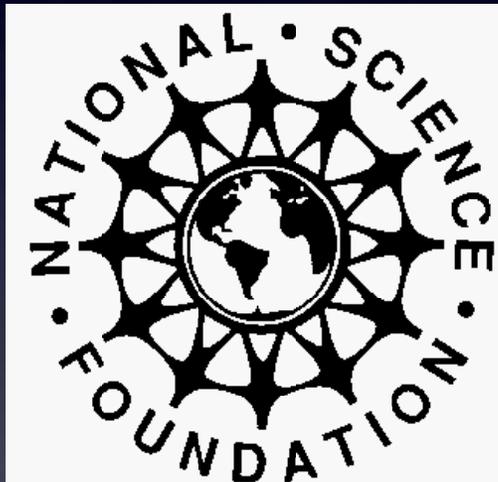


“Math Lessons” from Research

Douglas H. Clements
University at Buffalo, SUNY



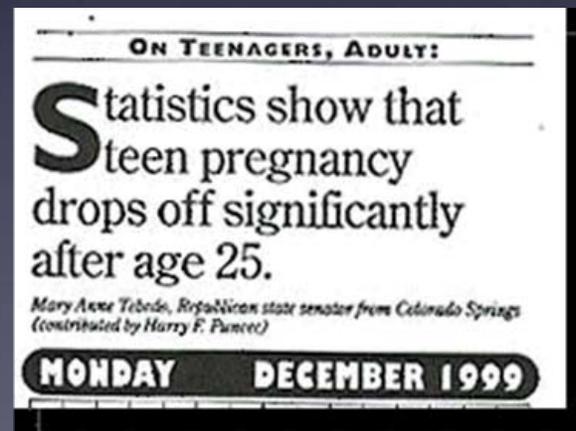
Building Blocks



ED.gov

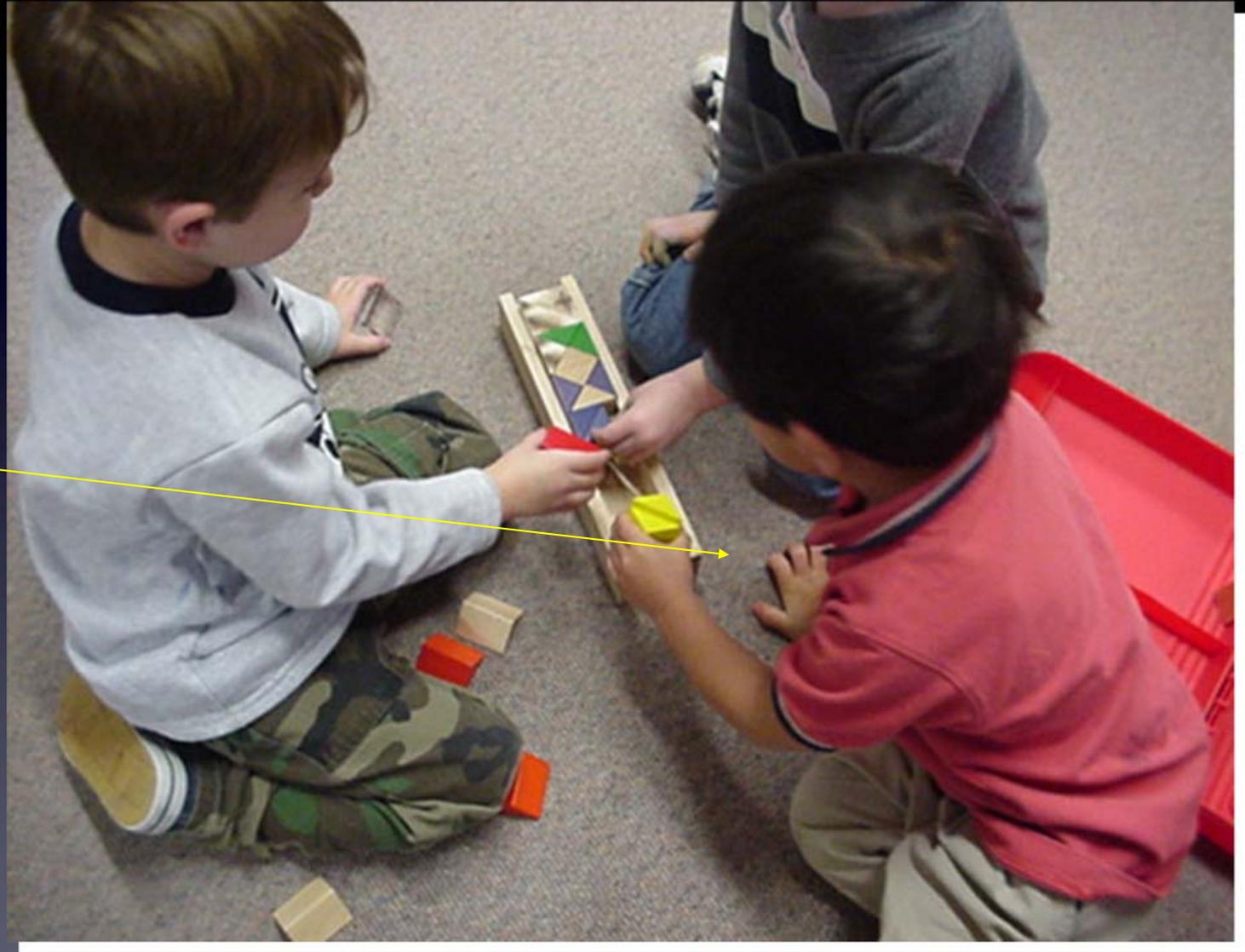
U. S. Department of Education
Promoting educational excellence for all Americans

We Need Better Math

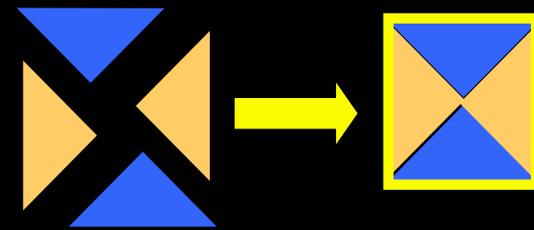


Vision

- 4- and 5-year-olds
- Puzzle
- Cory puts 4 triangles together to make squares



Vision



Cory makes a new shape: A unit of

units!

Another
boy sees
the
square
structure,
but builds
the wrong
square



Vision

Finishing, Cory shows adult, who asks:
“How many triangles did you use?”

Cory counts: “24”

“24 what?”

“Triangles.”

“How many squares
do you have?”

Puts 4 fingers on
triangles in each
new unit and counts
each square: “6!”





