Studying Instructional Improvement

Study of Instructional Improvement
Consortium for Policy Research in Education (CPRE)
University of Michigan
Deborah Loewenberg Ball and Heather C. Hill

Co-Principal Investigators: David K. Cohen and Brian Rowan

Doctoral students and post-docs who worked on the analyses in this presentation:
Douglas Corey
Jenny DeMonte
Keisha Ferguson
Delena M. Harrison
Geoffrey Phelps

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What is Involved in Trying to Study Instruction, and Efforts to Improve It, at Scale?

- What have we tried to do?
- What have we been learning?

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Overview of Presentation

- Brief introduction to the study
- Two early results from study
  - Instructional time
  - Teachers' content knowledge
- Lessons learned



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What is the Study of Instructional Improvement (SII)?

- A longitudinal multi-method study of three major school reform programs (America's Choice, Success for All, Accelerated Schools)
- In 112 high poverty urban elementary schools (25-30 schools per program; plus comparison schools)
- Investigating language arts (ELA) and mathematics instruction
- Study components
  - Case studies of intervention programs
  - Survey study of schools (school leaders, teachers, students, parents, opportunities to learn)
  - Case studies of sub-sample of schools (12 schools)
- What is involved in improving instruction at scale in high poverty elementary schools?

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Data Collection Instruments for the Survey Study

- Annual teacher questionnaire (school policies, professional development, instructional practice, curriculum, content knowledge, beliefs about students, pressures)
- Teacher instructional logs
- Questionnaires from school leaders
- Parent interviews
- Student achievement data
- Observations of school intervention programs



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A View of U.S. Instruction at Scale

- Widespread concern about student learning in elementary schools
- Over many years of efforts at reform
- Little empirically-based detailed knowledge about patterns of practice in language or mathematics in U.S. elementary schools
  - How much time is spent on language or math?
  - What is actually taught?
  - Does teachers' knowledge of content for teaching make a difference?
- SII offers an opportunity to learn answers to these questions.

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Two Investigations

- Instructional time in mathematics
  - Use instructional log data
- Teachers' mathematical knowledge for teaching
  - Use variety of data sources



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Why Investigate Instructional Time?

- Instructional improvement: programs aim at regulating instructional time
- Our sample: high-poverty urban elementary schools
- Opportunity to learn: Time predictive of learning in many studies

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Instructional Time: Using Data from the Instructional Log

- Goal of log: to gather behavioral data on instruction on a large scale
- Teachers complete in less than 5 minutes
- Not biased toward a particular view of "good" instruction

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Design of the Mathematics Log

