Building Systems to Support Mathematics Instruction for All Students

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Yes we will talk about math!

- But first a diversion
  - To talk about Cholera….

The Ghost Map – Steven Johnson

- London 1854
- Explosive growth of cities linked to the Industrial Revolution
- Limited infrastructure – garbage removal, clean water, sewers
- London and all cities were prone to outbreaks of disease

The Ghost Map

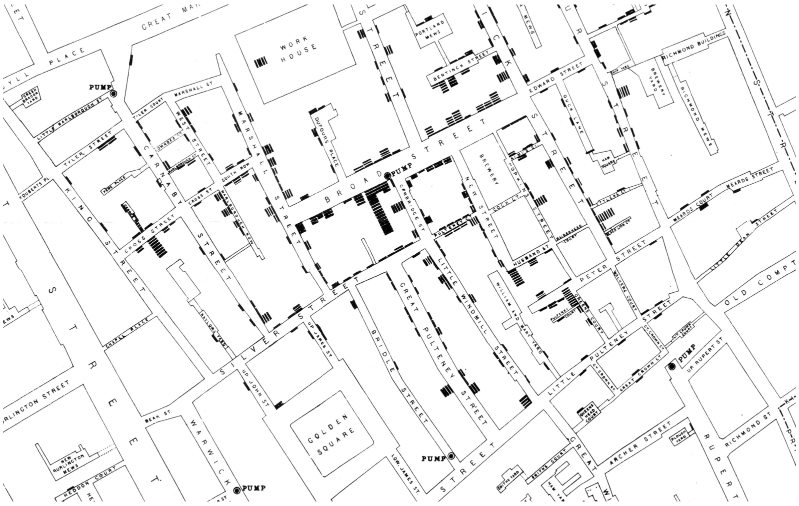
- But why – multiple theories but most prevalent was Maisma theory
- Maisma theory – disease was carried by bad or polluted air often indicated by smell
- This fit well with the public/governing perspective at the time since most disease was found in poor areas and led to some questionable policies

The Ghost Map

- Cholera outbreaks were feared and deadly (e.g. 1849 outbreak killed 50,000 Londoners
- 1854 – Fast acting/deadly but concentrated outbreak of Cholera in a poor London neighborhood
- Dr. John Snow teamed with Reverend Henry Whitehead to investigate another theory
- Snow believed the transmitting agent was something that was swallowed through drinking water (bacteriology was not yet a full fledged field)

The Ghost Map

- Systematically set about trying to observe the patterns of individuals who were dying.
- Traced source to a water pump on Broad street
  - Discovered the first case and source
  - Discovered an outlier to the current theory
- Created a ghost map (linking victims to the pump) and calculated probabilities linking access to the pump to cases.



The Ghost Map

- Countered prevalent wisdom (that was not tested) by a systematic pattern of observation
- Observation was grounded in beginning science of bacteriology
- Linked to (and cited as one of the first cases of) epidemiology

Science as a framework

- Science is: A systematic and empirical examination of solvable problems
  - Empiricism – the practice of relying on observation
  - Systematic – a replicable research methodology to study variables of interest
    - Through methodology

Science as a framework for education

- At it's heart science involves identifying and trying to solve problems
  - When applied to education
    - For education researchers (Hypothesis testing)
    - But also for practitioners (RTI/MTSS)

Challenges in Translating Research

- Deciphering evidence is difficult. Consider two interventions:
  - Intervention 1
    - Statistically significant result (p = .04)
    - Effect size of .5
  - Intervention 2
    - Non statistically significant result (p = .20)
    - Effect size of .25

Two interventions cont.

- Intervention 1
  - Two week intervention 10 total lessons (15 minute per day)
  - Computer delivery
  - Focused on addition/subtraction facts
- Intervention 2
  - 20 week intervention 60 total lessons (30 minutes per day 3 times per week
  - Delivered in small groups
  - Focused on broad whole number understanding and application

Discussion

- Which intervention is “better”?

Types of significance

- Statistical Significance
  - The golden rule of .05
  - Quantifiable
- Clinical Significance
  - Does the difference matter
  - Judgment of the value of quantitative metrics
- Take away – Examining research is both quantitative and qualitative.

Challenges in translating research cont.

- The majority of research in education is considered efficacy research.
  - E.g. Does this reading program improve reading comprehension?
  - Does this instructional strategy results in greater student gains?
- Efficacy research creates what is considered a research base

Discussion

- What is the difference between research evidence and research based?

