Research to Practice

MARY KAY STEIN
RICHARD CORRENTI
JENNIFER RUSSELL
# Integrating Research and the Improvement of Mathematics Teaching at Scale

<table>
<thead>
<tr>
<th>Year</th>
<th>Project Description</th>
<th>Funding Body</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013-2017</td>
<td>Study of Natural Variation in Teaching (NSF)</td>
<td>NSF</td>
<td>Stein, Correnti, Russell</td>
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<tr>
<td>2014-2018</td>
<td>Continuous Improvement Study (IES)</td>
<td>IES</td>
<td>Russell, Correnti, Stein, Bill, Schwartz, Kirk</td>
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<tr>
<td>2017-2020</td>
<td>The Development of Teaching</td>
<td>Lyle Spencer</td>
<td>Correnti, Stein, Russell</td>
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</tbody>
</table>
Tennessee

1. One of earliest adopters of Common Core
2. One of only two states to win in the first round: Race-to-the-Top (RttT) [2010]
3. Last-in-the-nation to fastest-improving: National Assessment of Educational Progress (NAEP)
4. Dedicated resources to professional development in mathematics
5. IFL opened the door!
Teacher Participants Year One

Number of People
- 500,000 to 927,644
- 200,000 to 499,999
- 100,000 to 199,999
- 25,000 to 99,999
- 5,077 to 24,999

Total State Population: 6,346,105
Tennessee is not unique

Many states and districts face similar challenges

What is unusual: how informed and engaged the TN state department of education (TDOE) is around issues of instructional improvement
Research to Practice
The Linear Model

Basic Research → Applied Research → Development → Dissemination
The Linear Model

Basic Research

Cognitive psychological research on how students learn mathematics

LRDC basic researchers and others (80s)

Applied Research

Research on how Ts select and enact tasks in classrooms

(LRDC applied researchers (90s)

Development

Articles, Books, and Tools are developed for teachers

LRDC Researchers with practitioners (00s)

Dissemination

Institute for Learning
The Linear Model

**Basic Research**
- Cognitive psychological research on how students learn mathematics
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**Applied Research**
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**Dissemination**
- Institute for Learning
Cognitive psychological research on how students learn mathematics

*LRDC basic researchers and others (80s)*

Research on how Ts select and enact tasks in classrooms

*LRDC applied researchers (90s)*

Articles, Books, and Tools are developed for teachers

*LRDC Researchers with practitioners (00s)*

Institute for Learning
Nature of the Conversation is Changing

FROM

- Research TO Practice
- Uni-directional
- Information Transfer
- Hand-off Process

TO

- Research AND Practice
- Bi-directional
- Learning
- Partnerships
Nature of the Conversation is Changing

<table>
<thead>
<tr>
<th>FROM</th>
<th>TO</th>
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</thead>
<tbody>
<tr>
<td>◦ Research TO Practice</td>
<td>Research AND Practice</td>
</tr>
<tr>
<td>◦ Uni-directional</td>
<td>Multi-directional</td>
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<tr>
<td>◦ Information Transfer</td>
<td>Learning</td>
</tr>
<tr>
<td>◦ Hand-off Process</td>
<td>Partnerships</td>
</tr>
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</table>
Why Research-Practice Partnerships?

- Enable greater use of research in decision making (Tseng, 2012)

- Address persistent problems of practice (Penuel, et al., 2011; Bryk et al., 2015)

- Improve educational outcomes (Donovan, 2013)
What are research-practice partnerships?

1. Include researchers and practitioners
2. Long Term
3. Share commitment to build and sustain collaboration over time
4. Multiple projects
5. Focus on Problems of Practice
6. Mutualistic
7. Original Data Analysis
Research

NSF Natural Variation

IES Continuous Improvement

Lyle: secondary analysis

Lyle: district work

IFL Teacher Training

Practice

Time
Study of Natural Variation (NSF)

The “landscape study”

Goal: To design a state-wide, empirically-based instructional indicator system that TDOE leaders can use to make decisions regarding the improvement of mathematics instruction
Current models of teaching

Reform *versus* traditional

Student-centered *versus* teacher centered

Discovery *versus* telling

Reform
- Use of manipulatives
- Students work in small groups
- More than one way of solving problems
- Students talk about mathematics

Traditional
- Rapidly paced instruction
- Teacher demonstration of accurate procedures followed by student practice
- Ample feedback, including quick correction of errors
THEORY

Few well-developed theories of how mathematics teaching influences student learning (Hiebert & Grouws, 2007; Floden, 2001)

Different kinds of teaching foster different kinds of student learning

Patterns emerge across empirical studies
THEORY

Few well-developed theories of how mathematics teaching influences student learning (Hiebert & Grouws, 2007; Floden, 2001)

Different kinds of teaching foster different kinds of student learning

Patterns emerge across empirical studies

Patterns emerge across empirical studies
  ◦ Students opportunity to struggle
  ◦ Explicit attention to concepts
Theory of Teaching for Conceptual Understanding

Explicit attention to mathematical ideas and concepts

Students opportunity to struggle with important mathematics
Theoretical Framework

<table>
<thead>
<tr>
<th>Explicit Attention to Concepts</th>
<th>High</th>
<th>Low</th>
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<tbody>
<tr>
<td>High</td>
<td></td>
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<tr>
<td>Low</td>
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Theoretical Framework

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<tr>
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<th>STUDENT OPPORTUNITY TO STRUGGLE</th>
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<td></td>
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<tr>
<td>Low</td>
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## Theoretical Framework

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<td>High</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
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</table>

- Quadrant 2

**High**

**Low**
# Theoretical Framework

<table>
<thead>
<tr>
<th>Explicit Attention to Concepts</th>
<th>Student Opportunity to Struggle</th>
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<tbody>
<tr>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
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</table>

Quadrant 3
Theoretical Framework

<table>
<thead>
<tr>
<th>EXPLICIT ATTENTION TO CONCEPTS</th>
<th>STUDENT OPPORTUNITY TO STRUGGLE</th>
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<tbody>
<tr>
<td>High</td>
<td>Low</td>
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<td>Low</td>
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Quadrant 4
# Theoretical Framework

<table>
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<tr>
<th>Explicit Attention to Concepts</th>
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<tbody>
<tr>
<td><strong>STUDENT OPPORTUNITY TO STRUGGLE</strong></td>
<td><strong>High</strong></td>
<td><strong>Low</strong></td>
</tr>
<tr>
<td>&quot;Reform&quot; Instruction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Traditional&quot; Instruction</td>
<td></td>
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</table>
# Theoretical Framework

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<th>STUDENT OPPORTUNITY TO STRUGGLE</th>
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<tbody>
<tr>
<td>High</td>
<td>High “Reform” Instruction</td>
</tr>
<tr>
<td>Low</td>
<td>Low “Traditional” Instruction</td>
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Measuring Teaching at Scale to Inform a Professional Learning Agenda

RICHARD (RIP) CORRENTI
Unidimensional Measurement Approach

**Measurement of Instruction**

<table>
<thead>
<tr>
<th>EXPLICIT ATTENTION TO CONCEPTS</th>
<th>HIGH</th>
<th>LOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>“Reform-Oriented”</td>
<td>A</td>
</tr>
<tr>
<td>Low</td>
<td>“Traditional”</td>
<td>B</td>
</tr>
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**Association with Student Learning**

Does A = B?

Implications for Improvement – Be More Reform-Oriented
Multidimensional (2x2 Matrix) Measurement Approach

THEORETICAL FRAMEWORK

<table>
<thead>
<tr>
<th>EXPLICIT ATTENTION TO CONCEPTS</th>
<th>STUDENT OPPORTUNITIES FOR STRUGGLE</th>
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<tr>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Q1</td>
<td>Q2</td>
</tr>
<tr>
<td>Q3</td>
<td>Q4</td>
</tr>
</tbody>
</table>

ASSOCIATION WITH STUDENT LEARNING

Can we build a validity argument to support our assumption that measuring the off-diagonals is important for demonstrating empirical associations? ...professional learning

Do the off-diagonals exist in the wild?
## Data For a Validity Argument

<table>
<thead>
<tr>
<th></th>
<th>Video</th>
<th>Lesson Artifacts</th>
<th>Survey</th>
<th>Student Achievement Data</th>
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<tbody>
<tr>
<td>Intensive Sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=50</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Intermediate Sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=75</td>
<td></td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Scale Sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(400-1,200)</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
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</table>
Convergent Validity Evidence Claims

1. Self-reported teaching practices should reflect a tendency for teaching within one of the four quadrants

   Do the Quadrants Exist – Can Surveys Measure Off-Diagonal Teaching?

2. Patterned responses resulting in quadrant placements ought to reveal instructional practices (EAC and SOS) consistent with our 2 x 2 matrix

   Quadrant Placements Ought to Reveal Predictable Patterns of EAC and SOS

3. Self-identification of tendencies ought to correlate with other measures of teaching (e.g., videos and artifacts)

4. Differences in teaching tendencies ought to be related to student learning in theoretically meaningful ways

   Quadrant Placements Ought to Reveal Predictable Patterns of Student Learning
How did we measure constructs on the survey?

- **Atypical Items (see Handout)**
  - Vignettes
  - Unbounded Attribution of Time in Each Quadrant Vignette
  - After-Vignette Items
  - Bounded Attribution of Time in Each Quadrant Vignette – sum to exactly 100%
  - Constraints on their Teaching (Preceding Frequency Reports)

- **More Typical Items - Guided by Theoretical Framework**
  - Two different likert scales
    - “Strongly Disagree” to “Strongly Agree” (5 point scale)
    - Example: *A teacher's main priority is to teach the most efficient algorithm (SOS)*
  - Frequency – “Never” to “Almost Daily”
  - Example: *Students draw connections between numbers / symbols and other forms of representation (e.g., manipulatives, diagrams, graphs) (EAC)*
Typical Problems with Teachers’ Self-Report on a Survey

Well known problems with validity of teachers’ self-reports

- **Social desirability**

- **Accuracy accounting events over extended time periods** (Sudman, Bradburn and Schwartz, 1996)

- **Over-reports**
  - About 75% of teachers over-report on survey when compared to daily log (Camburn et al, 2015)
  - Difficulty interpreting meaning of response scales
  - Measurement problem: Over-reports are different for different teachers
    - Teachers with *MORE* expertise may over-report *LESS* *(Ibid)*
Our Measurement Approach Addressed **Over-Report Problem**

**SIMPLE QUADRANT PLACEMENT**

**Vignettes**

- P=40; Q1
- E=35; Q2
- J=15; Q3
- S=10; Q4

**Cross-Validate With**
- After-Vignettes
- Cross-Vignettes
- EAC Sub-constructs
- SOS Sub-constructs

+ 100 Undecided

**OUR PATTERNED APPROACH (LATENT PROFILE ANALYSIS)**

<table>
<thead>
<tr>
<th>Ratios (5)</th>
<th>Q Vs. Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>122</td>
</tr>
<tr>
<td>156</td>
<td>65</td>
</tr>
</tbody>
</table>

**Vignettes (4)**
- After-Vignettes
- EAC Items (few)
- SOS items (few)

**Cross-Validate With**

Unused:
- EAC Items Forming Sub-constructs
- SOS Items Forming Sub-constructs
Convergent Validity Evidence

Hypothetical Example

QUADRANT PLACEMENTS OUGHT TO REVEAL PREDICTABLE PATTERNS OF EAC AND SOS

- Q1 (Park)
- Q2 (Evans)
- Q3 (Jones)
- Q4 (Smith)

QUADRANT PLACEMENTS OUGHT TO REVEAL PREDICTABLE PATTERNS OF STUDENT LEARNING

- Q1 (Park)
- Q2 (Evans)
- Q3 (Jones)
- Q4 (Smith)
Convergent Validity Evidence

Our Patterned Approach (LPA in Y2)

INSTRUCTIONAL PATTERN

STUDENT LEARNING PATTERN
Concluding Remarks
What About Professional Learning?

_Surveys helped to generate initial validity evidence_

- Appropriate power to test theory in Y2 (n=429)
- Survey-Based quadrant placements allow us to test theoretical propositions (claims)
- Quadrant identification through large-scale surveys could help:
  - Act as an Indicator to inform Policy
  - Evaluating Interventions
  - Understanding Trends/Growth
  - i.e., informing and monitoring the improvement process

_But what about professional learning?_

- *How might we leverage different measures of teaching (i.e., video and survey both aligned with the theoretical framework) to design professional learning for teaching improvement in 4th through 8th grade mathematics?*_
LPA Survey Results with Sub-Constructs (Linear Model)

- Focus on Math. Meaning
- Building Und. Thru Connections
- Active St. Input Twrds. Understanding
- Importance of Practice
- Tchr. Guid. For Ensuring Accuracy
- Teacher Directed
- Priority for Algorithms
- Std. “Not Ready” for Complexity
- EAC
- SOS

All SOS Scales were reverse-scored to reflect High Struggle
Video Micro-Coding: Comparison of Indicators Across Quadrants

Indicators associated with **Struggle (SOS)**

Indicators associated with **Concepts (EAC)**
Engage in empirical work to examine teaching development using:
- NSF Natural Variation Data --- Approx. 200 Teachers Over 4 Years
- IES Coaching Study --- Approx. 250 Teachers Over 1 Year; Video Data

Transition from “Social Science” Realm to “Practice” Realm
- Survey Whole Districts
- Create District Maps of Teaching (and Social Resource Profiles)
- Co-Design Professional Learning with District Leaders
Questions?

rcorrent@pitt.edu
Collaborating to Design and Test a Model for Statewide Math Coaching

THE TN MATH COACHING PROJECT

Jenn Russell
Continuous Improvement Research in Education

Partnerships & Collaborations Focused on Problems of Practice

“The partnerships established under the Collaborations Program are intended to increase the responsiveness of the research through the required inclusion of education agencies as partners from the start of the work with the identification of the research questions, design of the project, carrying out of the research, and adoption and dissemination of the results.”
Collaborative Project Team

Researchers from LRDC

Fellows from the Institute for Learning (IFL)

The Tennessee Department of Education

74 Mathematics Coaches, representing 32 Districts and 230 Partnering Teachers
TN Math Coaching Project Goals

Develop a network of instructional coaches
TN Math Coaching Project

Goals

**Develop a network of instructional coaches** who will partner in testing and refining the TN Mathematics Instructional Coaching Model.
Tennessee Math Coaching Project Goals

**Develop a network of instructional coaches** who will partner in testing and refining the TN Mathematics Instructional Coaching Model.

Support high-quality mathematics teaching and student learning throughout the state of TN.
TN Math Coaching Model

State Actions to Spread the Model
• Support a sustainable coaching network
• Distribute training modules and other tools to support coaching improvement

Districts & School Actions to Implement the Model
• Protect time for coaching
• Promote a consistent vision of instruction

Coaching Model
- Coach Development Framework
- Coaching Framework
- Continuous Improvement and Adaptive Integration

Improve Mathematics Teaching
• Build students’ conceptual understanding
• Engage students in productive struggle
• Maintain cognitive demand of high level tasks
• Orchestrate productive classroom discourse

Student Conceptual Understanding of Mathematics & Mathematical Performance Consistent with TN Standards
Coach & teacher communicate to select a high level task for the cycle

Pre-Observation Planning Conference (20-45 min.)

Coach & teacher schedule pre-observation planning conference within 24-48 hours before lesson

Coach & teacher mark specific pedagogical goals in service of the mathematical goal for the lesson and both commit to working toward the goals

Coach & teacher engage in a deep & specific discussion of the mathematical goals and the pedagogy to support student learning (the Instructional Triangle)

Teacher is asked to commit to enacting in class what has been discussed (a Call to Action)

Lesson Observation

Coach observes the teacher teaching the lesson

Strategic and limited coach assist

Coach & teacher gather evidence related to student understanding of the mathematical goals & pedagogy that supports student learning

Post Observation Conference (20-45 min.)

Coach & teacher schedule post-observation conference within 48 hours of observation

Coach & teacher analyze evidence to highlight the goals that were and were not accomplished via evidence-based feedback

Coach & teacher co-construct pedagogical goals for next cycle and commit to working toward goals

Coach & teacher independently work out solutions for task prior to planning conference

Coach & teacher independently work out solutions for task prior to planning conference
TN Math Coaching Model

State Actions to Spread the Model

- Support a sustainable coaching network
- Distribute training modules and other tools to support coaching improvement

Districts & School Actions to Implement the Model

- Protect time for coaching
- Promote a consistent vision of instruction

Coach Development Framework

Coaching Framework

Continuous Improvement and Adaptive Integration

Improve Mathematics Teaching

- Build students’ conceptual understanding
- Engage students in productive struggle
- Maintain cognitive demand of high level tasks
- Orchestrate productive classroom discourse

Student Conceptual Understanding of Mathematics & Mathematical Performance Consistent with TN Standards
Adaptive Integration Guided by the Model for Improvement

Model for Improvement

- What are we trying to accomplish?
- How will we know that a change is an improvement?
- What change can we make that will result in improvement?

The Improvement Guide

Adaptive Integration Guided by the Model for Improvement

Institute for Healthcare Improvement
TN Math Coaching Model

State Actions to Spread the Model
- Support a sustainable coaching network
- Distribute training modules and other tools to support coaching improvement

Districts & School Actions to Implement the Model
- Protect time for coaching
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Coaching Model
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Improve Mathematics Teaching
- Build students’ conceptual understanding
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Student Conceptual Understanding of Mathematics & Mathematical Performance Consistent with TN Standards
COACHES partner in the continuous improvement of the coaching model:

- Gather and share data about their practice
- Engage in reflective practice
- Generate ways to improve or augment the coaching model for use in their specific local context.
Data & Improvement Cycles

YEAR 1

OCT. 2014
IMPROVEMENT CYCLE 1
NETWORK MEETING

DEC. 2014
IMPROVEMENT CYCLE 2
NETWORK MEETING

MAR. 2015
IMPROVEMENT CYCLE 3
NETWORK MEETING

YEAR 2

AUG. 2015
IMPROVEMENT CYCLE 4
NETWORK MEETING

NOV. 2015
IMPROVEMENT CYCLE 5
NETWORK MEETING

MAR. 2016
NETWORK MEETING

IMPROVEMENT CYCLES:

- IMPROVEMENT CYCLE 1: OCT. 2014
- IMPROVEMENT CYCLE 2: DEC. 2014
- IMPROVEMENT CYCLE 3: MAR. 2015
- IMPROVEMENT CYCLE 4: AUG. 2015
- IMPROVEMENT CYCLE 5: NOV. 2015
- IMPROVEMENT CYCLE 6: MAR. 2016
Teaching improvement indicators

Improving maintenance of cognitive demand

Gradual release of coach assistance
Maintenance of Cognitive Demand over 2 Years (n=105 Teachers)

ES = .79 over 2 Years; Including “stable positive” group (39 out of 105)
Rigor of pre-conferences predicts rate of teaching improvement
Year 3: Further Testing the Model’s Promise of Efficacy

Study Participants

- TN Math Coaching Project Coaches (N=165)
- Other Math Coaches
- Partner Teachers (N=100)
- Comparison Teachers
  - Active (N=100)
  - Passive (N=1000+)
Scaling up the TN Math Coaching Model

**State Actions to Spread the Model**

**Toward a Scaling Strategy**
- Embed model in tools and materials
- Support a sustainable coaching network
- Build capacity of regional math consultants
- Build will in the TDOE for unified commitment to coaching (e.g., link our work with literacy initiative)
- Seek future grant support

**Coach Development Framework**

**Coaching Framework**

**Continuous Improvement and Adaptive Integration**

**Improve Mathematics Teaching**
- Build students’ conceptual understanding
- Engage students in productive struggle
- Maintain cognitive demand of high level tasks
- Orchestrate productive classroom discourse

**Student Conceptual Understanding of Mathematics & Mathematical Performance Consistent with TN Standards**
Questions?

jrussel@pitt.edu
Summary
What are research-practice partnerships?

1. Include researchers and practitioners
2. Long Term
3. Share commitment to build and sustain collaboration over time
4. Multiple projects
5. Focus on Problems of Practice
6. Mutualistic
7. Original Data Analysis
### Research-Practice Partnership?

<table>
<thead>
<tr>
<th>Feature</th>
<th>Displayed?</th>
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<tbody>
<tr>
<td>Include researchers and practitioners</td>
<td>✓</td>
</tr>
<tr>
<td>Long term</td>
<td>✓</td>
</tr>
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<td>✓</td>
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<tr>
<td>Original data analysis</td>
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What do we add to the conversation?

Time: Looking at a 10 year trajectory of time

Different methodologies are in ascendency at different points in time

Keeping an eye on “how the puzzle pieces fit together”
  ◦ For Tennessee
  ◦ For Research?

Flexibility to interact with practitioners at different levels of the system
Research

- NSF Natural Variation
- IES Continuous Improvement
- Lyle: secondary analysis
- Lyle: district work

Practice

- IFL Teacher Training

Questions?
Our LRDC Based Collaborators

Victoria Bill (IFL)
Maggie Hannan
Katelynn Kelly
Stacey Kehoe
Chris Matthis
Deanna Prine
Laurie Speranzo (IFL)
Laura Stelitano
Debra Moore
Ally Thomas
Baeke San Yu
Bilge Yurekli
Limitations

Largely convergent research-based evidence, but...

◦ Can these results be replicated across years?
◦ Can these results be replicated with a different population of teachers?

Unresolved tension between measures of teachers versus measures of teaching

◦ Quadrant Placement ignores variability within each teachers’ practice
◦ Infrequent surveys rely on holistic self-reports
Convergent Validity Evidence

**Hypothetical Vs. LPA (Instruction)**

**HYPOTHETICAL**

- Q1 (Park)
- Q2 (Evans)
- Q3 (Jones)
- Q4 (Smith)

**PATTERNED APPROACH (LPA)**

- Q1 (n=80)
- Q2 (n=122)
- Q3 (n=156)
- Q4 (n=65)
Convergent Validity Evidence

Hypothetical Vs. LPA (Learning)

HYPOTHETICAL

LPA

- Q1 (Park) - Q2 (Evans)
- Q3 (Jones) - Q4 (Smith)

- Q1 (n=64) - Q2 (n=89)
- Q3 (n=122) - Q4 (n=47)
To deal with Measurement Error Introduced by Over-Reports:

Particular Items Indicate Teaching Tendencies

Theoretical teaching profiles (aka, quadrants) also guided item development

- “What would quadrant 2 answer?”
- “How would a quadrant 2 teacher differ from a quadrant 4 teacher?”