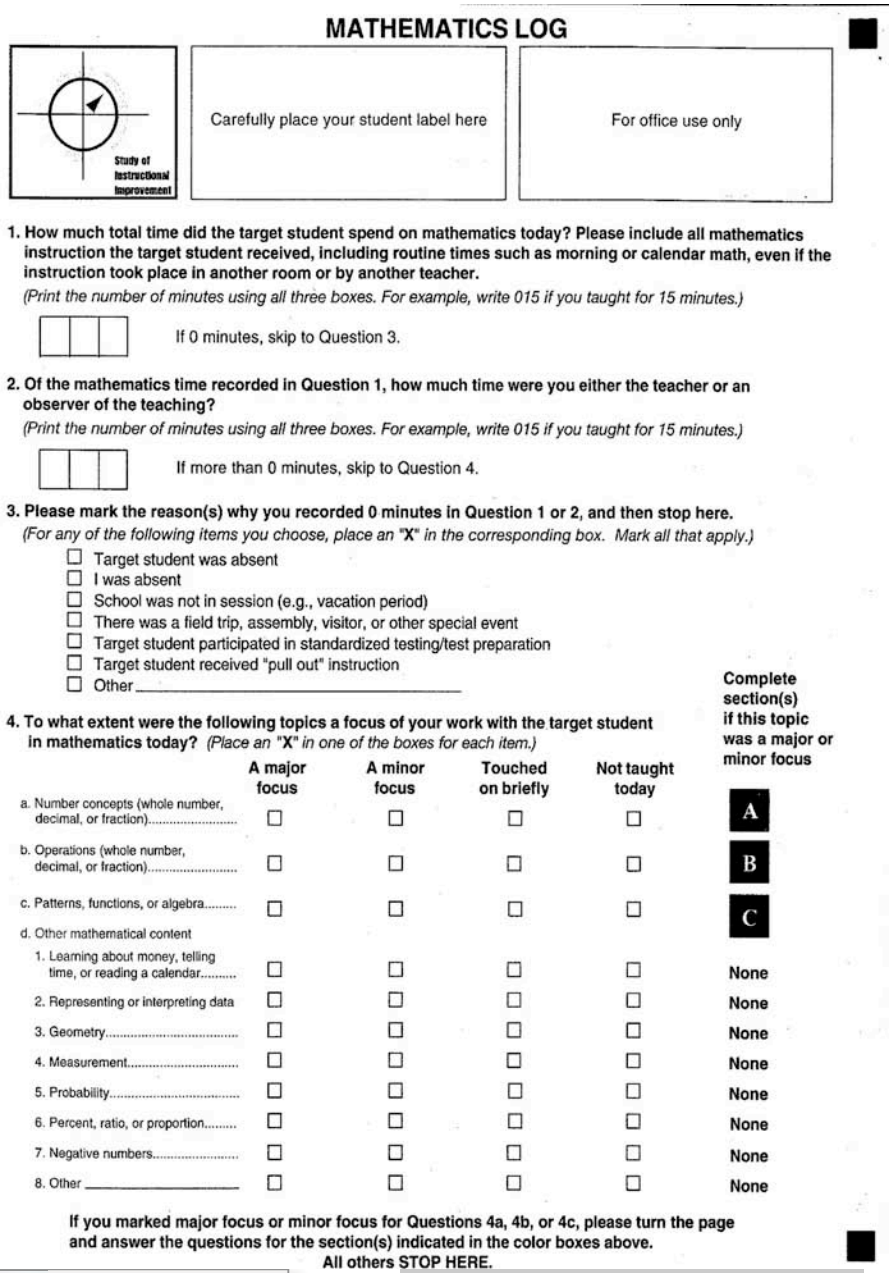
- Gateway: instructional time, reason for missed time, topic emphasis
- Inside: detail for three gateway topics: number concepts, operations, patterns/functions/algebra
  - Finer content breakdown
  - Representations used
  - Level of cognitive and mathematical complexity
  - Student tasks



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Log Gateway

- Length of the lesson
- If not taught, why not?
- Topics taught:
  - Number concepts
  - Operations
  - Patterns, functions, or algebra



MATHEMATICS LOG

Study of Instructional Improvement

Carefully place your student label here

For office use only

1. How much total time did the target student spend on mathematics today? Please include all mathematics instruction the target student received, including routine times such as morning or calendar math, even if the instruction took place in another room or by another teacher.

(Print the number of minutes using all three boxes. For example, write 015 if you taught for 15 minutes.)

☐☐☐ If 0 minutes, skip to Question 3.

2. Of the mathematics time recorded in Question 1, how much time were you either the teacher or an observer of the teaching?

(Print the number of minutes using all three boxes. For example, write 015 if you taught for 15 minutes.)

☐☐☐ If more than 0 minutes, skip to Question 4.

3. Please mark the reason(s) why you recorded 0 minutes in Question 1 or 2, and then stop here.

(For any of the following items you choose, place an "X" in the corresponding box. Mark all that apply.)

- ☐ Target student was absent
- ☐ I was absent
- ☐ School was not in session (e.g., vacation period)
- ☐ There was a field trip, assembly, visitor, or other special event
- ☐ Target student participated in standardized testing/test preparation
- ☐ Target student received "pull out" instruction
- ☐ Other _____

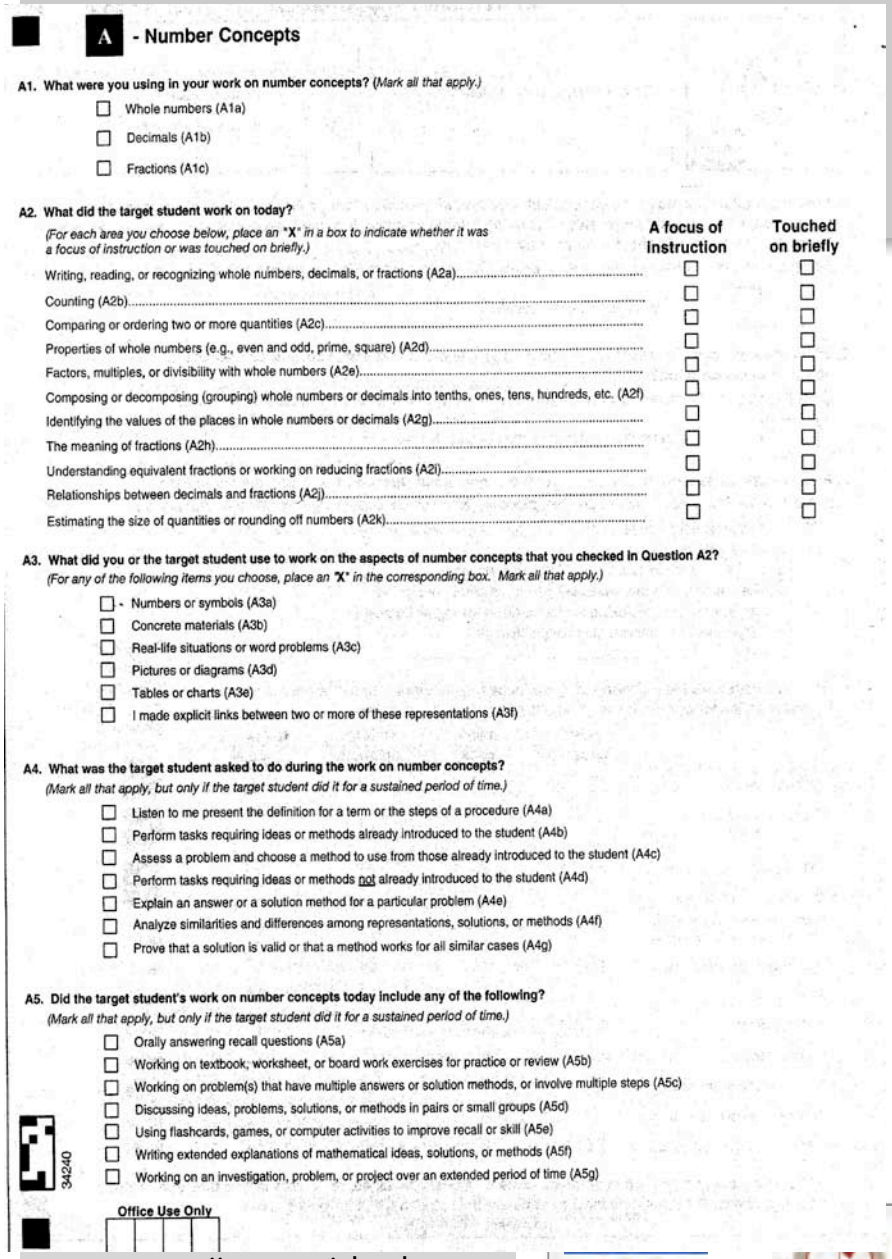
4. To what extent were the following topics a focus of your work with the target student in mathematics today? *(Place an "X" in one of the boxes for each item.)*