The case of Reading First

- Reading First was initially designed to implement programs with efficacy data
- Changed to implement research based practices derived from cumulative evidence from multiple efficacy trials
  - National Reading Panel
  - Meta analyses on instructional practices

Reading First cont.

- No impact on reading comprehension. But why?
- Competing Explanations
  - The research base is wrong
  - How the research base is operationally defined matters
- Take away - How the research base is defined and implemented matters

Challenges in translating research within reform efforts

- Research and Education do not occur in a vacuum.

- What is current in the social context can drive changes in educational practice

- Consider two examples
  - Technology
  - Charter Schools

The Promise of Technology

- Multiple benefits espoused
  - E.g. Individualization of instruction

- Yet….
  - In-depth analysis of technology programs found relatively few programs had been analyzed using rigors methods and of those relatively few showed any promise of impact.

- But why?

Charter Schools

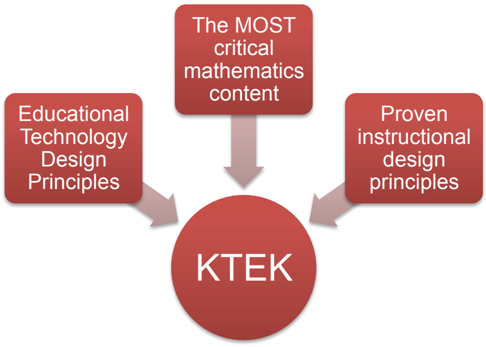
- Advocated for as a means to improve student achievement through market principles (i.e. competition)
- Yet….
  - Major reviews of charter schools show no impact on student achievement
- But why?

But why?

- Reform efforts or new solutions still need to be based on research
  - It isn't enough to do the same thing in a different manner (technology) or different setting (charter schools)
  - For example, technology programs failed to attend to key instructional design principles and focused content

But why:

- Take away - Reform efforts need to reflect the cumulative knowledge of the field



Challenges in translating research cont.

- As we acquire new knowledge we integrate it with existing knowledge
  - Good – provides a framework for deciphering new research and implications for practice
  - Bad – may result in a set way of viewing the world.
- Take away – Be grounded yet flexible.

Challenges in Translating Research to the Classroom

- Research is based on analyzing group trends
- Take away – as you practice in schools you essentially are conducting research. This is the logic of RTI or MTSS.

The Case of the IES Practice Guides

All Practice Guides are available at:

http://ies.ed.gov/ncee &
http://ies.ed.gov/ncee/wwc/publications/practiceguides/

Why the Guides?

- Back Story: Transition to a medical model for evaluation
  - Institute of Education Sciences (IES)
  - What Works Clearinghouse Reports
  - Practice Guides
- Build stronger links between research and practice.

Why the RTI Math Guide?

High Level of Interest in Mathematics

- National Research Council: Adding it Up
- National Council Teachers of Mathematics: Focal Points
- National Mathematics Advisory Report

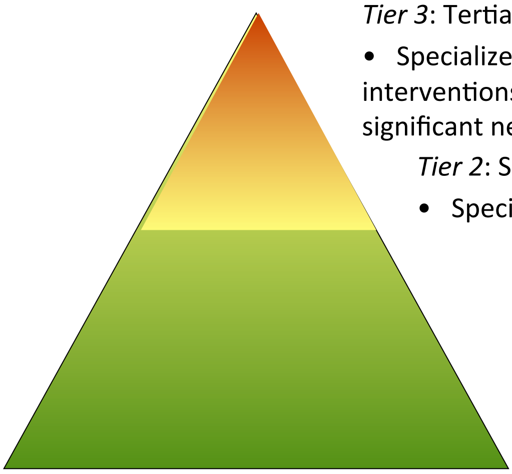
Need for mathematical knowledge

- "For people to participate fully in society, they must know basic mathematics. Citizens who cannot reason mathematically are cut off from whole realms of human endeavor. Innumeracy deprives them not only of opportunity but also of competence in everyday tasks." (Kilpatrick, Swafford, & Findell, *Adding It Up*, 2001)

Response to Intervention

- Reauthorization of IDEA (2004) allowed for RtI to be included as a component in special education evaluations
- Premised on the use of research-based interventions and student response to intervention
  - Students who respond are not identified as learning disabled
  - Students who do not respond are referred for a complete evaluation and potential identification as learning disabled

RtI/MTSS: A Framework



Tier 3: Tertiary/Intensive

- Specialized, individualized interventions for students with significant needs

Tier 2: Secondary/Targeted

- Specialized interventions for students at-risk for failure

Tier 1: Primary/Universal

- School-wide system of support
- Designed to support the needs of all students

Figure courtesy of Nelson-Walker (2009)

Foundations of RtI/MTSS

- Requires high-quality interventions and research-based instruction
- Identifies students based on risk rather than deficits
  - Prevention model vs. Remediation model
- Links identification assessments and progress monitoring tools with instructional planning (i.e., data-based decision making)

Potential Benefits of RtI/MTSS

- Builds a communication bridge between general education, special education, and other support services
- Allows educational decisions to be based on intervention outcomes rather than other factors
- Most often implemented in the area of reading BUT

  What about MATH?

Discussion Items

- What initiatives are in place to improve mathematics achievement?
- Is that work linked to an RtI/MTSS model?
- How does your student performance compare to the RtI "triangle" and what type of RtI/MTSS system do you use?

Assisting Students Struggling with Mathematics: Response to Intervention (RtI) for Elementary and Middle Schools

Copies available at the IES website:
http://ies.ed.gov/ncee
http://ies.ed.gov/ncee/wwc/publications/practiceguides/

Panelists

- Russell Gersten (Chair)
- Sybilla Beckman
- Ben Clarke
- Anne Foegen
- Laurel Marsh
- Jon R. Star
- Bradley Witzel

Search for Coherence

Panel works to develop 5 to 10 assertions that are:

- Forceful and useful
- And COHERENT
- Do not encompass all things for all people
- Do not read like a book chapter or article

Challenges for the panel:

- State of math research
- Distinguishing between tiers of support

Jump start the process by using individuals with topical expertise and complementary views

Structure of the Practice Guide

- Recommendations
- Levels of evidence
- How to carry out the recommendations
- Potential roadblocks & suggestions

The Research Evidence

- The panel considered:
  - High-quality experimental and quasi-experimental studies
  - Also examined studies of screening and progress monitoring measures for recommendations relating to assessment

Evidence Rating

- Each recommendation receives a rating based on the strength of the research evidence
  - Strong
  - Moderate
  - Low

Recommendations

Recommendation	Level of Scientific Evidence
1. Universal screening (Tier I)	Moderate
2. Focus instruction on whole number for grades K-5 and rational number for grades 6-8	Low
3. Systematic instruction	Strong
4. Solving word problems	Strong
5. Visual representations	Moderate
6. Building fluency with basic arithmetic facts	Moderate
7. Progress monitoring	Low
8. Use of motivational strategies	Low

Recommendation 1

- Screen all students to identify those at risk for potential mathematics difficulties and provide interventions to students identified as at risk
  - Level of Evidence: **Moderate**

Suggestions

- Have a building-level team select measures based on critical criteria such as reliability, validity, and efficiency
- Select screening measures based on the content they cover with a emphasis on critical instructional objectives for each grade level
- In grades 4-8, use screening measures in combination with state testing data
- Use the same screening tool across a district to enable analyzing results across schools

Recommendation 2

- Instructional materials for students receiving interventions should focus intensely on in-depth treatment of whole numbers in kindergarten through grade 5 and on rational numbers in grades 4 through 8. These materials should be selected by committee
  - Level of Evidence: **Low**

From the field

- Consensus across mathematicians, professional organizations, and research panels
  - Milgram and Wu (2005) covering fewer topics with greater depth
  - National Council Teachers of Mathematics (NCTM) and National Mathematics Advisory Panel (NMAP)

Suggestions (1)

- For tier 2 and 3 students in grades K-5, interventions should focus on the properties of whole numbers and operations. Some older students would also benefit from this approach
- For tier 2 and 3 students in grades 4-8, interventions should focus on in-depth coverage of rational numbers and advanced topics in whole numbers (e.g., long division)

Focused Content

- Increasingly found in researcher developed mathematics interventions
  - Number Rockets (Fuchs and colleagues)
  - Number Sense (Jordan and colleagues)
  - Work by Bryant and colleagues

- Efforts are expanding for the upper elementary grades

Suggestions (2)

- Districts should appoint committees with experts in mathematics instruction and mathematicians to ensure specific criteria are covered in depth in adopted curriculums
  - Integrate computation with problem-solving and pictorial representations
  - Stress reasoning underlying calculation methods
  - Build algorithmic proficiency
  - Contain frequent review of mathematical principles
  - Contain assessments to appropriately place students in the program

