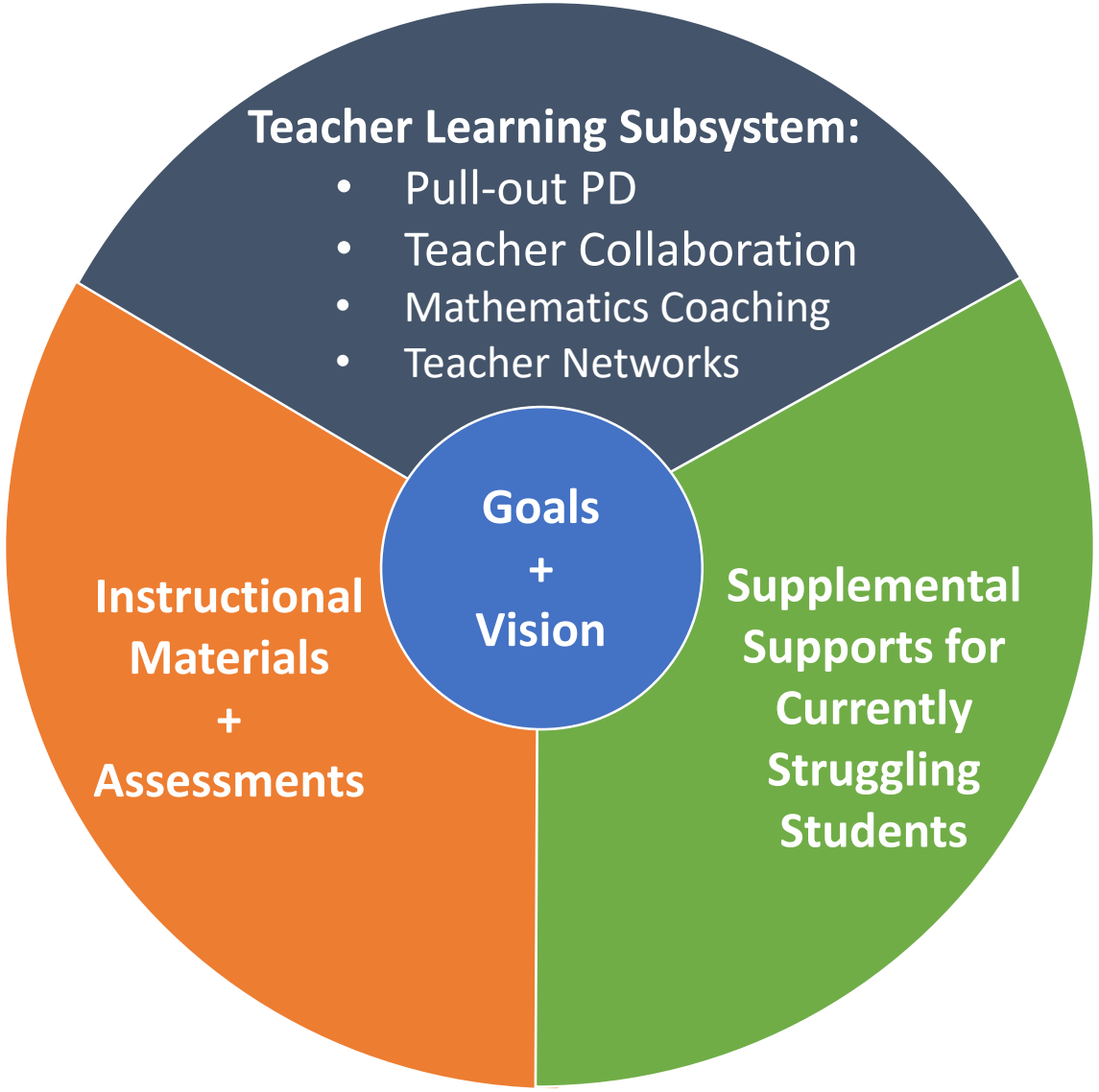
Coherent Instructional System



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
- *IQA* 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 Teacher Knowledge

- *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

Teachers' Visions of High Quality Mathematics Instruction (VHQMI)

- Instruction (IQA) of teachers who had higher VHQMI scores was more likely to improve
  - A leading indicator of instructional improvement

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

Teachers' Views of Students' Current Mathematical Capabilities (VSMC)

- *View of Student's Mathematical Capabilities (VSMC)*
- Interviews
  - ***Diagnostic dimension***: Explanations of the source of student success or failure
  - ***Prognostic dimension***: Descriptions of the supports provided to students perceived as struggling

Teachers' Views of Students' Current Mathematical Capabilities (VSMC)

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

Teachers' Views of Students' Current Mathematical Capabilities (VSMC)

- Teachers with productive VSMC 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
  - Controlled for Mathematical Knowledge for Teaching (MKT) and instructional vision (VHQMI)