	A major focus	A minor focus	Touched on briefly	Not taught today	Complete section(s) if this topic was a major or minor focus
a. Number concepts (whole number, decimal, or fraction)	☐	☐	☐	☐	A
b. Operations (whole number, decimal, or fraction)	☐	☐	☐	☐	B
c. Patterns, functions, or algebra	☐	☐	☐	☐	C
d. Other mathematical content					
1. Learning about money, telling time, or reading a calendar	☐	☐	☐	☐	None
2. Representing or interpreting data	☐	☐	☐	☐	None
3. Geometry	☐	☐	☐	☐	None
4. Measurement	☐	☐	☐	☐	None
5. Probability	☐	☐	☐	☐	None
6. Percent, ratio, or proportion	☐	☐	☐	☐	None
7. Negative numbers	☐	☐	☐	☐	None
8. Other _____	☐	☐	☐	☐	None

If you marked major focus or minor focus for Questions 4a, 4b, or 4c, please turn the page and answer the questions for the section(s) indicated in the color boxes above. All others STOP HERE.

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A - Number Concepts

A1. What were you using in your work on number concepts? *(Mark all that apply.)*

- ☐ Whole numbers (A1a)
- ☐ Decimals (A1b)
- ☐ Fractions (A1c)

A2. What did the target student work on today?

(For each area you choose below, place an "X" in a box to indicate whether it was a focus of instruction or was touched on briefly.)

	A focus of instruction	Touched on briefly
Writing, reading, or recognizing whole numbers, decimals, or fractions (A2a)	☐	☐
Counting (A2b)	☐	☐
Comparing or ordering two or more quantities (A2c)	☐	☐
Properties of whole numbers (e.g., even and odd, prime, square) (A2d)	☐	☐
Factors, multiples, or divisibility with whole numbers (A2e)	☐	☐
Composing or decomposing (grouping) whole numbers or decimals into tenths, ones, tens, hundreds, etc. (A2f)	☐	☐
Identifying the values of the places in whole numbers or decimals (A2g)	☐	☐
The meaning of fractions (A2h)	☐	☐
Understanding equivalent fractions or working on reducing fractions (A2i)	☐	☐
Relationships between decimals and fractions (A2j)	☐	☐
Estimating the size of quantities or rounding off numbers (A2k)	☐	☐

A3. What did you or the target student use to work on the aspects of number concepts that you checked in Question A2?

(For any of the following items you choose, place an "X" in the corresponding box. Mark all that apply.)

- ☐ Numbers or symbols (A3a)
- ☐ Concrete materials (A3b)
- ☐ Real-life situations or word problems (A3c)
- ☐ Pictures or diagrams (A3d)
- ☐ Tables or charts (A3e)
- ☐ I made explicit links between two or more of these representations (A3f)

A4. What was the target student asked to do during the work on number concepts?

(Mark all that apply, but only if the target student did it for a sustained period of time.)

- ☐ Listen to me present the definition for a term or the steps of a procedure (A4a)
- ☐ Perform tasks requiring ideas or methods already introduced to the student (A4b)
- ☐ Assess a problem and choose a method to use from those already introduced to the student (A4c)
- ☐ Perform tasks requiring ideas or methods not already introduced to the student (A4d)
- ☐ Explain an answer or a solution method for a particular problem (A4e)
- ☐ Analyze similarities and differences among representations, solutions, or methods (A4f)
- ☐ Prove that a solution is valid or that a method works for all similar cases (A4g)

A5. Did the target student's work on number concepts today include any of the following?

(Mark all that apply, but only if the target student did it for a sustained period of time.)