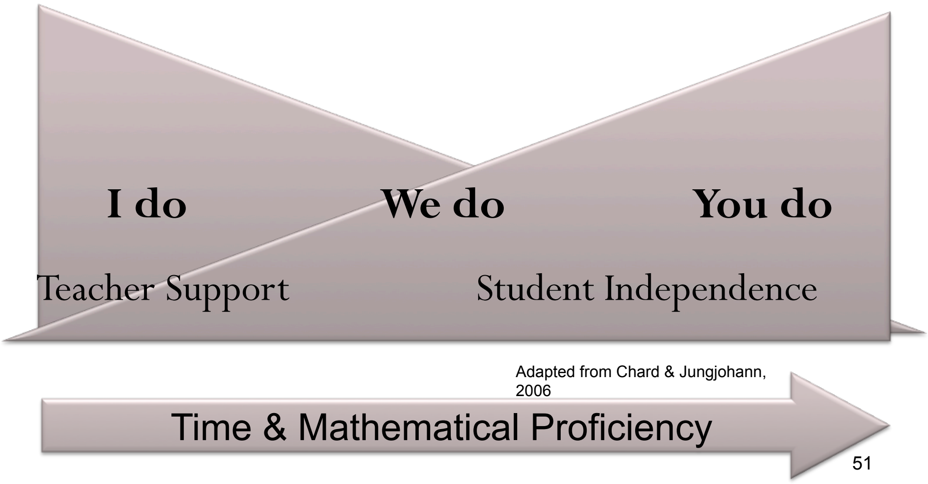
Recommendation 3

- Instruction during the intervention should be explicit and systematic. This includes providing models of proficient problem-solving, verbalization of thought processes, guided practice, corrective feedback, and frequent cumulative review
  - Level of Evidence: **Strong**

Suggestions

- Ensure that intervention materials are systematic and explicit, and include numerous models of easy and difficult problems with accompanying teacher think-alouds
- Provide students with opportunities to solve problems in a group and communicate problem-solving strategies
- Ensure that instructional materials include cumulative review in each session

Scaffolding Instruction for Learning Success



Adapted from Chard & Jungjohann, 2006

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Recommendation 4

- Interventions should include instruction on solving word problems that is based on common underlying structures
  - Level of Evidence: **Strong**

Suggestions

- Teach students about the structure of various problem types, how to categorize problems, and how to determine appropriate solutions
- Teach students to recognize the common underlying structure between familiar and unfamiliar problems and to transfer known solution methods from familiar to unfamiliar problems.

Recommendation 5

- Intervention materials should include opportunities for the student to work with visual representations of mathematical ideas and interventionists should be proficient in the use of visual representations of mathematical ideas
  - Level of Evidence: **Moderate**

Suggestions

- Use visual representations such as number lines, arrays, and strip diagrams
- If necessary, consider expeditious use of concrete manipulatives before visual representations. The goal should be to move toward abstract understanding.

Recommendation 6

- Interventions at all grades should devote about 10 minutes in each session to building fluent retrieval of basic arithmetic facts
  - Level of Evidence: **Moderate**

Suggestions

- Provide 10 minutes per session of instruction to build quick retrieval of basic facts. Consider the use of technology, flash cards, and other materials to support extensive practice to facilitate automatic retrieval
- For students in grades K-2, explicitly teach strategies for efficient counting to improve the retrieval of math facts
- Teach students in grades 2-8 how to use their knowledge of math properties to derive facts in their heads

Recommendation 7

- Monitor the progress of students receiving supplemental instruction and other students who are at risk
  - Level of Evidence: **Low**

Suggestions

- Monitor the progress of tier 2, tier 3 and borderline tier 1 students at least once a month using grade appropriate general outcome measures
- Use curriculum-embedded assessments in intervention materials to determine whether students are learning from the intervention. Measures can be used as frequently as every day or infrequently as once every week

Recommendation 8

- Include motivational strategies in tier 2 and tier 3 interventions
  - Level of Evidence: **Low**

Suggestions

- Reinforce or praise students for their effort and for attending to and being engaged in the lesson
- Consider rewarding student accomplishment
- Allow students to chart their progress and to set goals for improvement.

Discussion

- Which aspects of the report are surprising?
  - Recommendations
  - Levels of evidence
  - Suggestions
- Which recommendations from the Practice Guide are the highest priority for you? Why?
- From where you sit in your current job, was the presentation consistent with how you think about RtI?

Getting Started

- Primary:
  - Valid system for screening
  - An array of evidence-based intervention or at least promising interventions for beginning Tier 2 students
- Secondary:
  - Focus on core program efficacy
  - System for progress monitoring
  - Diagnostic assessments