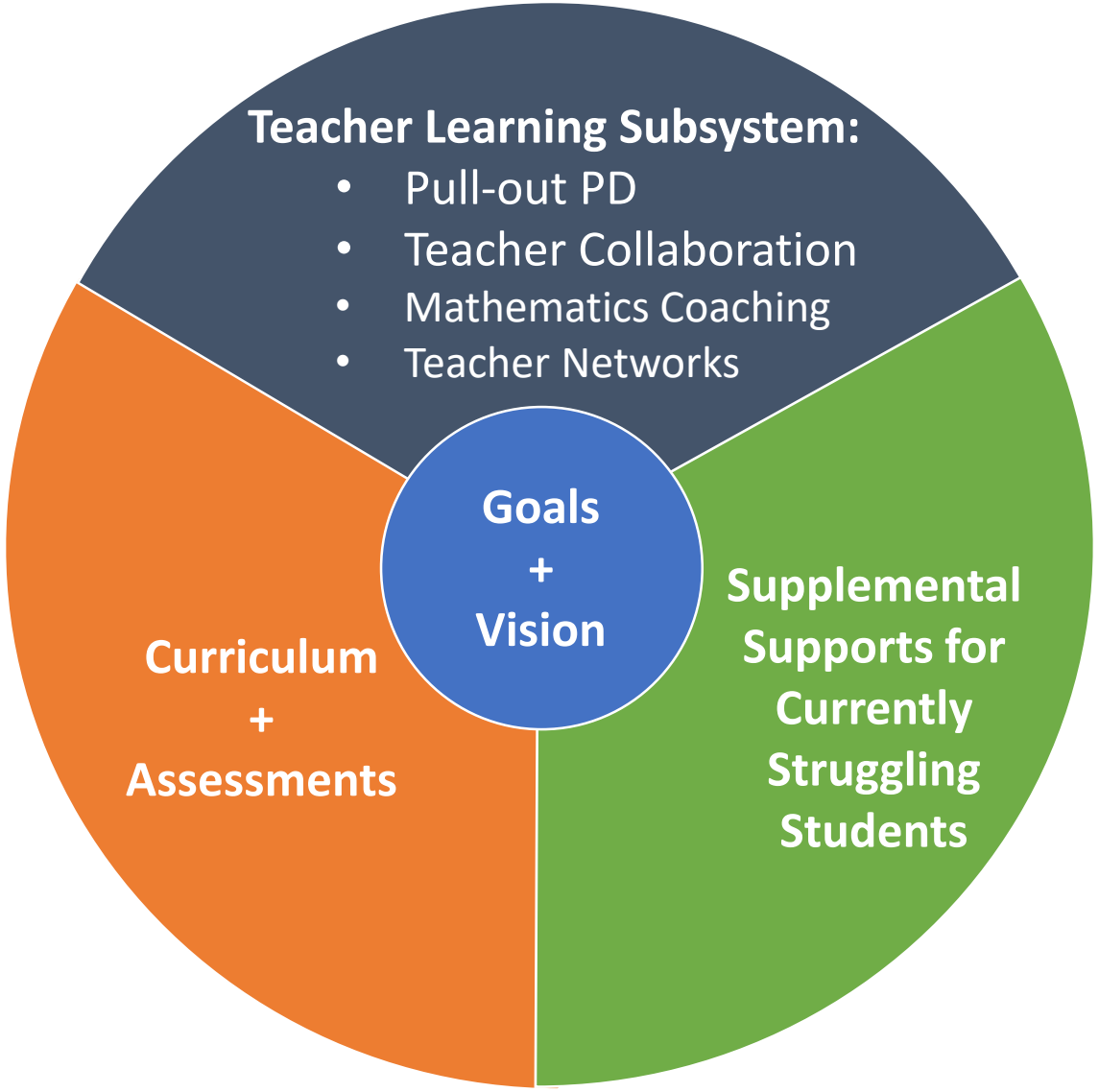
Teachers' Views of Students' Current Mathematical Capabilities (VSMC)

- Teachers' instruction unlikely to improve unless they have developed both relatively sophisticated VHQMI and productive VSMC

Implications

- MKT clearly matters, but supporting improvements in 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 teachers select
    - Extent to which they maintain that level of challenge
    - Extent to which they elicit and build on their students' thinking

Content-Focused Coaching



Pull-Out Teacher Professional Development

- High quality PD:
  - Organized around the instructional materials teachers are using
  - Sustained over time -- sessions build on each other
  - Focuses on a small set of high-leverage aspects of instruction
  - Foregrounds students' thinking in relation to instruction
  - Involves both investigating and enacting specific instructional practices

Pull-Out Teacher Professional Development

- Goal: Support teachers to adjust their current instructional practices
  - *Which* topics are taught and *when* they are taught
- One or two pull-out PD sessions can be effective