Math and Literacy

- Large-scale research, predicting school success
(Duncan et al., 2004)
- Early literacy predicted later reading (only)
- Early math predicts later math
 - *And* reading,
 - particularly for low SES & black



Lessons from Research

- Gaps are striking
- Less is more
- Use truly research-based education
- Connect informal and school math
- Include geometry
- Use learning trajectories

School Mathematics Is Not Working Well Enough for Enough Students

- Internationally, our students are not mathematically competitive



Source: TIMSS Grade 8, 1994–1995

• Best funded U.S. →

• Worst funded. →

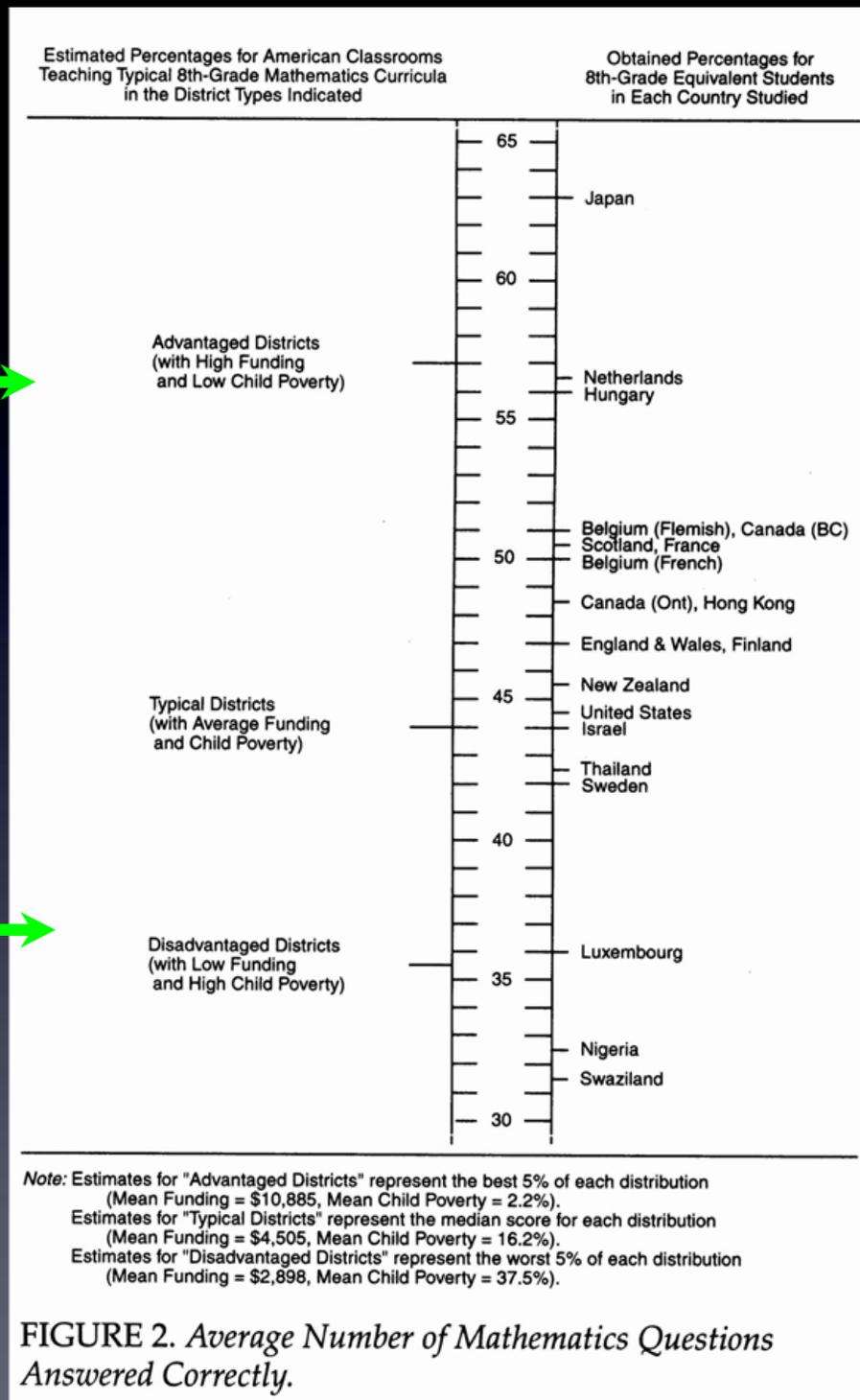


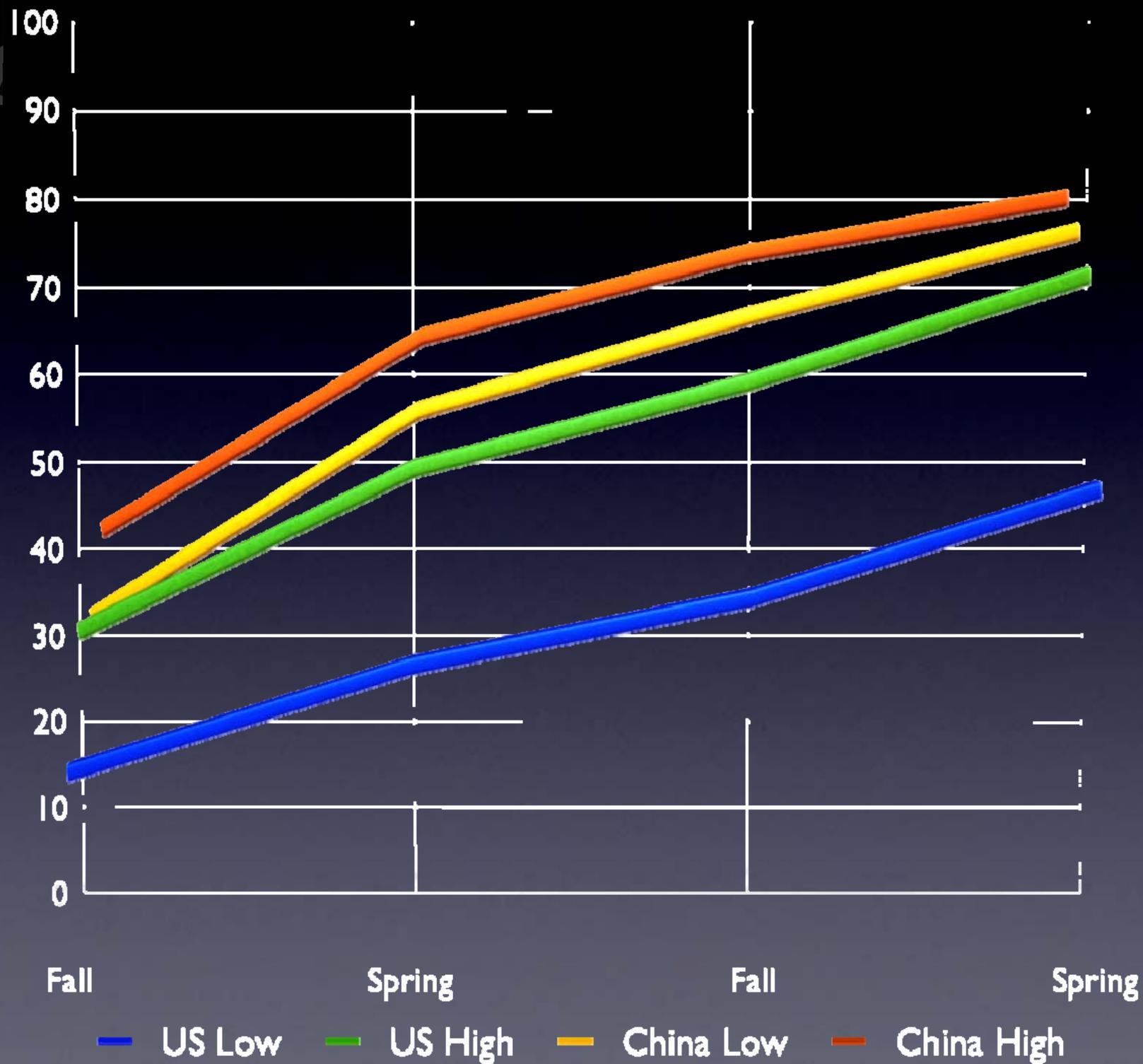
FIGURE 2. Average Number of Mathematics Questions Answered Correctly.



10 to 1



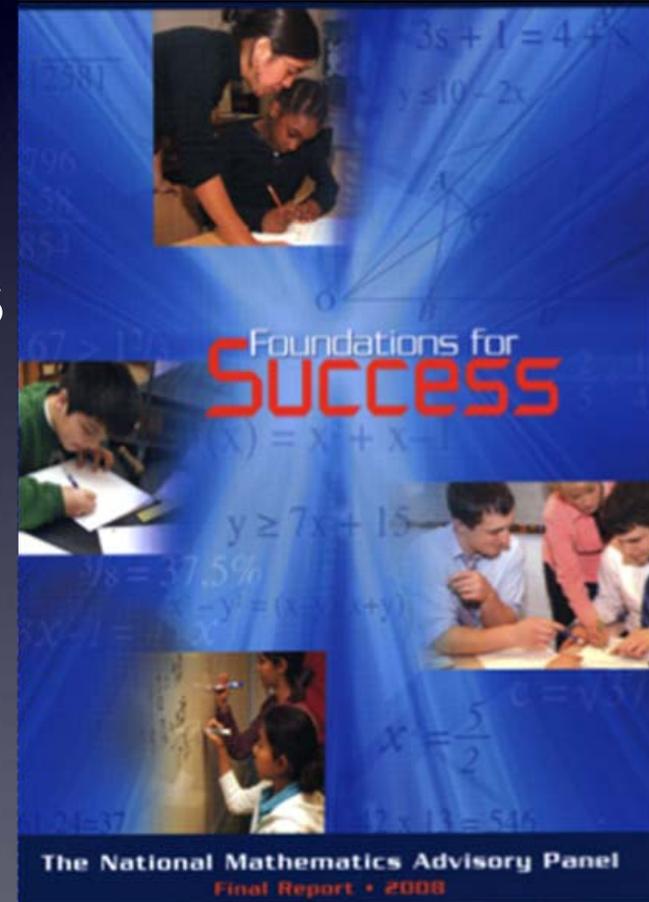
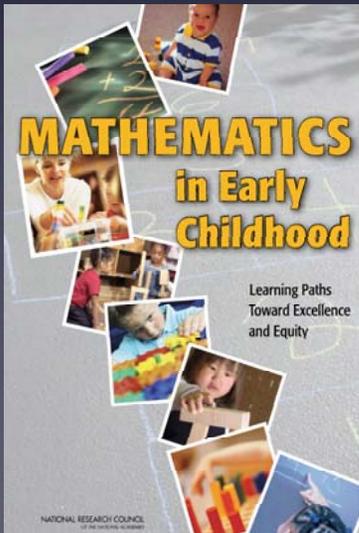
Inequities Begin *Early*



National Math Panel

Children from low-income backgrounds enter school with far less knowledge...

gap...progressively widens throughout their PreK-12 years”

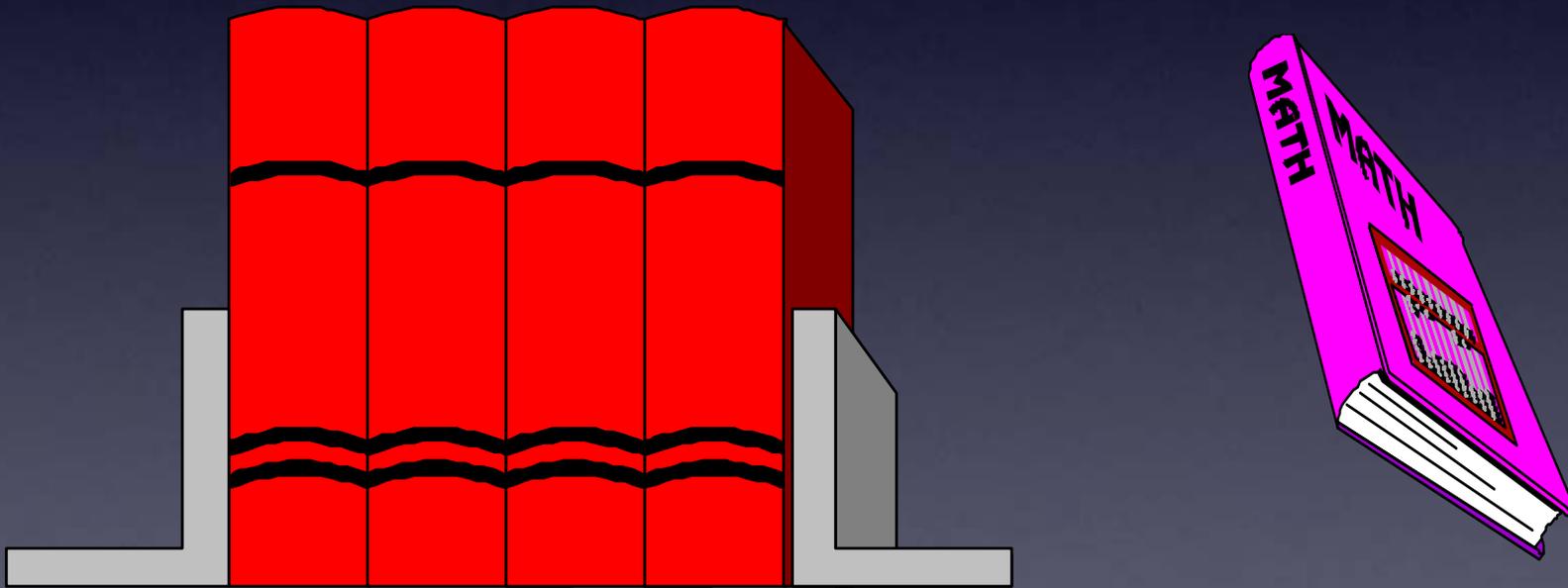




Lesson:
Gaps Are Striking
(internationally and
between SES groups)

Lesson: Less is More

- Sustained time on *fewer* key *concepts*



Which illustrates the U.S. and which the Japanese texts?



- Built upon CFP and NRC reports, and, like them...
- *Born from learning trajectories*

Common Core State Standards Initiative

Curriculum Research Framework



- A Priori Foundation
 - General: Broad philosophies, theories, and empirical results

Building Blocks: Approach

- Basic approach is *finding the mathematics in, and developing mathematics from,* children's activity
- Help children extend and mathematize their everyday activities, from building blocks to art to songs to puzzles.



Curriculum Research Framework

- A Priori Foundation
 - General: Broad philosophies, theories, and empirical results
 - Subject Matter



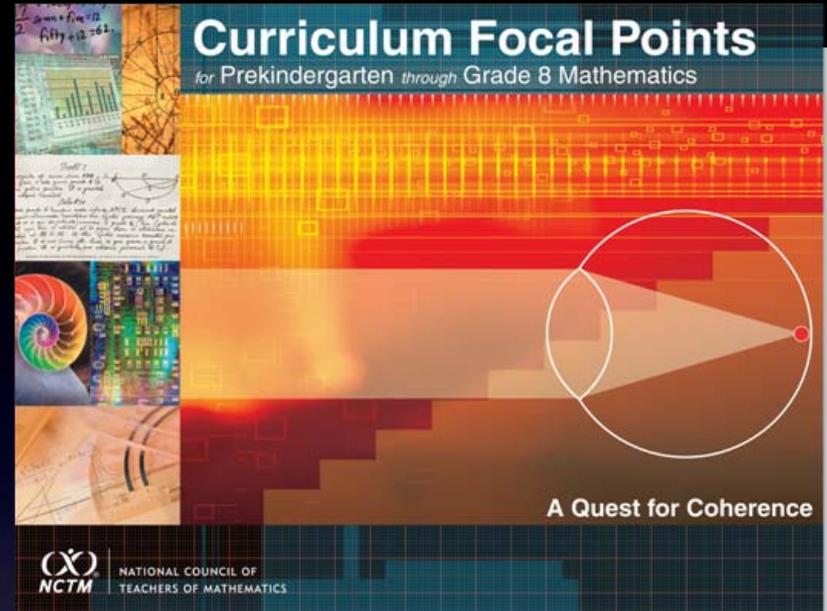
Engaging Young Children in Mathematics

Standards
for Early
Childhood
Mathematics
Education



Edited by
Douglas H. Clements
Julie Sarama

Associate Editor
Ann-Marie DiBiase



Building Blocks

Curriculum Research Framework

- A Priori Foundation
 - General: Broad philosophies, theories, and empirical results
 - Subject Matter
 - Pedagogical
 - E.g., What makes computer activities engaging and effective
 - Specific combination of instruction strategies



Curriculum Research Framework

- Learning Trajectories



Curriculum Research Framework

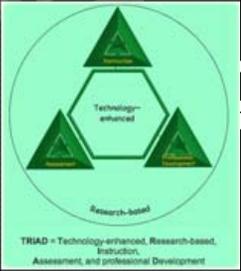


- Formative Evaluation
 - Formative Research: Small Group
 - Formative Research: Single Classroom
 - Formative Research: Multiple Classrooms
 - Diverse group of teachers
 - Support required

Curriculum Research Framework

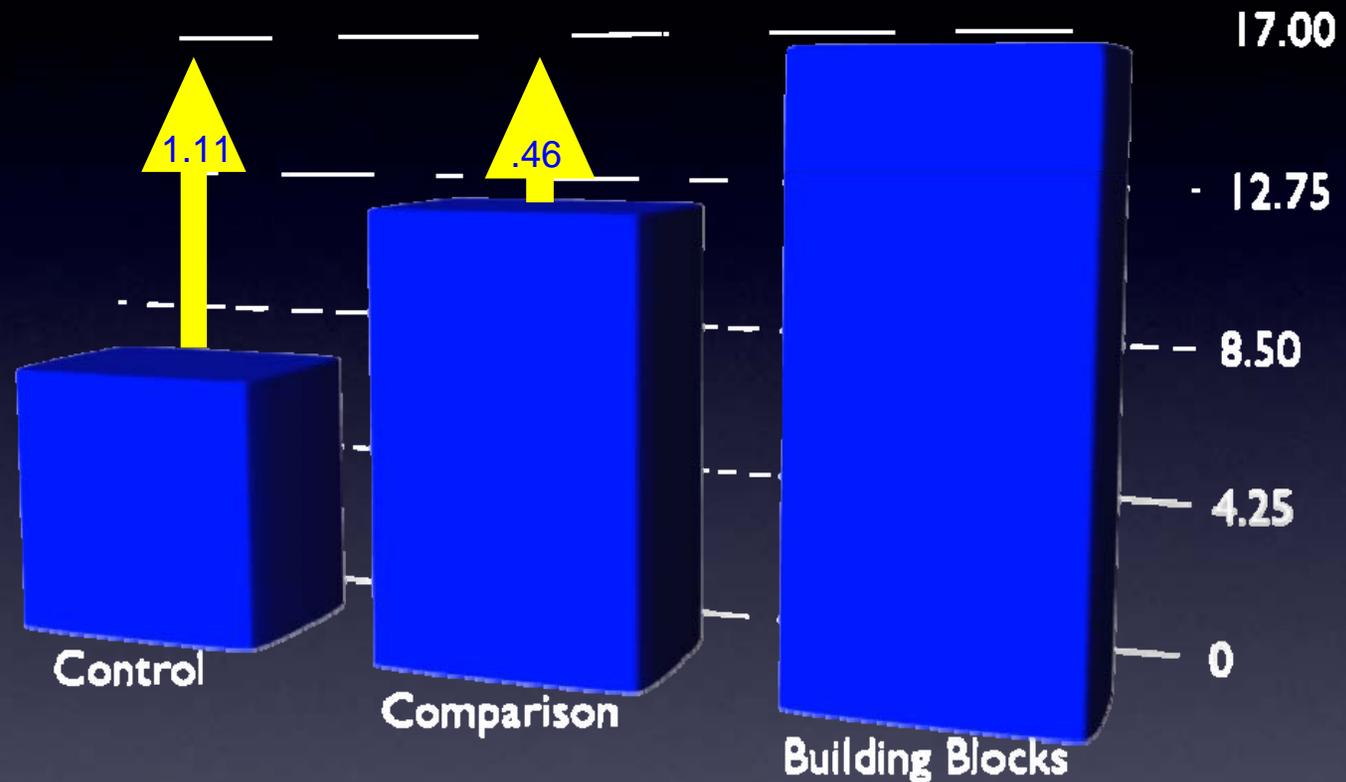
- Summative Research: Small Scale
 - 4-10 classrooms
- Summative Research: Large Scale
 - IERI-type scale up
- (Note: “Gold standard” of evaluation: Randomized trials)





Results: Child Assessment

- $F(1, 32) = 40.52$,
 $p = .000+$
- T Scores:
 - 50 Mean
 - 10 SD



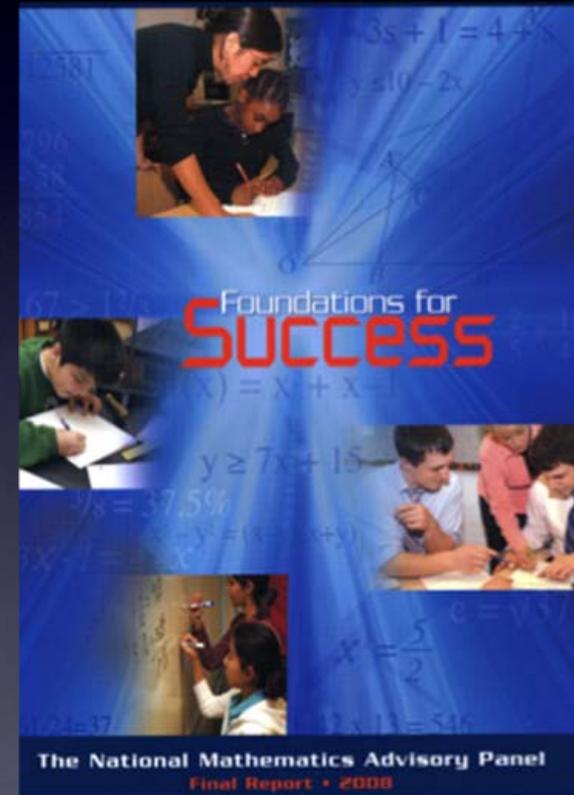
Clements, D. H., & Sarama, J. (2008). Experimental evaluation of the effects of a research-based preschool mathematics curriculum. *American Educational Research Journal*, 45, 443-494.

National Math Panel

“Research that scales up early interventions capable of strengthening mathematical knowledge,

evaluates their utility in Pre-K and K, and examines long term effects

is urgently needed, with a particular focus on at-risk learners”



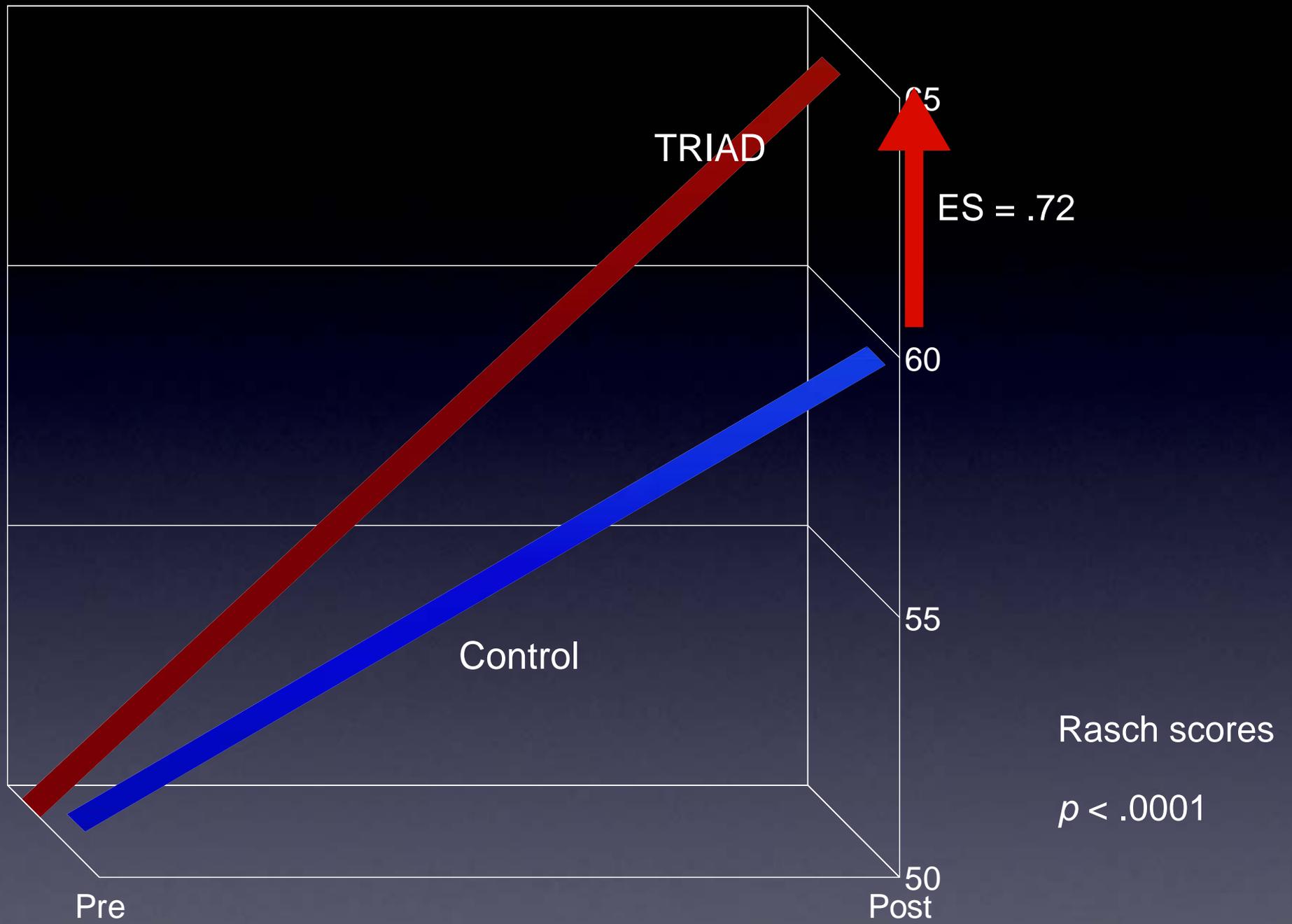
TRIAD II: Large- Scale Evaluation



Design



- 167 classrooms in 3 states
- Schools publicly, randomly assigned to:
 - TRIAD
 - TRIAD-*with Follow Through*
 - Control



