Early Math: Surprisingly Important

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Building Blocks

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What's Surprising?

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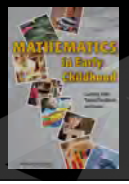
Surprise #1: Math's Predictive Power

Large-scale research, predicting school success
(Duncan et al., 2007)



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Early Math Predicts

- *Pre-K math best predictor* of high school graduation and college (Duncan et al., in press)
- Note: *Persistent* elementary math problems were most reliable predictor

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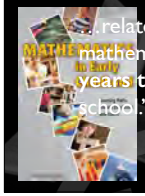
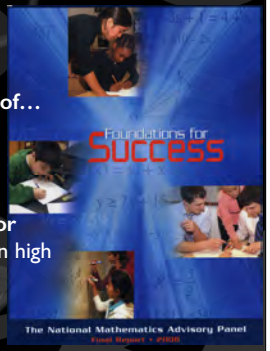
National Math Panel

"Most children acquire considerable knowledge of… mathematics before … kindergarten.

…related to their mathematics learning for years thereafter - even high school."





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Surprise #2: Children's Math Potential

Young children can learn amazingly broad, complex, and sophisticated mathematics.

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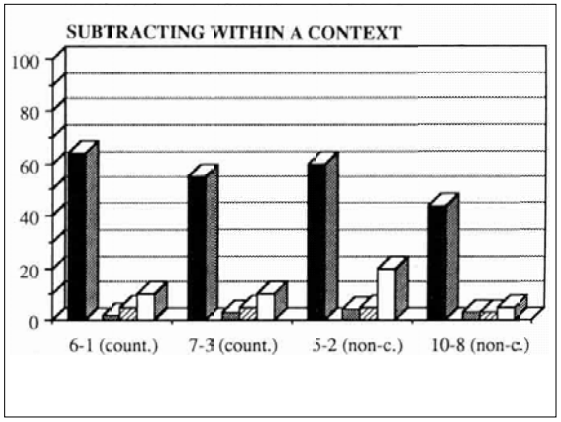

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Surprise #3: Surprise to Educators

- What young children can learn is a surprise to most early/primary educators.
- Therefore, they do not challenge children or use formative assessment effectively (especially "ends").

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Surprise #4: *Most* Children Need a Math Intervention

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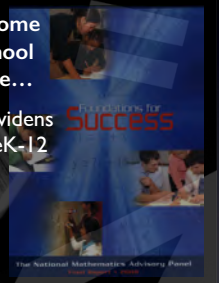
National Math Panel

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

gap…progressively widens throughout their PreK-12 years"



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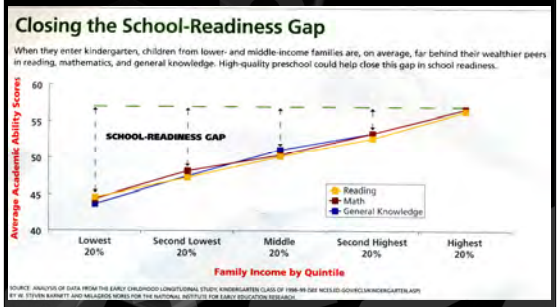
Not Just the Poor



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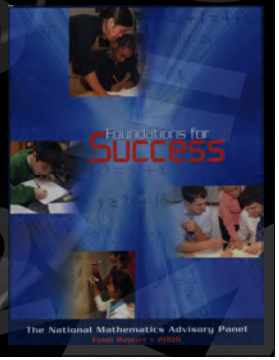
National Math Panel

"The mathematics curriculum in Grades PreK-8 should be streamlined and should emphasize a well-defined set of the most critical topics in the early grades."



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The Building Blocks of Mathematics

Less…but *what?*

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Curriculum Focal Points and Connections for Prekindergarten

The set of three curriculum focal points and related connections for mathematics in prekindergarten follow. These topics are the recommended content emphases for this grade level. It is essential that these focal points be addressed in contexts that promote problem solving, reasoning, communication, making connections, and designing and analyzing representations.

Prekindergarten Curriculum Focal Points	Connections to the Focal Points
Number and Operations: **Developing an understanding of whole numbers, including concepts of correspondence, counting, cardinality, and comparison** Children develop an understanding of the meanings of whole numbers and recognize the number of objects in small groups without counting and by counting—the first and most basic mathematical algorithm. They understand that number words refer to quantity. They use one-to-one correspondence to solve problems by matching sets and comparing number amounts and in counting objects to 10 and beyond. They understand that the last word that they state in counting tells "how many;" they count to determine number amounts and compare quantities (using language such as "more than" and "less than"), and they order sets by the number of objects in them.	***Data Analysis:*** Children learn the foundations of data analysis by using objects' attributes that they have identified in relation to geometry and measurement (e.g., size, quantity, orientation, number of sides or vertices, color) for various purposes, such as describing, sorting, or comparing. For example, children sort geometric figures by shape, compare objects by weight ("heavier," "lighter"), or describe sets of objects by the number of objects in each set. ***Number and Operations:*** Children use meanings of numbers to create strategies for solving problems and responding to practical situations, such as getting just enough napkins for a group, or mathematical situations, such as determining that any shape is a triangle if it has exactly three straight sides and is closed. ***Algebra:*** Children recognize and duplicate simple sequential patterns (e.g., square, circle, square, circle, square, circle,…).
Geometry: **Identifying shapes and describing spatial relationships** Children develop spatial reasoning by working from two perspectives on space as they examine the shapes of objects and inspect their relative positions. They find shapes in their environments and describe them in their own words. They build pictures and designs by combining two- and three-dimensional shapes, and they solve such problems as deciding which piece will fit into a space in a puzzle. They discuss the relative positions of objects with vocabulary such as "above," "below," and "next to."	
Measurement: **Identifying measurable attributes and comparing objects by using these attributes** Children identify objects as "the same" or "different," and then "more" or "less," on the basis of attributes that they can measure. They identify measurable attributes such as length and weight and solve problems by making direct comparisons of objects on the basis of those attributes.	

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Children develop, discuss, and use efficient, accurate, and generalizable methods to add and subtract multidigit whole numbers. …. They develop fluency with efficient procedures, including standard algorithms, for adding and subtracting whole numbers, understand why the procedures work (on the basis of place value and properties of operations), and use them to solve problems.

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Myths

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"The CCSS are only skills."

Myth.

- Concepts, skills, problem solving
- Number, arithmetic, fractions, geometry, algebra
- And…

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CCSS' Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

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Practices and Processes

Common Core State Standards Initiative | Curriculum Focal Points and Connections for Grade 1

Mathematical Practices	NCTM Processes
Make sense of problems and persevere in solving them.	Problem Solving
Reason abstractly and quantitatively.	Reasoning and Proof
Construct viable arguments and critique the reasoning of others.	Reasoning and Proof, Communication
Model with mathematics.	Connections
Use appropriate tools strategically.	Representation
Attend to precision.	Communication
Look for and make use of structure.	Communication, Representation
Look for and express regularity in repeated reasoning.	Reasoning and Proof

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But *Do* Require Fluencies

Grade	Required Fluency
K	Add/subtract within 5
1	Add/subtract within 10
2	Add/subtract within 20 Add/subtract within 100
3	Multiply/divide within 100 Add/subtract within 1000
4	Add/subtract within 1,000,000
5	Multi-digit multiplication
6	Multi-digit division Multi-digit decimal operations
7	Solve $px + q = r$, $p(x + q) = r$

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"The CCSS is a national curriculum."

Myth. *Standards.*

- *What,* not *how,* to teach
- Key building block—Building a road for teachers, students, and parents

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Sample of Works Consulted

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"Lowest common denominator"

Myth.

- Most advanced research & thinking

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"Lowest common denominator"

Myth.

- Even high-performing states, remediation needed in college
- Addresses deficits; more math integrity than any state
- Highest international standards—will move all states to next level

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"Teachers were not involved"

Myth. *Teachers', supervisors', etc., voices critical.*

- Involved in all phases
- NEA, AFT, NCTM

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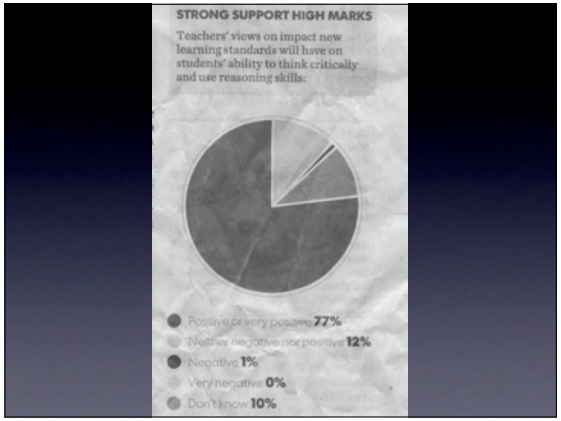

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What Might Be Missed

2nd Grade: "They develop, discuss, and use efficient, accurate, and generalizable methods to compute sums and differences of whole numbers."

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What Might Be Missed

Learning Trajectories at the *Core* of the Common Core

(return to that soon)

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Surprise #2 Revisited: Children's Math Potential

Children *invent* mathematics:

Develop, discuss, and use

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Why Develop, Discuss, Use?

Develops and Uses *Practices*

1. Make sense of problems and persevere in solving them.
2. Construct viable arguments and critique the reasoning of others.
3. Look for and make use of structure.
4. Look for and express regularity in repeated reasoning.

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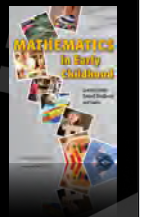
Surprise #5: We Know a *Lot*

- About how children think about and learn math
- *Learning trajectories*



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Learning Trajectories: 3 Parts

1. Goal
2. Developmental Progression
3. Instructional Activities

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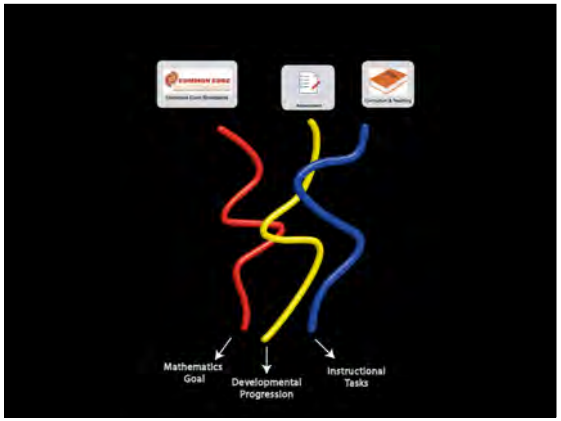

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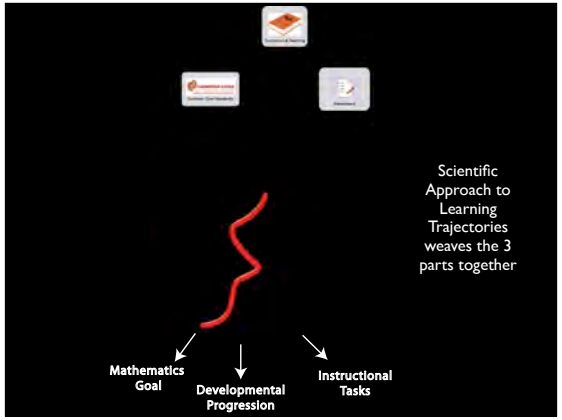

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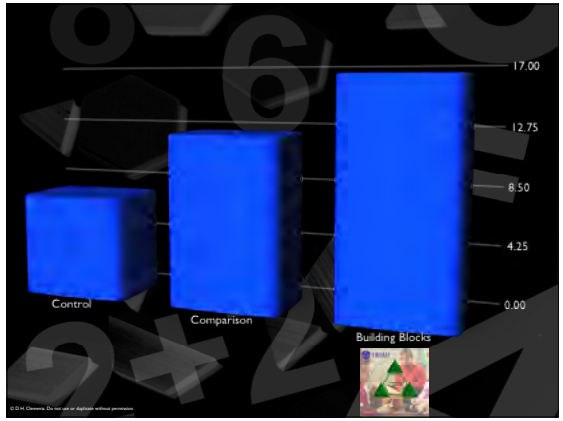

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Surprise #5a: Math + Play

Building mathematics knowledge does not require sacrificing play.

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Mathematical Activity in PreK Play

Average percentage of minutes in which mathematical activity occurred:

42%

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Math, Literacy, and Play

- Curricula focus lead to stronger emphasis in subject-matter
- Children in content-focused classrooms *more* likely to engage at high-quality level during free play
- Those focusing on *both math and literacy* more engaged at high level than neither or only one!

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Play with Ideas

- Regular play with blocks, puzzles, socio-dramatic play (with self-regulation), *and*
- *Enhancement of math* in that play, *and*
- Intentional, planned, math (LTs)...*and*
- *Play with mathematics*

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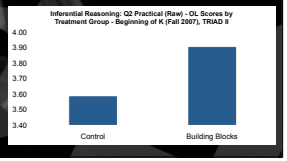
Surprise #5b: Language and Literacy Do Not Suffer

- *No difference on letter naming or 3 expressive language measures.*
- *Sig. higher* for TRIAD on:
  - Information
  - Complexity
  - Independence
  - Inferential Questions