- Goal: Support teachers to reorganize their current practices
  - Not just *which* topics are taught and *when* they are taught, but *how* they are taught
- Pull-out PD is often not sufficient even if it is of high quality

System of Supports for Teachers' Learning

- Supports for teachers' learning:
  - Pull-out PD
  - Teacher collaborative time
  - Coaching

- Deliberately coordinate different types of support so that they *constitute a system*

Instructional 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

Identify Potentially Productive One-on-One Coaching Activities

- Criteria
  - Sustained over time
  - Focuses on high-leverage aspects of instruction
  - Foregrounds students' thinking
  - Involves both investigating and enacting ambitious forms of practice

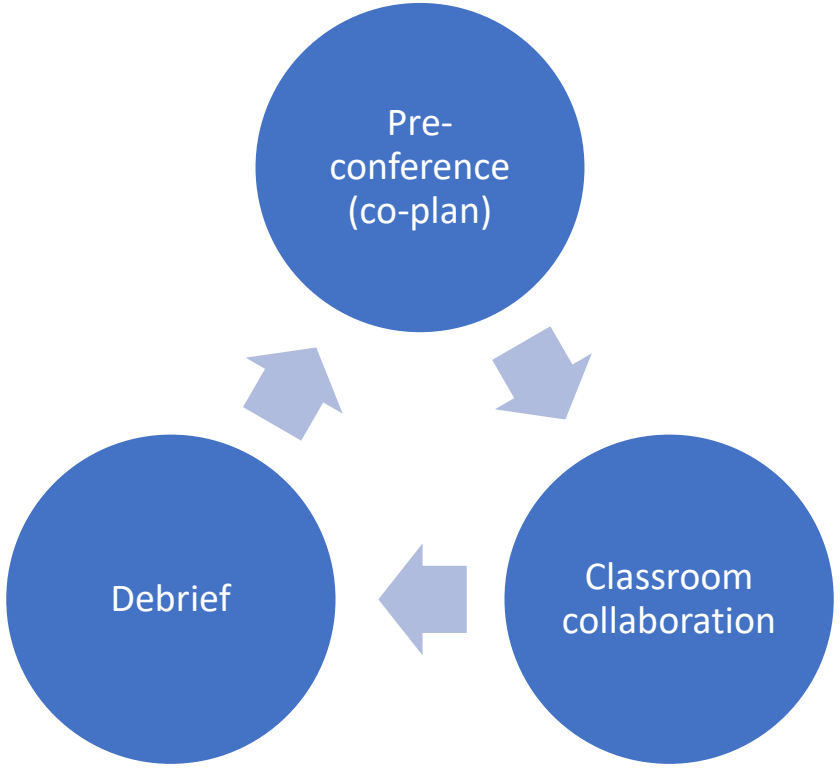
- Empirical evidence can support teachers' development of ambitious instructional practices

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
- Co-teaching
  - Support teachers' initial implementation of specific instructional practices
- Observing instruction and providing feedback
  - Support teachers in improving their implementation of specific instructional practices

Working One-on-One with Teachers in Their Classrooms

- Coaching Cycle



Working with Groups of Teachers

- Engaging teachers in mathematics
  - Identify the big mathematical ideas
  - Anticipate student solution strategies
- Analyzing student work
  - Assess students' thinking and link to instruction
- Analyzing classroom video
  - Assess instruction and link to student thinking
- Engaging in lesson study
  - Analogous to one-on-one coaching cycle

Coaching Expertise

- Content-specific pedagogical expertise
  - Ambitious and equitable instructional practices
  - Relatively sophisticated mathematical knowledge for teaching
  - Productive views of students' current mathematical capabilities

Coaching Expertise

- Relationship-building skills
  - Essential that teachers *trust* coaches to help them improve their instruction
    - Can be intimidating for teachers to make their work public
    - Have to feel comfortable sharing their current problems of practices
  - Negotiate improvement goals with teachers
    - Improvement goals have to become personal goals for teachers
    - Listen to and take teachers concerns seriously

Facilitation Skills

- Press and support teachers to explain their pedagogical reasoning while also maintaining trust
  - Provide detailed descriptions and analyses of students' thinking
  - Relate that thinking to instruction
  - Consider how instruction might be improved to support students' learning more effectively