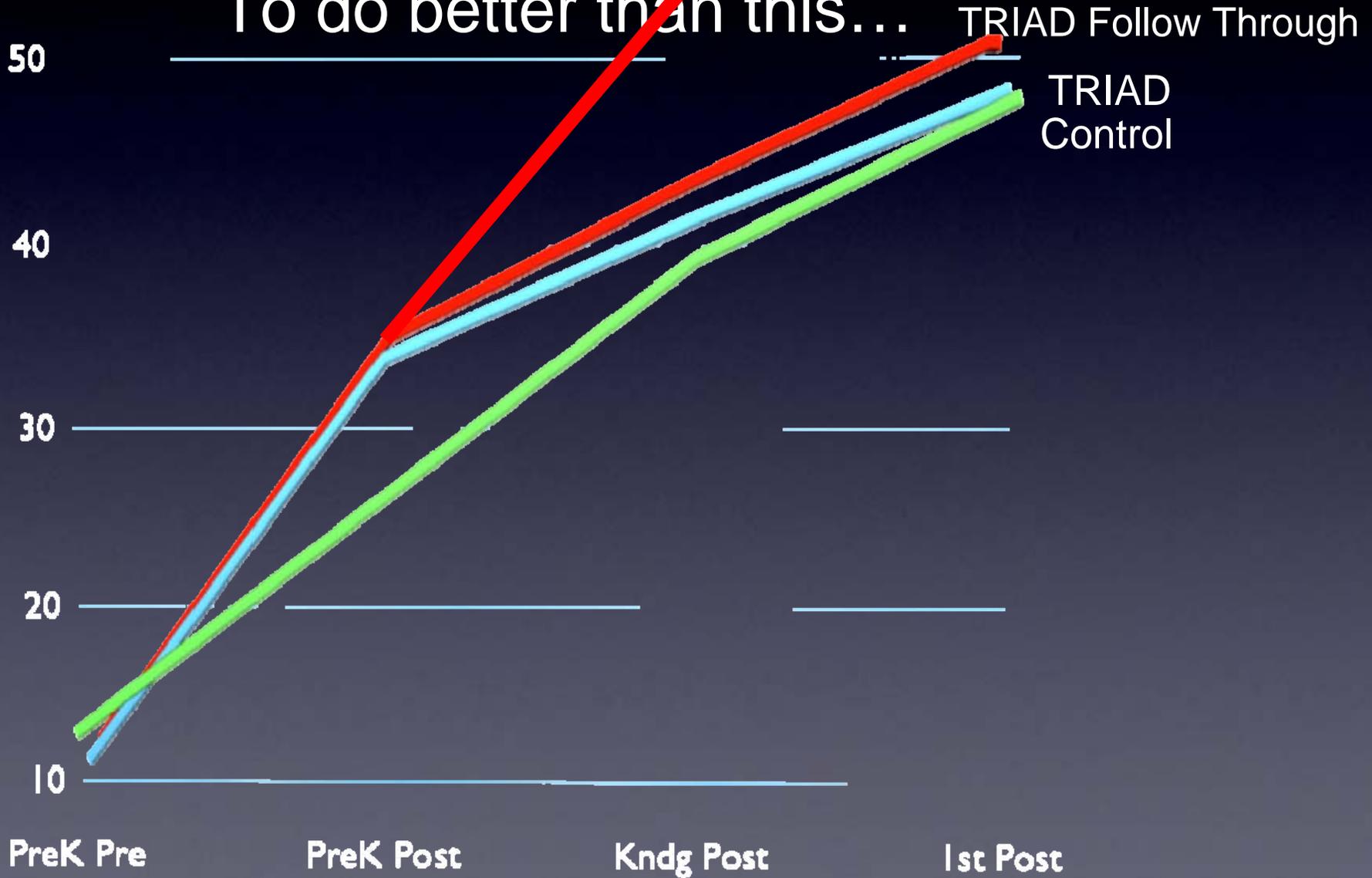
Building Blocks in the News



- <http://www.thebostonchannel.com/news/15776035/detail.html>

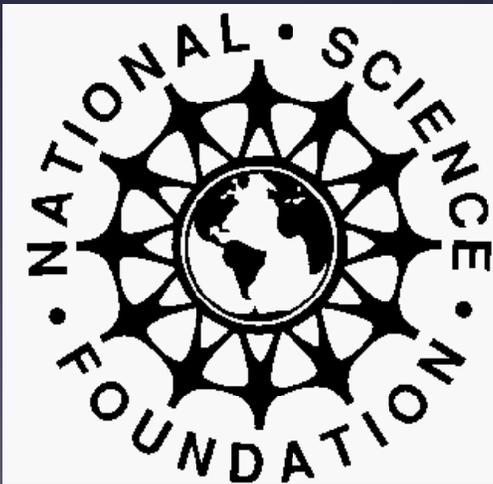
We need *this...*

To do better than this...



Lesson

Use truly research-based education



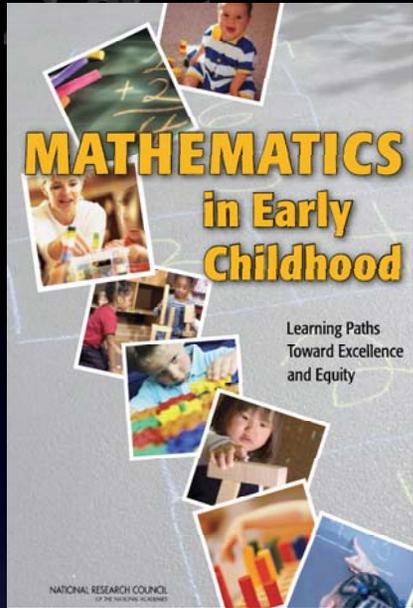


Informal and School Math

Creative Mathematics

- Alex, a five-year-old girl whose brother, Paul, was age three.
- Alex: When Paul is six, I'll be eight; when Paul is nine, I'll be eleven; when Paul is twelve, I'll be fourteen [she continues until Paul is 18 and she is 20].
- My word! How on earth did you figure all that out?
- Alex: It's easy. You just go "three-FOUR-five" [saying the "four" very loudly, and clapping hands at the same time, so that the result was very strongly rhythmical, and had a soft-LOUD-soft pattern], you go "six-SEVEN [clap]-eight," you go "nine-TEN [clap!]-eleven",.... (Davis, 1984, p. 154)

How?



