Early Math: Surprisingly Important
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What's Surprising?

Surprise #1:
Math's Predictive Power
Large-scale research, predicting school success
(Duncan et al., 2007)

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

Surprise #2:
Children’s Math Potential
Young children can learn amazingly broad, complex, and sophisticated mathematics.

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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”).

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

- 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**

- Closing the School-Readiness Gap

“...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.”
Curriculum Focal Points and Connections for Prekindergarten

Prekindergarten Curriculum Focal Points

| Number and Operations: Developing an understanding of whole numbers, including concepts of correspondence, counting, cardinality, and comparison |
| Geometry: Identifying shapes and describing spatial relationships |
| Measurement: Identifying measurable attributes and comparing objects by using these attributes |

Connections to the Focal Points

| Data Analysis: Identifying measurable attributes and comparing objects by using these attributes |
| Number and Operations: Identifying measurable attributes and comparing objects by using these attributes |
| Algebra: Identifying measurable attributes and comparing objects by using these attributes |

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.
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.

Practices and Processes

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

But Do Require Fluencies

<table>
<thead>
<tr>
<th>Grade</th>
<th>Required Fluency</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>Add/subtract within 5</td>
</tr>
<tr>
<td>1</td>
<td>Add/subtract within 10</td>
</tr>
<tr>
<td>2</td>
<td>Add/subtract within 20</td>
</tr>
<tr>
<td></td>
<td>Add/subtract within 100</td>
</tr>
<tr>
<td>3</td>
<td>Multiply/divide within 100</td>
</tr>
<tr>
<td></td>
<td>Add/subtract within 1,000</td>
</tr>
<tr>
<td>4</td>
<td>Add/subtract within 1,000,000</td>
</tr>
<tr>
<td>5</td>
<td>Multi-digit multiplication</td>
</tr>
<tr>
<td>6</td>
<td>Multi-digit division</td>
</tr>
<tr>
<td></td>
<td>Multi-digit decimal operations</td>
</tr>
<tr>
<td>7</td>
<td>Solve 3x + 4 = 13, 2x + 5 = 7</td>
</tr>
</tbody>
</table>

“The CCSS is a national curriculum.”

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

“Lowest common denominator”

Myth.
- Most advanced research & thinking
“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

“Teachers were not involved”  

Myth. Teachers’, supervisors’, etc., voices critical.  
- Involved in all phases  
- NEA, AFT, NCTM

What Might Be Missed  

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

Learning Trajectories at the Core of the Common Core  
(return to that soon)

Surprise #2 Revisited: Children’s Math Potential

Children invent mathematics: Develop, discuss, and use
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.

Surprise #5: We Know a Lot

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

Learning Trajectories: 3 Parts
1. Goal
2. Developmental Progression
3. Instructional Activities

Scientific Approach to Learning Trajectories weaves the 3 parts together
Surprise #5a: Math + Play

Building mathematics knowledge does not require sacrificing play.

Mathematical Activity in PreK Play

Average percentage of minutes in which mathematical activity occurred:

42%

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!

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

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

Building Blocks In the News

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#5c: We Throw Gains Away

To do better than this…

#5d: Sustains

Surprise #5d: Sustains

What Children See

Geometry Must Move

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

A Trajectory for Composing Geometric Shapes
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.
4. Most children need an intervention.
5. We know a lot. LT + Interventions

References