- ☐ Orally answering recall questions (A5a)
- ☐ Working on textbook, worksheet, or board work exercises for practice or review (A5b)
- ☐ Working on problem(s) that have multiple answers or solution methods, or involve multiple steps (A5c)
- ☐ Discussing ideas, problems, solutions, or methods in pairs or small groups (A5d)
- ☐ Using flashcards, games, or computer activities to improve recall or skill (A5e)
- ☐ Writing extended explanations of mathematical ideas, solutions, or methods (A5f)
- ☐ Working on an investigation, problem, or project over an extended period of time (A5g)

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Number Concepts

- What numbers?
- Detail about topic
- Representations
- Cognitive and mathematical level
- Student tasks

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Helping Teachers Complete Logs

- Training teachers to use the logs
- Incentives
  - Large: financial
  - Small: treat teachers as colleagues
- Site coordinator visits
- Glossaries

Response rate:
Log completion rate exceeds 90 percent for mathematics

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Questions About Instructional Time

- How much time do students spend learning mathematics? (across teachers, grade levels, schools, programs)
- How does instructional time spent on ELA and math compare?
- How much variability is there in instructional time?



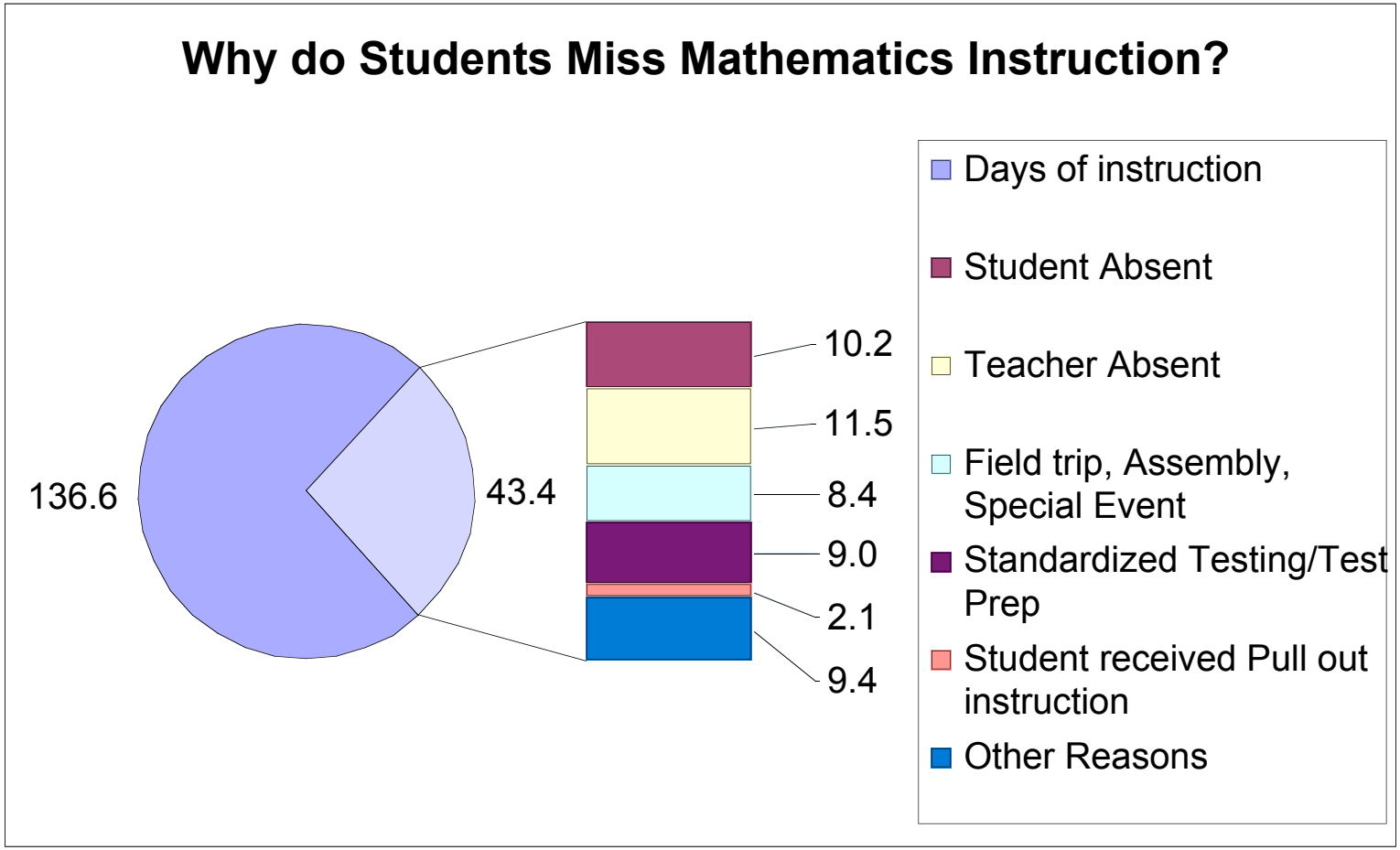
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What Do We Mean By "Instructional Time"?

- Began by calculating mean amounts of time spent
  - 72,000+ records of math instruction:
    - mean 44.34 minutes
    - standard deviation of 33.33 minutes
- What is going on?
  - Minutes of instruction = 0 on 24.1% logs
- Why might students receive no mathematics instruction on these days?

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Why Does Instructional Time = 0 on 24.1% of Logs?



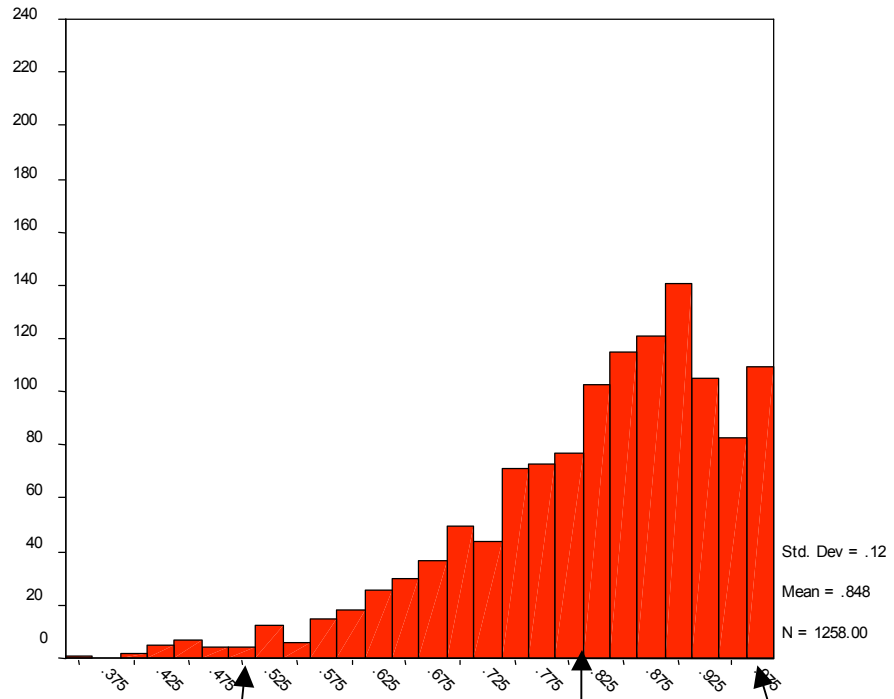
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How Much "Actual" Instruction Takes Place on "Possible" Instructional Days?

- "Possible" instruction: Days when both the student and teacher are in school
- "Actual" instruction: Student receives instruction
- RESULTS
  - Probability of receiving instruction on a given day
  - Mathematics: 84.4% (miss 1 out of 7 days)
  - ELA: 87.3% (miss 1 out of 8 days)
  - But . . . enormous variation