Planned and sequenced

Variety of instructional approaches

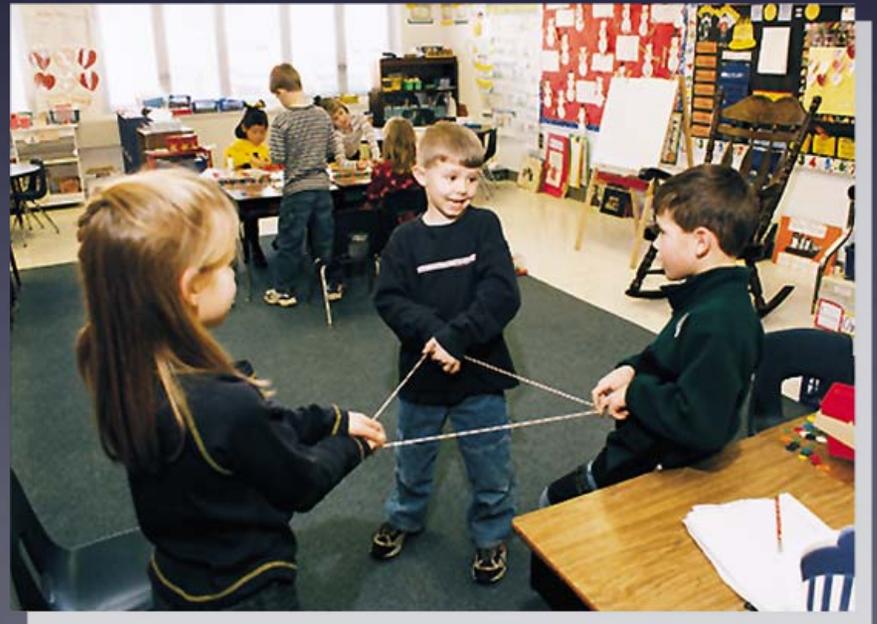
Intentional teaching

Formative assessment

Math talk

Positive learning environment

Geometry and Measurement





From PreK to HS

- Traditional instruction promotes little conceptual change
- E.g., 1st to 3rd graders

What Children See

- Ring the triangles

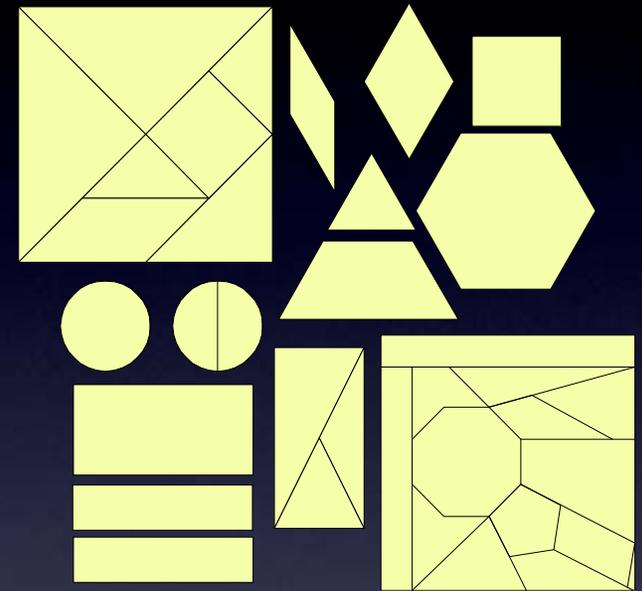
NAME Reginald

Ring the pictures that have the shape of a triangle.

Triangles 155

Geometry Must Move

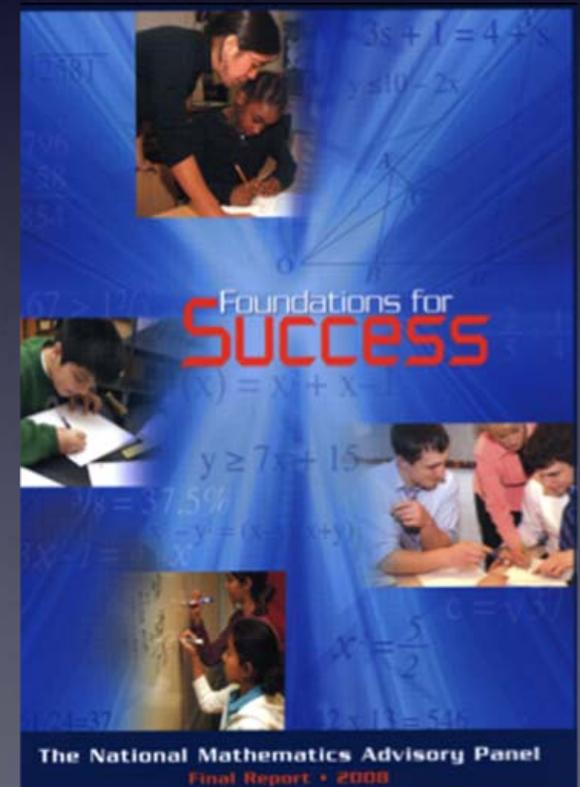
- Beyond “basic” shape naming, to
- Parts & Properties
 - Shape attributes
 - Including analysis and description
- Mental images and transformations
- Composing and decomposing



NMP: Formative Assessment

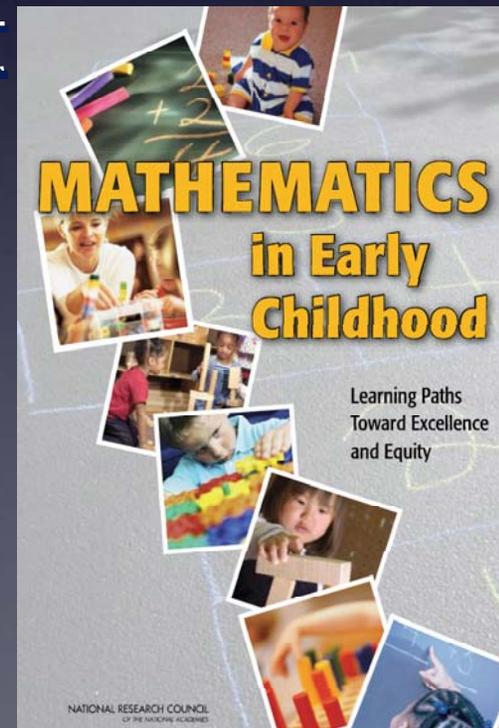
- Teachers' regular use of formative assessment improves their students' learning

