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

- October
- Jan. - March
- May
- Feb. - May
October:
- Interviewed district leaders to document their current strategies for improving middle-school mathematics

Annual Cycles of Data Collection, Analysis, and Feedback

- Jan. - March
- Feb. - May
- May
Annual Cycles of Data Collection, Analysis, and Feedback

- October
- May
- Feb. - May

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

Feb. - May

• 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

- 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

**May:**
- Met with district leaders to discuss our findings and recommendations
Research Team

**PI and co-Pls:**
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Kara Jackson (University of Washington)
Ken Frank (Michigan State University)

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**Other Collaborators:**
Melissa Boston (Duquesne University)
Min Sun (University of Washington)
Coherent Instructional System

Teacher Learning Subsystem:
- Pull-out PD
- Teacher Collaboration
- Mathematics Coaching
- Teacher Networks

Instructional Materials + Assessments

Supplemental Supports for Currently Struggling Students

Goals + Vision
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:*

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Doing genuine mathematics: Exploring, justifying, explaining, generalizing, etc.</td>
</tr>
<tr>
<td>3</td>
<td>Using procedures with connections to underlying mathematical concepts</td>
</tr>
<tr>
<td>2</td>
<td>Using specified procedures</td>
</tr>
<tr>
<td>1</td>
<td>Memorizing or reproducing facts, rules, formulae, or definitions</td>
</tr>
</tbody>
</table>
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 VHQM1 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

Teacher Learning Subsystem:
- Pull-out PD
- Teacher Collaboration
- Mathematics Coaching
- Teacher Networks

Curriculum + Assessments

Goals + Vision

Supplemental Supports for Currently Struggling Students
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

- Pre-conference (co-plan)
- Classroom collaboration
- Debrief
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
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 coachess