Upside-Down Teaching

The Secret to Developing Mathematical Thinkers

Cathy Seeley (cseeley@utexas.edu)
Senior Fellow Emeritus, Charles A. Dana Center
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Today...

• Thinking about the mathematics our students need

• How we can unintentionally shut down thinking

• How we can stimulate thinking
What math do all students need?

• The Big Three:
  - Understanding mathematics (making sense of it)
  - Doing mathematics (skills, facts, procedures)
  - Using mathematics (thinking, reasoning, applying, solving a range of problems)

• The New Basics: deep transferable skills for versatilizing:
  - Problem solving, reasoning, research, communication, creativity
Emerging themes in mathematics...

- Focus, depth, coherence from grade to grade
- Connections among key topics, skills, and contexts within and outside of mathematics
- Algebraic thinking across the grades
- Smart review
Decades of trajectory on the vision

- *Agenda for Action*, 1980
- *Everybody Counts*, 1989
- *Principles and Standards for School Mathematics*, 2000
- *Adding It Up*, 2001
- *Common Core Standards*, 2010
DISCUSSION

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

• Focus on covering material
• Teach bits and pieces, instead of chunks and clusters (of the curriculum, standards, test specifications)
• Show them exactly what to do
• Ask one too many questions
• Answer all of their questions
• Tell them if they’re right or wrong
How can we stimulate student thinking?
If we focus on communication (students’ and ours), we can move toward helping students learn to think.
Communication

When students justify, defend, share, and describe their thinking (out loud or in writing), they:

• Clarify and solidify their thinking
• Increase the likelihood they can recreate what they have done
• Demonstrate their understanding or expose potential misconceptions
https://www.mathreasoninginventory.com/Home/AssessmentsOverview
DISCUSSION

- How did the teacher find out what Marisa was thinking?
- Had Marisa likely had experience developing mathematical thinking?
- How much does Melissa know about solving challenging problems?
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.
Marisa didn’t get to finish...
The difference between...

• Clue/key words vs. mathematical communication
• Teacher talking vs. students engaging
• Learning rules and tricks vs. constructively struggling with good problems
All students need to constructively struggle--to get to the good stuff.
Why allow struggling?

• Sometimes math problems are hard.
• American students give up--don’t persevere.
• American teachers are compassionate.
• Structured struggle and purposeful talking can lead to learning.
Upside-down teaching

• From: "I - We - You"

• To: "You - We - I"
Upside-down teaching

• Starting with a rich problem
• Students engaged in dealing with the problem
• Discussion, comparing, interacting
• Teacher helps students connect and notice what they’ve learned
• Then, exercises and homework
How can we stimulate student thinking?

• Understand that every student can and needs to think.
• Value *wrong* answers as much as *right* answers.
• Choose rich, engaging tasks.
• Ask good questions that push students’ thinking.
• Let them constructively struggle.
• Let them talk with each other about math and about math problems.
A look inside a high school classroom...

Kelly Flickinger, Bowie High School, Austin ISD
utdanacenter.org/amdm
(Advanced Mathematical Decision Making)

[video available at website]
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, Bowie High School, Austin ISD
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(Advanced Mathematical Decision Making)

[video available at website]
What Kelly said...

- 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 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.
What are some of your favorite questions that push students’ thinking?
Ask good questions

• How do you know?
• Why do you think so?
• Can you convince your partner?
• What’s the same about...?
• What’s different about...?
From Frances (middle school teacher)

• The more I listened, the more I learned from my students.

• When I started asking questions, I found out what the student was thinking.

• It doesn’t usually work when I show students their mistakes and then show them how to do it correctly.

• Eventually the students start asking the questions of each other.
From Debbie (1st-gr. teacher)

• I finally figured out that if I shut up long enough, I’ll find out what the student really knows.
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.
• Don’t always show students exactly what to do.
• Avoid asking one too many questions.
• Avoid answering all of their questions.
• Consider not always telling them whether they’re right.
It’s all about the teacher.
It always has been.
It’s about what you do and how you do it.

It’s about not losing sight of how students think in exchange for what they know how to do.
Their future is in our hands

...and ours is in theirs
E-mail for a copy of the slides: cseeley@utexas.edu

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

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: