Turning Classrooms Upside-Down--
Helping Every Student Become a
Mathematical Thinker

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DISCUSSION

How do we (unintentionally) shut down students’ thinking?

From a presentation by Cathy Seeley, 2015
Today...

• Mathematical Thinking
• An Upside-Down Teaching Model
• The TEKS and Mathematical Habits of Mind
• Helping Students Grow Smarter
• Closing the Achievement Gap

From a presentation by Cathy Seeley, 2015
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)

• Mathematical Thinking: Habits of Mind
  • Thinking, reasoning, expecting math to make sense

• The New Basics: deep transferable skills for versatilizing:
  • Problem solving, reasoning, research, communication, creativity

From a presentation by Cathy Seeley, 2015
How do we shut down thinking?

- Focus on covering material
- Focus on bits and pieces, instead of chunks and clusters (of the curriculum, standards, test specifications)
- Show them exactly what to do
- Don’t look too closely at understanding
- Ask one too many questions
- Answer all of their questions
- Tell them if they’re right or wrong
If we focus on communication (students’ and ours), we can move toward helping students learn to think.
Premise:
What students need for their future is as much about how they *think* as it is about what they *know*, and helping students succeed is as much about *how* we teach as about *what* we teach.

From a presentation by Cathy Seeley, January 2015
Math Reasoning Inventory™

Marilyn Burns, PI
Funded by Gates Foundation

videos at:
https://mathreasoninginventory.com/Home/AssessmentsOverview
DISCUSSION

• How did the teacher find out what Marisa was thinking?

• Had Marisa likely had experience developing mathematical thinking?

From a presentation by Cathy Seeley, 2015
The difference between...

• Learning clues, keys, and tricks vs. constructively struggling with good problems

• Knowing how to do mathematical procedures vs. learning how to think mathematically

From a presentation by Cathy Seeley, 2015
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

From a presentation by Cathy Seeley, 2015
The difference between Japan and the US

• Learning clues, keys, and tricks vs. constructively struggling with good problems
• Knowing how to do mathematical procedures vs. learning how to think mathematically.

From a presentation by Cathy Seeley, 2015
Covering and Mastering...

- It’s important for students to finish learning important skills, so they can build on and extend what they know.

- Students should *never* move on with misconceptions.

- Sometimes students get stuck on a particular concept or skill; how long do we hold them back until they learn it?

- Balancing finishing and moving on . . .

From a presentation by Cathy Seeley, 2015
Marisa didn’t get to finish...
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

From a presentation by Cathy Seeley, 2015
Let’s peek at a classroom...
While you watch...

• Listen for the questions the teacher asks.
• Listen for the nature of thinking students exhibit.
• Listen for when the teacher tells, answers questions.
A look inside a high school classroom...

Kelly Flickinger, Advanced Quantitative Reasoning
Bowie High School, Austin ISD
utdanacenter.org/aqr
What the teacher says...

• Say what you just said again/Say more about that.
• Then what did you do?
• What does the ‘1’ represent in your solution?
• How did you know to...? / What made you use 7 instead of 10?
• Did anyone have a different way of doing it? / And you did something different...
• What did you guys do differently?
• What if...? What would happen then?
What didn’t you hear?

• Yes, that’s right.
• Well, that’s almost right...
• I can see where you went wrong.
• Great! This group has the answer.
Mathematical Habits of Mind
Being a ‘Doer’ of Mathematics

“The only way to know mathematics is to do mathematics.”

Paul Halmos, mathematician

“It is pretty hard to understand mathematics without doing some mathematics.”

Jordan Ellenberg, mathematician and writer

From a presentation by Cathy Seeley, 2015
Thinking Like a Mathematician

- Doing mathematics--figuring out hard problems
- Reasoning and explaining and arguing
- Zooming in and zooming out
- Exploration that’s sometimes messy
- Trying things that sometimes work and sometimes don’t
- Reflecting, considering, analyzing

From a presentation by Cathy Seeley, 2015
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

From a presentation by Cathy Seeley, 2015

Al Cuoco, E. Paul Goldenberg, June Mark.
“Organizing a Curriculum around Mathematical Habits of Mind.”
Mathematics Teacher May 2010
Mathematical Habits of Mind--Common Themes

- Solving problems
- Thinking, Reasoning, and Reflecting
- Discussing and Communicating
- Justifying and Explaining
- Generalizing from Patterns
- Connecting
- Making sense
- Patience, persistence

From a presentation by Cathy Seeley, 2015
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

From a presentation by Cathy Seeley, 2015
DISCUSSION

• How smart do you think Marisa is?

• Why don’t some students reach their mathematical potential?

From a presentation by Cathy Seeley, 2015
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

From a presentation by Cathy Seeley, 2015
Carol Dweck: Theories of Intelligence

What has her research shown?

What can educators do with this information?

From a presentation by Cathy Seeley, January 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, 2015
Targeting beliefs with action

• Students’ beliefs matter.
• Teachers’ beliefs and actions matter.
• Modest interventions make a difference.

From a presentation by Cathy Seeley, January 2015
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
• Making sure they all get to struggle and succeed

From a presentation by Cathy Seeley, January 2015
Mathematical Habits of Instruction

• Use a problem-centered, upside-down teaching model

• Use appropriate technology appropriately

• Learn (and help students learn) to zoom out, zoom in, and go back and forth

• Help students learn to notice and use patterns, connections, and properties within and across mathematical topics and problems (mathematical structure)

• Use formative assessment to pay attention to learning

From a presentation by Cathy Seeley, 2015
Achievement Gap

From a presentation by Cathy Seeley, 2014
Untapped Potential
What if we raise the floor AND the ceiling?
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

• Untapped potential within each student, within groups of students, and at the school, district, state and national level--potential we haven’t reached ... YET.

From a presentation by Cathy Seeley, 2014
Untapped Potential
Unlimited Potential
Even our *best* students...

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

From a presentation by Cathy Seeley, 2014
How can we move closer to the goal?

• Focus less on covering material for the test and on the bits and pieces of the curriculum, standards, test items.

• Focus more on connected chunks and clusters.

• Look beyond outcomes--to see the understanding.

• Work together across grades; talk with each other.

• Don’t always show students exactly what to do.

• Avoid asking one too many questions.

• Avoid answering all of their questions.

From a presentation by Cathy Seeley, 2015
To do . . .

1. What’s one thing you can do differently before the end of this school year?

2. What’s one shift you’d like to make before next school year?
Their future is in our hands

...and ours is in theirs

From a presentation by Cathy Seeley, 2014
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Just published April 2014: Smarter Than We Think
Messages from today...
Smarter Than We Think*, Upside-Down Teaching*,
Clueless, Mathematical Habits of Mind*,
Mathematical Habits of Instruction
(Download 5 messages, including those with *)

Faster Isn’t Smarter--
Messages About Math, Teaching, and Learning in the 21st Century
Seeley 2009
http://mathsolutions.com/fasterisntsmarter (Download 5 messages)
Constructive Struggling*, Crystal’s Calculator*, Balance is Basic*

Cathy’s websites: