“Math Lessons” from Research
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We Need Better Math

- Special Deal!!
  Buy 3 for the price of 3!

- Get
  50% off
  or half price, whichever is less.

- Statistics show that
teen pregnancy
drops off significantly
after age 25.

Mary Anne Teboe, Republican state senator from Colorado Springs
(contrived by Harry F. Pemce)

On Teenagers, Adult:

Monday December 1999
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”

“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.
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*
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
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

“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
TRIAD

Rasch scores

ES = .72

$p < .0001$
Building Blocks in the News

We need **this**…

To do better than this…

**TRIAD Follow Through**

**TRIAD Control**
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
From PreK to HS

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

- Ring the triangles
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.”)
• 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
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 HOLMES
Mental arithmetic became easier after volunteers had been given large amounts of compounds found in chocolate, called flavonoids, in a hot cocoa drink.

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

Tasting 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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