Tapping the Mathematical Potential of Every Student

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DISCUSSION

- What does it mean to succeed in mathematics--to be good at math?

In this session . . .

- What it means to succeed in mathematics
- Making sense in mathematics
- What struggling has to do with being good or smart in math. . .
- Making room for making sense in our classrooms
- Helping every student succeed in mathematics (and on *The Test*)

What math do all students need?

- The Big Three:
  - **Understanding mathematics** (making sense of it)
  - **Doing mathematics** (skills, facts, procedures)
  - **Using mathematics** (applying math, modeling with mathematics, solving a range of problems)
- **The New Basics:** deep transferable skills for *versatilizing*:
  - Problem solving, reasoning, research, communication, creativity
- **Mathematical Thinking:** Habits of Mind
  - Thinking, reasoning, expecting math to make sense

From a presentation by Cathy Seeley, 2015

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, 2014

Math Reasoning Inventory™

mathreasoninginventory.com

Marilyn Burns, PI

Funded by Gates Foundation

https://mathreasoninginventory.com/Home/AssessmentsOverview

DISCUSSION

- What kind of teaching may have led Marisa to where she is?
- How did the teacher find out what Marisa was thinking?
- How much experience has Marisa had thinking mathematically?

From a presentation by Cathy Seeley, 2015

The difference between...

- Learning clues, keys, and tricks vs. constructively struggling with good problems
- Learning how to do mathematical procedures vs. learning mathematical habits of mind

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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

Math is *Supposed* to Make Sense . . .

. . . in solving problems and getting answers

. . . in listening to, understanding, and responding to others' reasoning

. . . in learning new mathematical ideas and skills

Making Sense of Mathematics

Wait a minute. That doesn't make sense. . .

. . . and math is *supposed* to make sense!

Questions to Consider

- How can we help students who struggle?

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

Answer-getting vs. learning mathematics

- USA:
  How can I teach my kids to get the answer to this problem?

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

Phil Daro, 2012

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 making sense of what they’re learning.

Marisa didn't get to finish...

Uncovering and Nurturing Potential

DISCUSSION

- How smart do you think Marisa is?
- Why don’t some students reach their mathematical potential?

Factors to consider

- Student factors: Motivation, intelligence, beliefs
- Teacher factors: Knowledge, expectations, beliefs
- Instructional factors
  - Nature of the task
  - Opportunities to struggle, think, figure things out, discuss
  - A classroom environment of trust, collaboration, respect, and (eventual) success, where perseverance and constructive feedback of each other are valued

From a presentation by Cathy Seeley, 2015

Common Unhelpful Beliefs

- A good math student--a smart student--makes sense of math without struggling.
- A student who consistently struggles with math is probably not making sense of math.
- Our goal (and students' goal) should be for students not to make mistakes.

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.
- Japanese teachers design tasks slightly beyond the 'capabilities' of their students--just outside their reach. They see struggling as an element of emotional strength.

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.

On Making Mistakes . . .

- Sign at YouCubed Summer Math Camp:

In this class, mistakes are:

Expected

Inspected

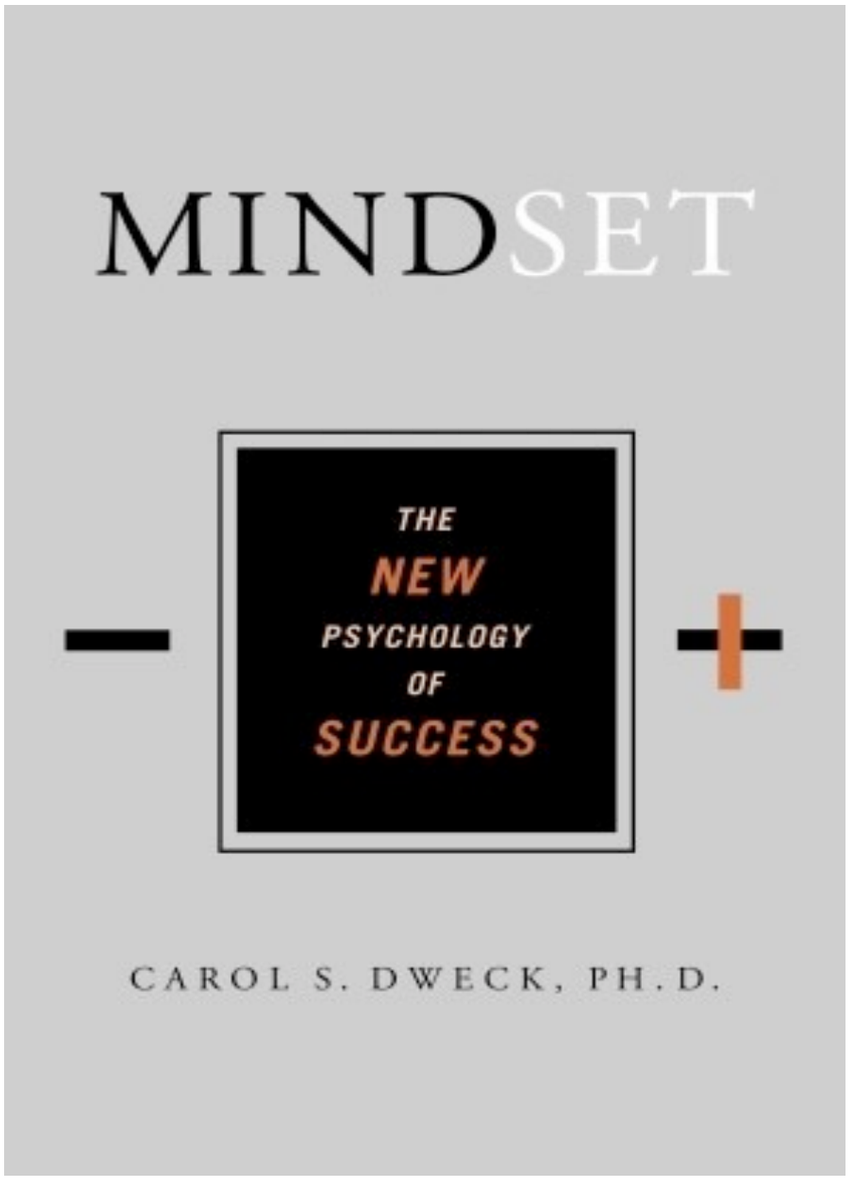
Respected

youcubed.org

(Jo Boaler's great website)

Intelligence

- Fixed vs. growth mindset . . .



From a presentation by Cathy Seeley, 2015

Intelligence

- Fixed vs. growth mindset . . .
  (Carol Dweck, *Mindset*, 1999)

- 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?

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Many students have difficulty in school not because they are incapable of performing successfully, but because they are incapable of believing that they can perform successfully.

Pajares and Schunk, 2002

Targeting beliefs with action

- Students' beliefs matter.
- Teachers' beliefs and actions matter.
- Modest interventions make a difference.

From a presentation by Cathy Seeley, 2014

High Expectations means...

- Challenging our habits and beliefs
- Setting challenging standards for all students
- Doing whatever it takes for students to achieve the standards
- Never thinking in advance that you know where they're headed or what they need
- Making sure they all get to struggle and succeed

From a presentation by Cathy Seeley, 2014

Making Room for Making Sense

Teaching Style

- Heather Hill (2015): the predominant teaching style in over 300 4th/5th grade math classrooms continues to be direct instruction via lecture.

- Only 5% of lessons involved whole-class discussion--students engaged in discussion with other students.

Racing the Pacing Guide

- We focus on telling, practicing rules and covering content, instead of giving time for students to **struggle with challenging mathematics or hard problems**.

- We teach short-cuts, tricks, and mnemonics, instead of helping students develop **mathematical habits of mind**.
(Homework: Video of Marisa at mathreasoninginventory.com)

- We teach **temporary mathematics** that we have to **unteach later**.
("13 Rules that Expire," Karp, Bush, & Dougherty, *Teaching Children Mathematics*, August 2014*)*

Upside-down teaching

- From: *"I - We - You"*
- To: *"You - We - I"*
- *Or: "You - Y'all - We - I"*

Thanks to Phil Daro, Deborah Ball, Magdalene Lampert, and Cathy Seeley

From a presentation by Cathy Seeley, 2014

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

From a presentation by Cathy Seeley, 2014

High Leverage Teaching Practices

- Establish **goals**
- **Tasks** that promote reasoning and problem solving
- Use/connect mathematical **representations**
- Facilitate meaningful mathematical **discourse**
- Pose purposeful **questions**
- Build fluency from **conceptual understanding**
- Support **productive struggle**
- Elicit/use evidence of **student thinking**

Principles to Actions, NCTM

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

What Students Do

- Struggle at times with tasks, learning that breakthroughs often come from confusion and struggle.
- Ask questions related to their struggles to help them make progress in understanding and solving tasks.
- Persevere in solving problems; realize it's ok to say, "I don't know how to proceed here," but not ok to give up.
- Help one another without telling classmates what the answer is or how to solve the problem.

Principles to Actions, NCTM

Teacher Actions for Productive Struggle

- Anticipate where students might struggle and support them productively through the struggle.
- Give students time to struggle with tasks, and ask questions that scaffold students' thinking ***without stepping in to do the work for them***.
- Help students realize that confusion and errors are a natural part of learning, by facilitating discussions on mistakes, misconceptions, and struggles.
- Praise students for effort in terms of making sense of mathematical ideas and perseverance in reasoning through problems.

Principles to Actions, NCTM

Flexible Expertise

- Students need to develop “flexible expertise.”
- Teachers need to create recurring and sustained exposure to:
  - Productive Struggle
  - Explicit Connections
  - Deliberate Practice

Jim Stigler

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

Making Room for Making Sense: Classroom Culture

- Create an expectation that math will make sense
- Help students learn to respect every person and every person's thinking
- Build classroom routines around thinking and discussing thinking

Making Room for Making Sense: Teaching

- Use a problem-centered, upside-down teaching model, with lots of opportunities for discussion
- Learn (and help students learn) to question until they make sense of what they're thinking, doing, hearing, learning
- Use appropriate technology appropriately and help students learn to **expect** what they see to make sense
- Help students learn to notice and use patterns and properties to make generalizations and connections to mathematical topics and problems
- Use meaningful formative assessment to pay attention to whether students are making sense of what they learn

Achievement Gap

From a presentation by Cathy Seeley, 2014

Untapped Potential

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What if we raise the floor AND the ceiling?

From a presentation by Cathy Seeley, 2014

Two Sides of Untapped Potential

- Bringing up all students to achieve their highest levels of mathematics and science--raising the floor
- Identifying the stars
- Raising the ceiling and letting them soar

From a presentation by Cathy Seeley, 2014

Untapped Potential

From a presentation by Cathy Seeley, 2014

Unlimited Potential

From a presentation by Cathy Seeley, 2014

Even our *best* students...

...will benefit from a strong, diverse, engaging, relevant classroom.

From a presentation by Cathy Seeley, 2014

Their future is in our hands

...and ours is in theirs

From a presentation by Cathy Seeley, 2014

Electronic Handout:
Math is *Supposed* to Make Sense!

Math Solutions Newsletter, June 4, 2015:

http://mathsolutions.com/curriculum/math-is-supposed-to-make-sense/

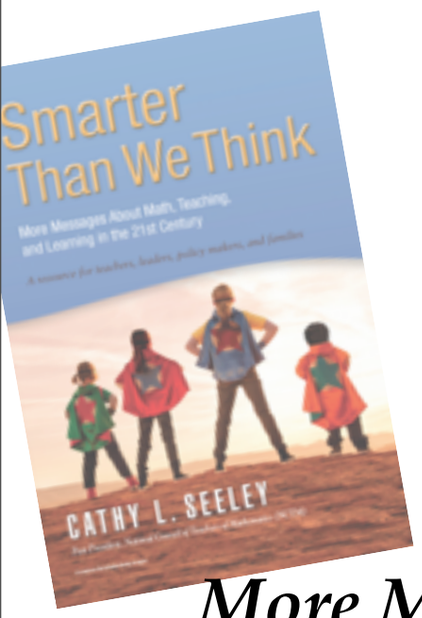
For a pdf of the slides: cseeley@utexas.edu

Faster Isn't Smarter--

Messages About Math, Teaching, and Learning in the 21st Century

Second (Expanded) Edition Just Published 2015 (4 new messages!)

http://mathsolutions.com/fasterisntsmarter



Messages from today...

Constructive Struggling, Math is *Supposed* to Make Sense

(Download 5 messages)

Smarter Than We Think:

More Messages About Math, Teaching, and Learning in the 21st Century

Published 2014

http://mathsolutions.com/smarterthanwethink

Messages from today...

Smarter Than We Think*, Upside-Down Teaching*, Mathematical Habits of Mind*

*(Download 5 messages, including those with *)*

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