Teacher Collaborative Meetings

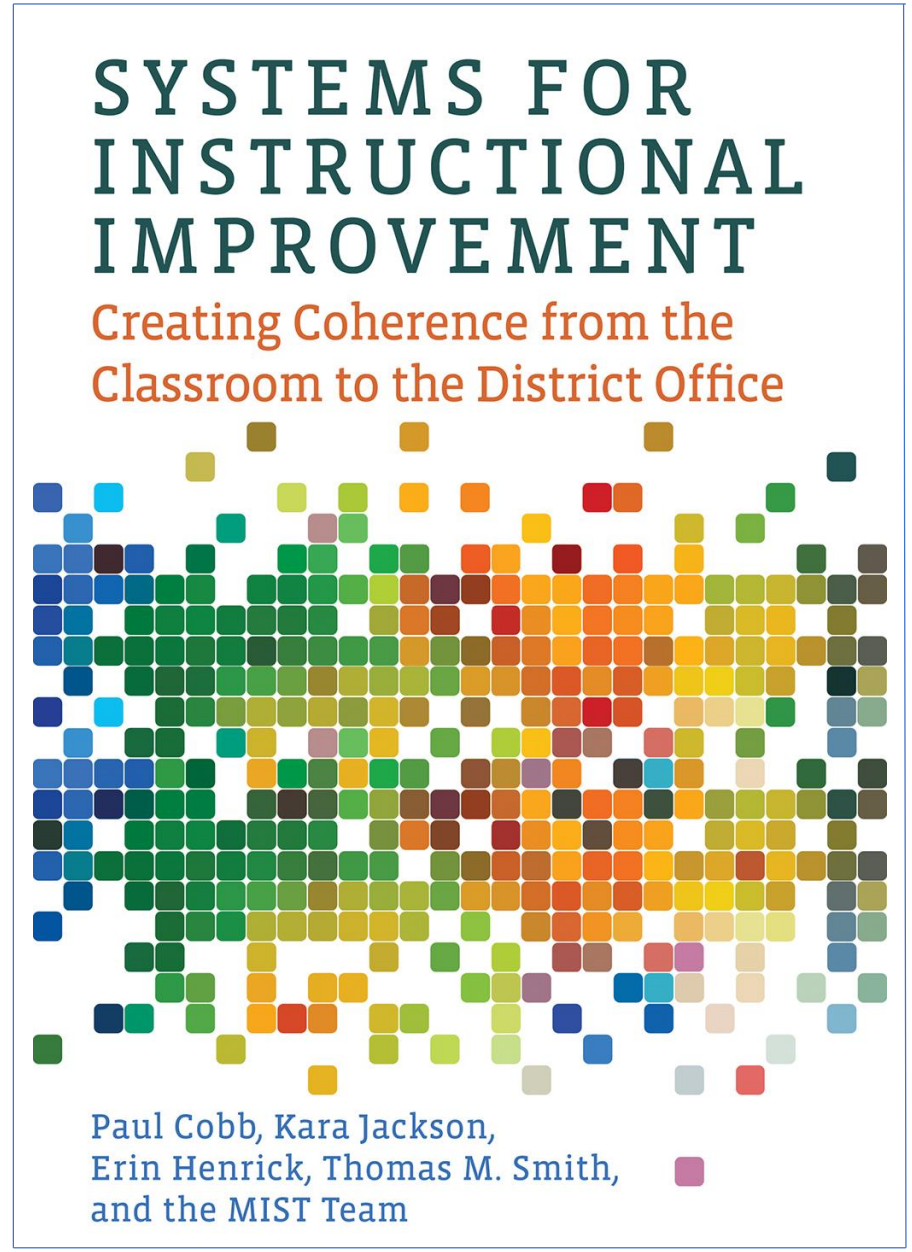
- Productive teacher collaborative groups connect:
  - Mathematical learning goals
  - Students' thinking
  - Instruction
- Requires expert facilitation
  - Negotiate feasible goals for teachers' learning
  - Select activities and materials in light of those goals
- Coaches facilitate teacher collaborative meetings when the participating teachers do not have the expertise to do so

Teacher Advice Networks

- Interactions with colleagues with more sophisticated instructional practices supports 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 outside of meetings
  - Those advice-seeking relationships tend to last

Teacher Learning Subsystem

- Coaches can play a key role in coordinating the various elements
  - Can play a leadership role in pull-out PD sessions that focus on particular aspects of instruction
  - Can lead or participate in teacher collaborative meetings that focus on the same aspects of instruction
  - Can support the teachers in enacting those aspects of instruction in their classroom


SYSTEMS FOR INSTRUCTIONAL IMPROVEMENT
Creating Coherence from the Classroom to the District Office
Paul Cobb, Kara Jackson,
Erin Henrick, Thomas M. Smith,
and the MIST Team

Resources

- Project papers, redacted feedback reports, interview protocols, surveys are all downloadable at:

http://vanderbi.lt/mist

Collaboration with School Leaders

- Coaches' effectiveness in supporting teachers' learning depends on the extent to which they collaborate with school leaders
  - Development of trusting relationships with teachers
  - Amount of time they actually work with teachers on instructional issues
- Principals who developed and implemented instructional improvement plans capable of supporting significant teacher learning
  - Collaborated with an accomplished coacheßs