National Math Panel



Learning Trajectories

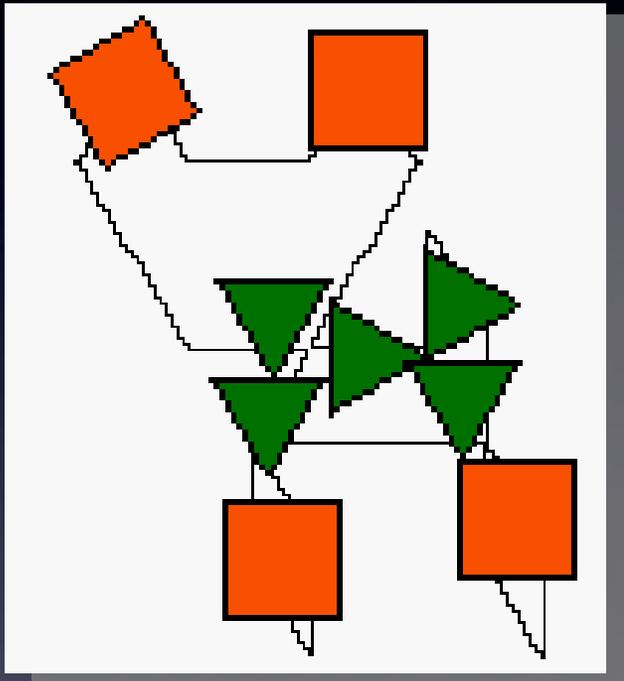
- Need path for concepts, skills
- Teachers who succeed do not “cover” curriculum, but move through LT
- *Building Blocks...*



A Trajectory for Composing Geometric Shapes

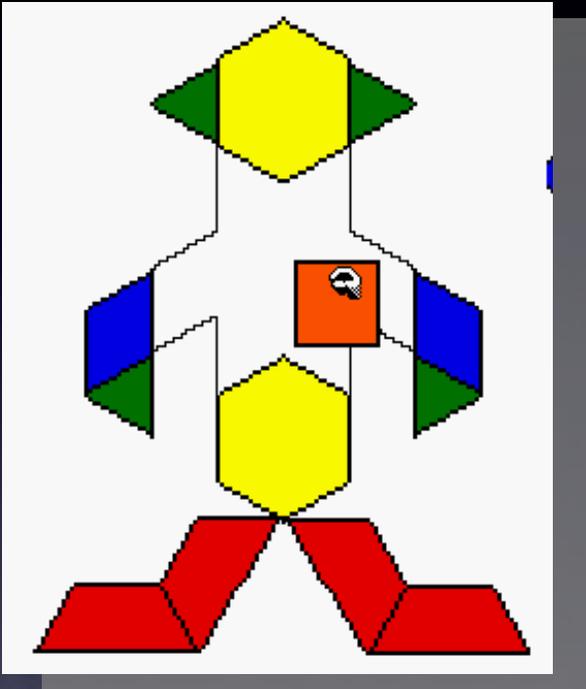


Pre-Composer



- Manipulates shapes as individuals, but unable to combine them to compose larger shape

Picture Maker



- Chooses shapes using gestalt configuration or one component such as side length; “pick and discard” strategy



Shape Composer

- Combines to make new shapes, with anticipation. Chooses shapes using angles as well as side lengths (Intentionality: “I know what fits.”)

Lessons from Research

- Gaps are striking
- Less is more





Lessons from Research

- Use truly research-based education
- Connect informal and school math

Lessons from Research

- Include Geometry
- Use learning trajectories, in
 - Teaching
 - Choosing curricula
 - RTI
 - Professional development





Early Childhood Mathematics Education Research

Learning Trajectories for Young Children

Julie Sarama & Douglas H. Clements



One Last Lesson

How eating chocolate can help improve your maths

Eating chocolate could improve the brain's ability to do maths, a new study suggests.

By Kate Devlin
Last Updated: 6:38AM BST 03 Apr 2009



Mental arithmetic became easier after volunteers had been given large amounts of compounds found in chocolate in a hot cocoa drink Photo: PHILIP HOLLIS
Mental arithmetic became easier after volunteers had been given large amounts of compounds found in chocolate, called flavanols, in a hot cocoa drink.

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Scientists reveal how eating chocolate can help improve your maths

Eating chocolate could improve the brain's ability to do maths, a new study suggests.

By Kate Devlin
Last Updated: 3:50PM BST 03 Apr 2009

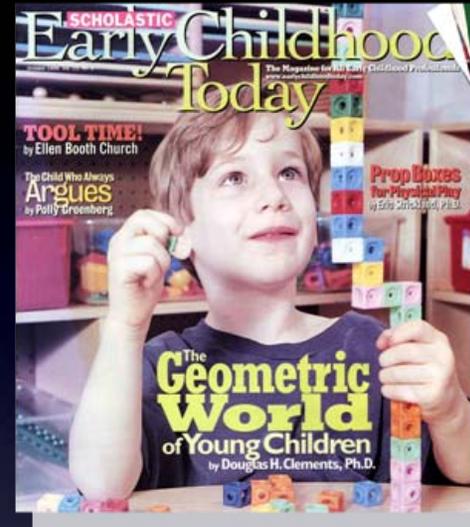
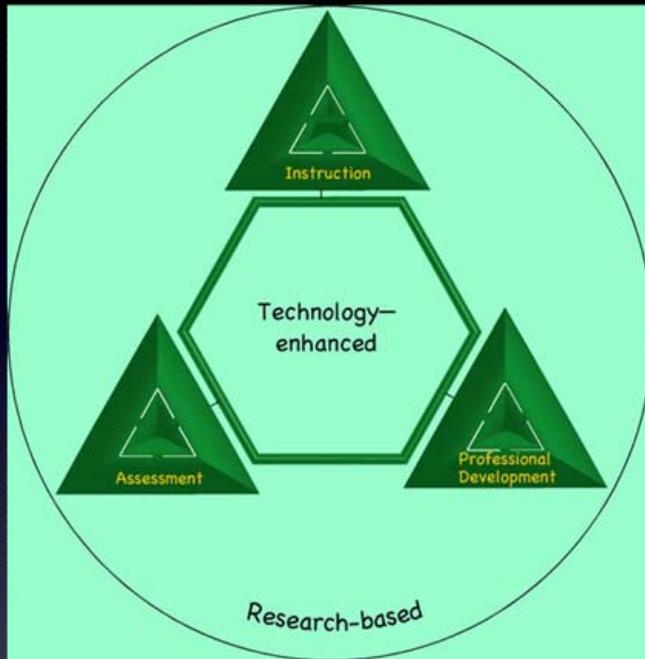


Taxing the treat would raise its profile as an unhealthy food which can contribute to weight-related conditions including diabetes and high blood pressure, says Dr Walker Photo: GETTY

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