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Building Blocks In the News

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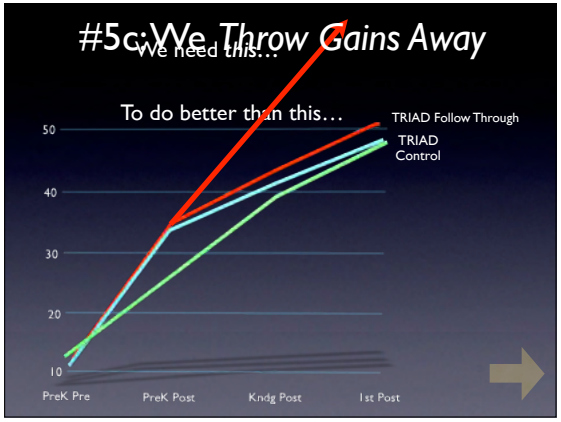
#5c: We Throw Gains Away



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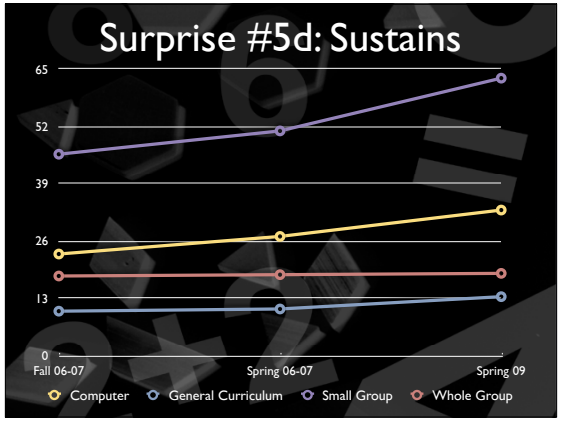
Surprise #5d: Sustains



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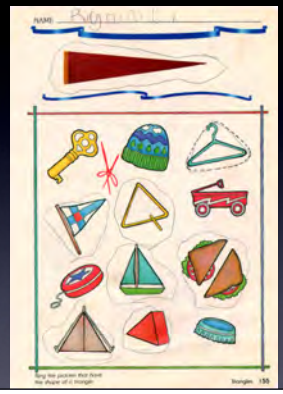
What Children See

- Ring the triangles



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Geometry Must Move

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

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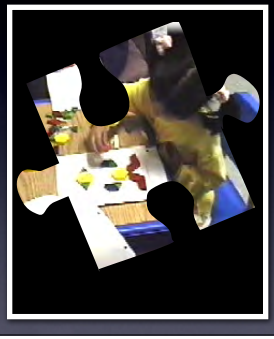
A Trajectory for Composing Geometric Shapes



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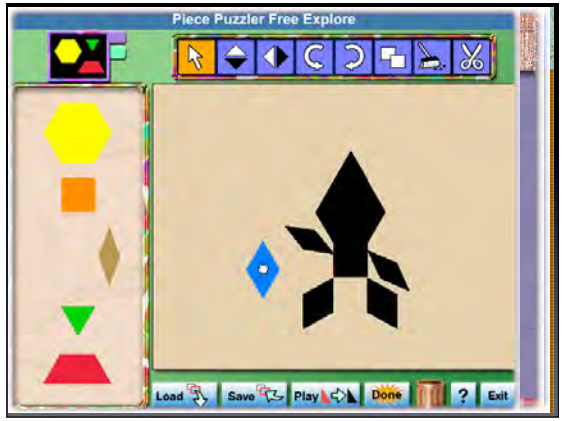

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Teachers'
Representations of
Learning Trajectories

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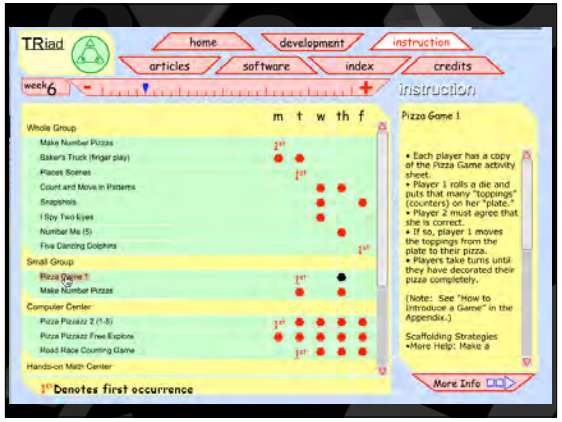

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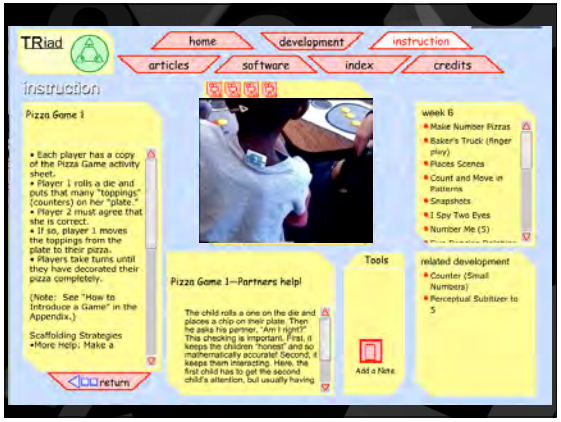

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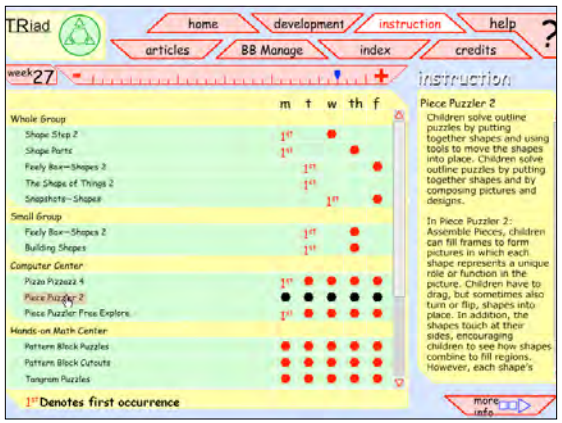

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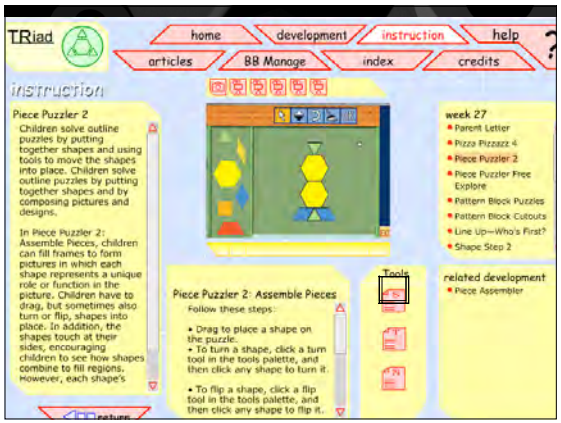

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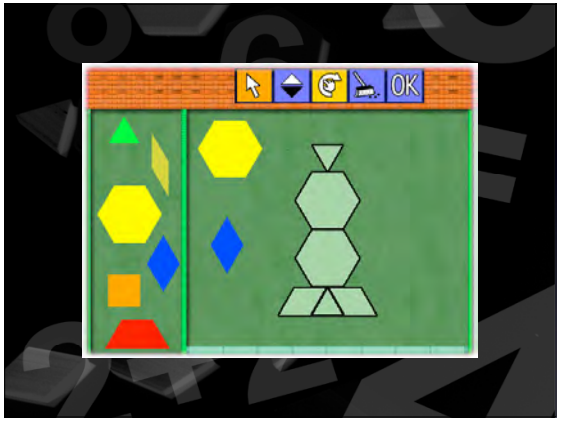

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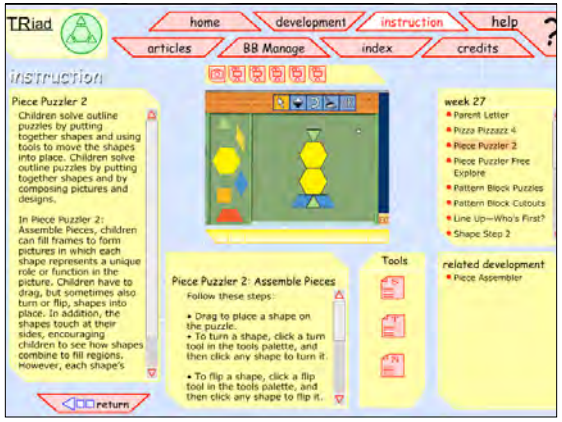

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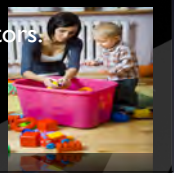
Early Math Surprises

1. Early math has surprising *predictor power.*
2. Young children have the potential to learn powerful math.
3. #2 is a surprise to most educators.



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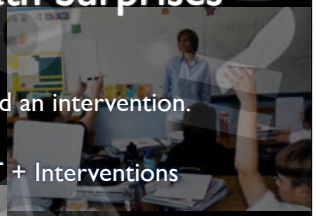
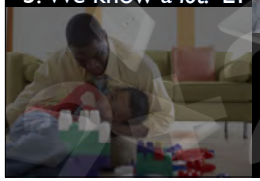
Early Math Surprises

4. Most children need an intervention.
5. We know a *lot.* LT + Interventions





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