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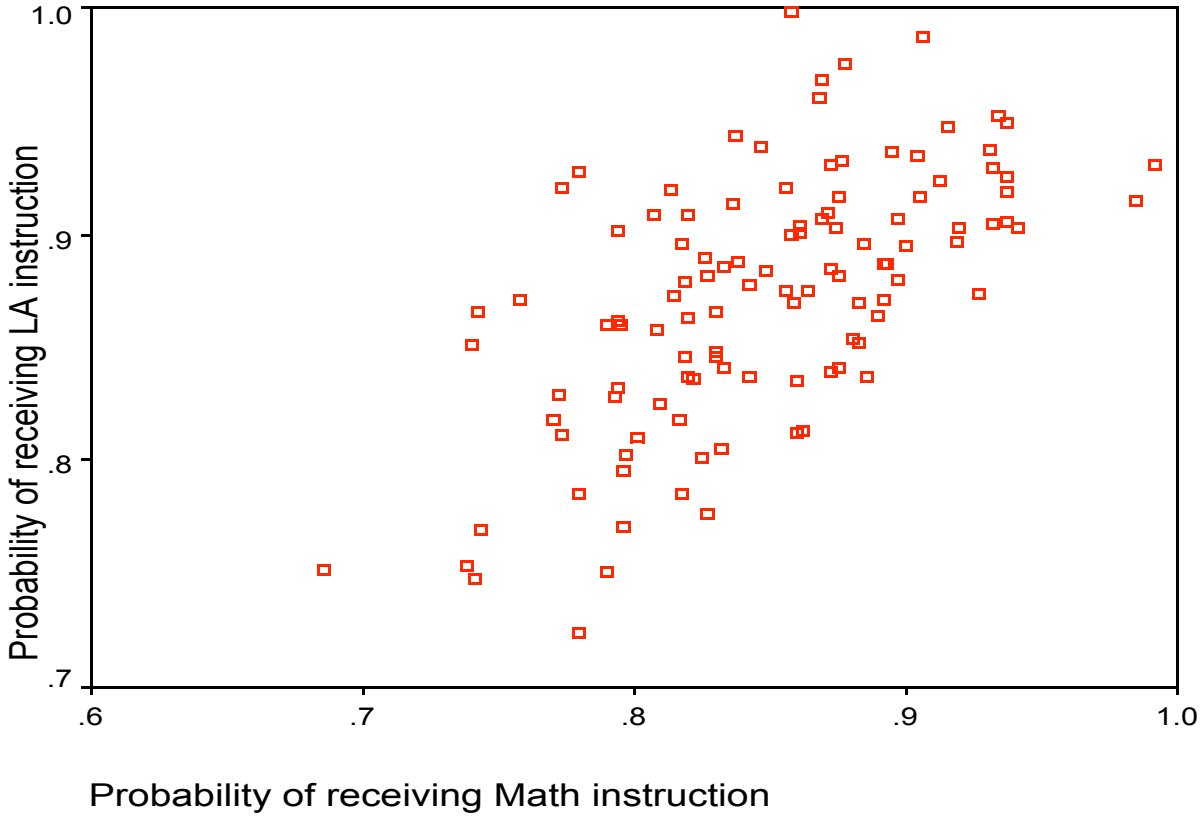
Probability by Teacher of Receiving Instruction



50% **75%** **100%**

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Relationship Between Teaching Mathematics and ELA



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Conclusions about Instructional Time

- Accurate measures of time show great variation in basic instructional opportunity
- Allows for investigating nuanced questions about how this instructional time is spent



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Teacher Knowledge

- What have we learned about the characteristics of teacher knowledge?
  - Measurement efforts
- Does teacher knowledge, measured in this way, affect student achievement?



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SII Measures of Teachers' Content Knowledge for Teaching Mathematics (CKT-M)

- Measure content that teachers use in teaching
- Contextualize the items in tasks (or situations) that all teachers face
- Usable measures:
  - Large sample of teachers (N=5500) = multiple choice
  - Not grade-specific (grade 1 - 6 teachers)
  - Not represent any single view of teaching (e.g., "reform")
  - Items that vary in difficulty
- Develop theory of knowledge for teaching in mathematics

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Writing Items: Our Strategy

- Limit topic domains: number concepts; operations; patterns, functions, and algebra
- SII measured content knowledge only
  - Common and specialized
  - Wider piloting: knowledge of content and students
- Use varied sources to identify task domains of teaching
- Involve experts in item development and review
- Pilot in California prior to SII use



