The Answer Still Matters . . .

Eventually

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DISCUSSION

- Which is more important, the answer or the way a student gets there? Talk about what you think.

In this session . . .

- What makes a ‘good’ answer, and how can we help students get more of them?
- What about wrong answers?
- How can we focus on the process students use to solve a problem?
- How can we balance the need for precision/right answers with . . .
- The need for students to travel a productive journey on the way to answers

What makes a *good* answer?

Premise:

What all students need for their future is as much about how they ***think*** as about what they ***know*** . . . and helping every student succeed is as much about ***how*** we teach as about ***what*** we teach.

From a presentation by Cathy Seeley, 2016

mathreasoninginventory.com

Marilyn Burns, PI

Funded by Gates Foundation

https://mathreasoninginventory.com/Home/AssessmentsOverview

DISCUSSION

- How did the teacher find out what Marisa was thinking?
- How could a teacher respond or follow up if Marisa gave that answer in class?
- Was Marisa's answer good or bad?

What makes a *good* answer?

- A well developed, justified answer aligned with the question/task (*Steve Leinwand*)
- An answer that generates new questions *(Cathy Carroll)*
- An answer that stimulates discussion
- An answer offered without fear
- An answer that shows what someone is thinking
- An answer that shows *that* someone is thinking

NCTM Process Standards

- Problem Solving
- Reasoning and Proof
- Communication
- Connections
- Representations

***Principles and Standards for School Mathematics*, NCTM 2000**
(expanded from *Curriculum and Evaluation Standards for School Mathematics*, NCTM, 1989)

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments; critique others' reasoning.
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 make use of regularity in reasoning.

CCSS for Mathematics, AZ Mathematical Practices . . .

TEKS Process Standards

(A) **apply mathematics** to problems arising in everyday life, society, and the workplace

(B) use a **problem-solving model** that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution

(C) select **tools**, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems

(D) **communicate** mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate

(E) create and use **representations** to organize, record, and communicate mathematical ideas

(F) analyze mathematical relationships to **connect and communicate** mathematical ideas

(G) **display**, **explain**, and **justify** mathematical ideas and arguments using **precise mathematical language** in written or oral communication

TEKS Process Standards

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analyze mathematical relationships to **connect and communicate mathematical ideas**

display, explain, and justify mathematical ideas and arguments using precise

From a presentation by Cathy Seeley, 2015

Math Prac. 1: Solve problems

- Explain to yourself; find entry points
- Analyze givens, constraints, relationships, goals
- Make conjectures; plan solution pathway
- Consider analogous problems; representations; use objects; search for regularity, trends
- Understand others' solutions
- Does this make sense?

Mathematical Habits of Mind

- Performing thought experiments
- Finding, articulating, and explaining patterns
- Generalizing from examples;
  articulating generality in precise language
- Creating and using representations
- **Expecting mathematics to make sense**

Al Cuoco, E. Paul Goldenberg, June Mark.
"Organizing a Curriculum around Mathematical Habits of Mind."
Mathematics Teacher May 2010

What about *wrong* answers?

Compassion vs. Challenge

- "American teachers are soft."
- To avoid frustrating students, we've too often told them everything they needed to know before we let them solve a problem.

What We Now Know

- **Struggling**—and persevering—through challenging problems and ideas can help students make sense of mathematics and can even lead to getting smarter.

- **Mistakes** are a critical part of learning—
and of making sense of what we do in mathematics.

- When students come to accept the importance of mistakes, they're more likely to be willing to **persevere** and struggle through to a solution.

Questions . . .

- How can we help students who struggle?
- How can we help students who don’t struggle enough?

Teaching for Productive Struggle

Effective mathematics teaching involves using students' struggles as valuable opportunities to deepen their understanding of mathematics.

Principles to Actions, p. 52

On Making Mistakes . . .

Sign at YouCubed Summer Math Camp:

In this class, mistakes are:

Expected

Inspected

Respected

youcubed.org (Jo Boaler's great website)

How can we focus on the process?

Problem solving is different from answer getting.

Solving a problem involves more than getting an answer if we're focused on student learning.

Answer-getting vs. learning mathematics

- Teachers in US:
  How can I teach my kids to get the answer to this problem?

- Teachers in Japan:
  How can I use this problem to teach the mathematics of this unit?
  - Devised methods for slowing down, postponing answer-getting

Phil Daro, 2012

Communication/Conversation

- The role of ***discourse***: Students talking with each other, asking questions, using tools and creating representations
- Students presenting, explaining, representing, in pairs, small groups and large groups
    - Looking for similarities, differences
    - Students clarifying, asking questions

The difference between Japan and the US

- "You quit teaching too soon and go on to the next thing."
- "We finish."
- Finishing happens when students have learned.
- And learning is incomplete if students aren't developing mathematical thinking.

Marisa didn't get to finish...

DISCUSSION

- What if she did get the opportunity to finish? How might a class have been structured to build on Marisa's 'wrong' answer and help her finish learning?

Upside-down teaching

- From: *"I - We - You"*
- To: *"You - We - I"*

Upside-down teaching

- Start with a rich problem
- Engage students in dealing with the problem, constructively struggling with the problem and the mathematics
- Students discuss, compare, interact, question
- Teacher helps students connect and notice what they've learned

We need ***teacher-structured*** classrooms, not ***teacher-centered*** classrooms

The need for precision

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CCSS for Mathematics, pages 6-8

From a presentation by Cathy Seeley, 2015

6: Attend to Precision

- Communicate precisely
- Use clear definitions in reasoning and communicating
- Specify units, state meaning of symbols they use
- Calculate accurately and efficiently
- Good explanations

Balancing the goal of precision with helping students learn from the journey

The hottest topic in learning and teaching today . . .

- The importance of adopting a ***growth mindset*** about intelligence:
    - Understanding that a person can grow smarter
    - Recognizing the impact of believing a person can grow smarter
    - Acting to help both students (and ourselves) adopt a growth mindset—believe in their untapped potential

- *Mindset*, Dweck, 2006 & *Mathematical Mindsets*, Boaler, 2015

Intelligence

- **Fixed mindset** *vs.* **growth mindset**
- Your mindset influences confidence, perseverance, and your willingness to take risks
- From brain research:
  The activities a person engages in can change their intelligence.
- Who determines the activities a student engages in in?

From a presentation by Cathy Seeley, 2016

Dweck on What Growth Mindset **Isn't**

- It's not just about effort—students need to try new strategies; seek input from others when stuck

- Effort is a means to an end toward the goal of learning and improving (good that they tried, not good they're not learning)

- NOT: If you want to make students feel good, even if they're not learning, just praise their effort.

- NOT: If you want to hide learning gaps, just tell them "Everyone is smart!"

Carol Dweck, *EdWeek*, Sept. 22, 2015

More from Carol Dweck

- Fixed mindset has become for some a way to justify that a student isn't learning (replacing environment or ability as an excuse)
- Growth mindset has become the thing to have . . . even though we don't always act like we say we believe
- To help (us) adopt a deeper growth mindset, acknowledge:
    - We're all a mix of fixed / growth mindsets
    - We probably always will be
    - Stay in touch with our thoughts and deeds

Carol Dweck, *EdWeek*, Sept. 22, 2015

Overcoming Our Fixed Mindset

- Less Testing
- More feedback
- Flexible grouping (not by ‘ability’)
- Different questioning (deep vs. surface)
- Stop talking so much

John Hattie, reported by Peter DeWitt, *Finding Common Ground*, July 17, 2015

Teaching for the journey
Making Room for Making Sense

- Create opportunities for **productive struggle**
- Use a problem-focused, student-centered, **upside-down teaching** model, with lots of opportunities for discussion about strategies, answers and **mistakes**
- Learn (and help students learn) to **question** until they make sense of what they're thinking, doing, hearing, learning because they **expect math to make sense**
- Use meaningful **formative assessment** to pay attention to whether students are making sense of what they learn

What is a good answer?

Unlocking Student Learning

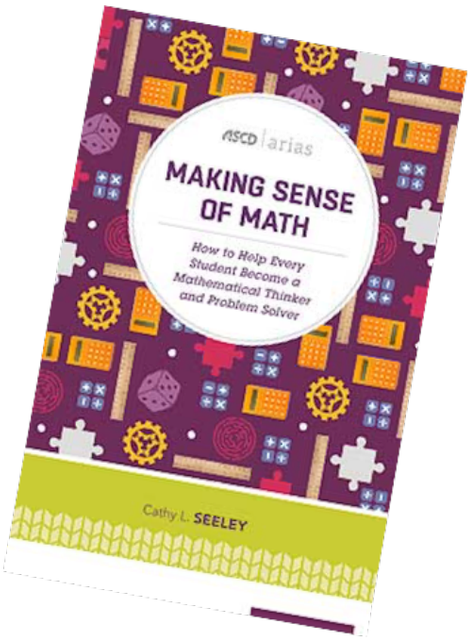
- "Teachers who understand the growth mindset do everything in their power to unlock that learning."

  Carol Dweck, Ed Week, 2015

- "We're all mathematical thinkers. It's up to us [teachers] to unlock it."

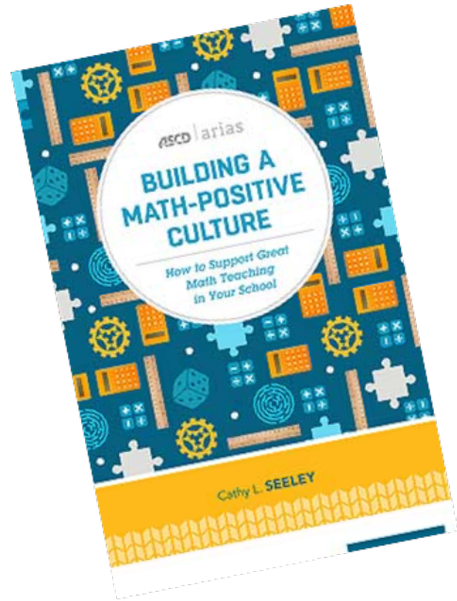
  Jordan Ellenberg, Wednesday

Every student deserves the best future we can prepare them for



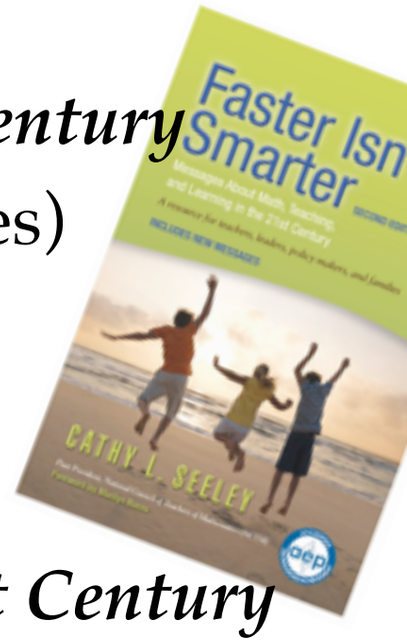
For a pdf of the slides: **cseeley@utexas.edu**

Two little books just published April 2016 from ASCD/NCSM/NCTM



Making Sense of Math (for teachers)
Building a Math-Positive Culture (for leaders)

Faster Isn't Smarter--
Messages About Math, Teaching, and Learning in the 21st Century
Second (Expanded/Updated) Edition 2015 (4 new messages)
http://mathsolutions.com/fasterisntsmarter



Smarter Than We Think:
More Messages About Math, Teaching, and Learning in the 21st Century
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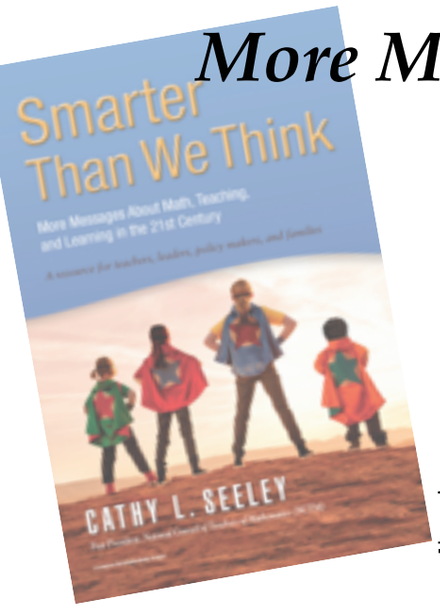

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