Sample Item: Q2 versus Q4

*Students need to understand WHY an algorithm works so they can apply it correctly to new and more difficult problems*
To deal with Measurement Error Introduced by Over-Reports:

We developed ratios using particular items indicating clear tendencies for teaching in one Q versus an adjacent quadrant:

Sample Item 1: Q2 versus Q4
Students need to understand WHY an algorithm works so they can apply it correctly to new and more difficult problems

Sample Item 2: Q2 versus Q4
By reviewing the graded worksheets Q4 teacher (Ms. Smith) learns how well each of her students understands equivalence

Sample Item 1
Sample Item 2

Sample Item 1: Q2 versus Q4 Ratio
Sample Item 2:

Strongly Disagree

Strongly Agree

Q4
Q2

1
1

22
22

33
33

Frequency

Q2 Versus Q4 Ratio
More than one construct guided item development

Explicit Attention to Concepts
- Focus on Mathematical Meaning (3 items)
- Building Understanding thru Connections (6 items)
- Active Student Input Towards Understanding (7 items)

Students’ opportunities for productive struggle with mathematics content*
- Importance of Practice (3 items)
- Teacher Guidance for Ensuring Accuracy (5 items)
- Teacher Directed (4 items)
- Priority on Algorithms (5 items)
- Students “Not Ready” for Complexity (5 items)

*Latent constructs measure endorsement of LOW struggle; we reverse score these items in later figures so positive scores reflect the rejection of LOW struggle items
### Why Simple Quadrant Placement is Inadequate

<table>
<thead>
<tr>
<th>DISTRIBUTION OF TEACHERS IN SELF-SELECTED QUADRANTS</th>
<th>WHY THIS IS PROBLEMATIC</th>
</tr>
</thead>
</table>
| Q1 (Park) N=143                                      | Need to separate wheat from chaff  
  - More than 70% self-identify with “high-conceptual” teaching most of the time |
| Q2 (Evans) N=92                                      | Need to use other information on the survey to cross-validate teachers’ own judgments |
| Q3 (Jones) N=30                                      | Accepting teachers’ own judgments at face-value invites measurement error  
  - Teachers with inaccurate estimates of own teaching behaviors (aka, Mrs. O)  
  - Social desirability  
  - Fails to account for different potential patterns (high agreeing teachers; non-distinguishing teachers; level of PCK, etc.) |
| Q4 (Smith) N=64                                      |                         |
| No Initial Placement N=78                           |                         |
Sample Items

Explicit Attention to Concepts

Three EAC Sub-constructs

- **Focus on Mathematical Meaning** (3 items)
  - *Teaching the mathematical meaning that underlies a procedure*
  - *Wrapping up the lesson by stating the main mathematical idea*

- **Building Understanding thru Connections** (6 items)
  - *Students explore how two different strategies can lead to the same answer*
  - *Students draw connections between numbers / symbols and other forms of representation (e.g., manipulatives, diagrams, graphs)*

- **Active Student Input Towards Understanding** (7 items)
  - *Students are challenged to come up with their own explanations for their observations about important mathematical relationships*
  - *Students demonstrate their understanding to the teacher as they reason their way through a new and challenging problem*
Sample Items
Students’ Opportunities for Prod. Struggle

Five SOS Sub-constructs – High score endorses low struggle

- Importance of Practice (3 items)
  - If students have enough practice using a procedure, they will be able to apply it to more difficult problems

- Teacher Guidance for Ensuring Accuracy (5 items)
  - Students practice using procedures to solve problems with accuracy
  - Teacher demonstrates procedures accurately

- Teacher Directed (4 items)
  - Instruction should include teacher presentations of worked-out examples

- Priority on Algorithms (5 items)
  - A teacher's main priority is to teach the most efficient algorithm

- Students “Not Ready” for Complexity (5 items)
  - Students are not ready for "higher order" learning until they have acquired the basics