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Piloting Result: Multidimensionality of "Content Knowledge"

- Content knowledge and knowledge of students and content on separate dimensions
- Within number concepts and operations content knowledge, two sub-scales:
  - "Common" content knowledge (CCK)
    - Number halfway between 1.1 and 1.11
  - Specialized content knowledge (SCK)
    - Known in ways useful for tasks of teaching (e.g., Appraising unusual methods, claims, or solutions; providing explanations for mathematical ideas and procedures; representing mathematical ideas and operations)

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Analyzing Unconventional "Correct" Solutions

Student A	Student B	Student C
35 x25 125 +75 875	35 x25 175 +700 875	35 x25 25 150 100 +600 875

Do these work for multiplying any two whole numbers?

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Analyzing Incorrect Answers

(a)

$$\begin{array}{r} 3.5 \\ \times\ 2.5 \\ \hline 255 \\ 80 \\ \hline 10.55 \end{array}$$

Why do you multiply before you add?

(b)

$$\begin{array}{r} 3.5 \\ \times\ 2.5 \\ \hline 62.5 \end{array}$$

Why do you have as many decimal places in the answer as the total number of decimal places in the problem?

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Mathematics: Validation

- Cognitive tracing interviews with teachers, laypeople, mathematicians
- Content validity checks
- Examining videotapes of classroom teaching
  - Comparing to measure scores



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Measuring Teacher Knowledge for SII: Mechanics

- Yearly teacher questionnaire
  - 30 items in number (13), operations (13), pre-algebra (4)
  - Common and specialized CKT-M
- Item response theory
  - Factor analyses and scoring
- Reliability: .88



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Student Achievement Data and Analysis

- Other key measures and data sources
  - Terra Nova gain scores (fall-fall or spring-spring)
  - Teacher coursework, certification, years experience
  - Time in mathematics instruction
  - CKT-English Language Arts (ELA)

- Mixed model (SAS)
  - 3-level model (students, teachers, schools)
  - Two models: 1st and 3rd grade

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SII Model

	Grade 1	Grade 3
Intercept	57.6 (1.32)	39.3 (.96)
Student variables		
SES	3.95*** (.94)	2.24** (.78)
….		
Teacher/classroom variables		
Math methods & content	.55 (.99)	1.69 (.92)
Certified	.28 (.87)	-.24 (.76)
Years experience	.72 (1.13)	1.04 (.65)
CKT-Mathematics	2.23* (.91)	2.23** (.77)
Math lesson length	-.13 (1.03)	1.80* (.85)
…..		

* Significant at p < .05
** Significant at p < .01
*** Significant at p < .001

- Teachers' CKT - M performance significantly predicts student gain scores
  - 1st and 3rd grade
- Small effect
  - 2-3 weeks of additional instruction
  - comparable to SES
- Instructional time
  - Positive in 3rd grade

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Correlates of Teacher Knowledge

	Math methods & content	Certified	Years experience	CKT-Math	CKT-ELA
Math methods & content	1.0	.03	.19**	-.08	-.05
Certified		1.0	.15*	.11*	.02
Years experience			1.0	-.09	.05
CKT-Mathematics				1.0	.37**
CKT-ELA					1.0

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Teacher Knowledge Conclusions

- Content knowledge does matter
- How it matters – just beginning to understand
  - "G" vs. subject-specific knowledge vs. specialized knowledge
- When it matters…
  - 1st grade finding
- Equity concerns
  - Student SES and minority status tied to teacher knowledge



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Lessons Learned

- Possibility of developing usable and useful instruments to collect data on important aspects of teaching at scale
- Importance of interdisciplinary expertise and joint work: mathematicians, teachers, teacher educators, researchers on teaching, sociologists, policy researchers, quantitative methodologists
- Importance of investment in many cycles of instrument development
- Usefulness for theory and for further studies of collaborating with international partners (new work underway)

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