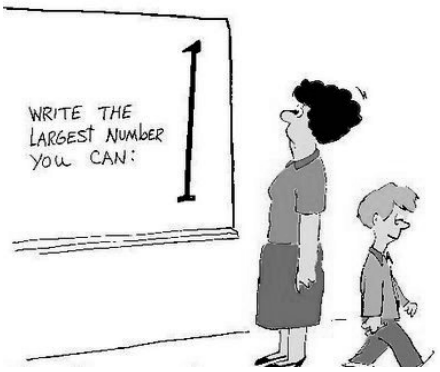


The Power of Yet:

The Benefits of Productive Struggle

Linda Menkis
Elementary Mathematics Department Head

Amy Burk
Elementary Mathematics Specialist

Special contributions from
Sharon FitzGerald, Elementary Mathematics Specialist
Rebecca DeSantis, Elementary Mathematics Specialist

Lexington Public Schools, Lexington Massachusetts

NCTM Fall Regional Conference Philadelphia November 2, 2016

Productive Struggle How?

- How do we encourage and develop students' perseverance in problem solving?
- How do we provide mathematical experiences that are engaging, meaningful and 'just right', low floor/ high ceiling, for all learners?
- How do we get students to embrace the Power of Yet?

Obtuse

Intentionally leaving details out of the explanation.

We will divulge the Goals later ☺

THREESOMES…

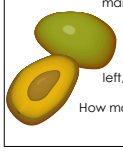
Problem Solver 1	Problem Solver 2	Observer
Work with your partner to solver the problem Use oral language to describe what you are thinking, doing, feeling, what steps are you taking. . Be as clear with your metacognition as possible	Work with your partner to solve the problem Use oral language to describe what you are thinking, doing, feeling, what steps are you taking. . . Be as clear with your metacognition as possible	Record what you see, hear and feel Ask clarifying questions Write in the sequence that the problem solving happens

Many Mangoes

One night, the King couldn't sleep, so he went down into the Royal kitchen, where he found a bowl full of mangoes. He was hungry so took $^1/_4$ of the mangoes.

Later that same night, the queen was hungry and couldn't sleep. She, too, found the mangoes and took $^1/_5$ of what the King had left.

Still later, the first Prince awoke, went to the kitchen, and ate ¼ of the remaining mangoes.



Even later, his sister, the Princess, ate $^1/_3$ of what was then left.

Finally, the youngest Prince woke up hungry and ate ½ of what was left, leaving only 4 mangoes for the kitchen staff.

How many mangoes were originally in the bowl?

Math Talk with Two Easels

Modeling the Problem

- Model how to model a problem

Observable Behavior, Moves and Metacognition

- Record the actions seen and heard during the problem solving as described by the observer (meta-strategies).

GOALS

Promoting the Standards for Mathematical Practices during Problem Solving

- Which standards are observable while engaging in problem solving?
- How do we promote perseverance during problem solving?

Describing, Exploring, Tinkering

- Tinkering is productive struggle
- How do we provide strategies to promote productive struggle?
- How do we encourage and support can students to keep trying even when they are stuck? The Power of Yet!

Standards for *Student* Mathematical Practice
These same standards endure from kindergarten through high school.

1. Make sense of problems and persevere in solving them. 6. Attend to precision.	*These standards weave throughout all the others.*	2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others.	*reasoning*
		4. Model with mathematics. 5. Use appropriate tools strategically.	*models and tools*
		7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.	*generalizations*

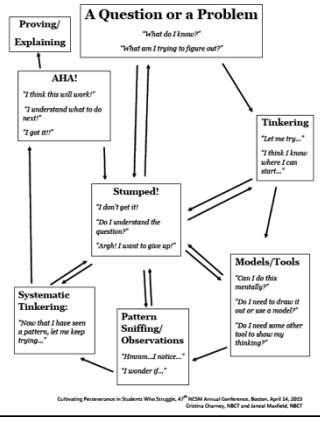
Reflect Back on your experience with the Mango Problem

Goal 1:

- What Practices did you see?

Goal 2:

- What did you learn about Tinkering



Standards for Mathematical Practice

- Perseverance through productive struggle
- Models with mathematics
- Reason abstractly and quantitively
- Critique the reasoning of others
- Attend to precision

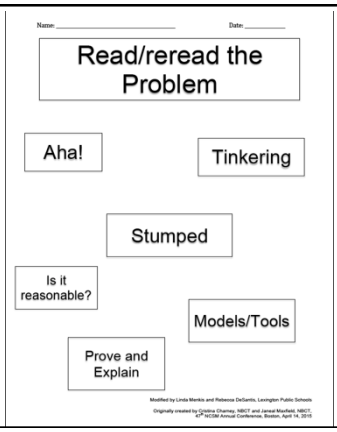
How to introduce the Tinker Chart to Students

Lesson Plan (in folder)

Mini-Lesson

- Introduce the Tinker Chart by modeling solving a problem –
  - With another teacher -your math specialist, a special educator – another professional that you can work with for this lesson.

Tinker Chart for Students

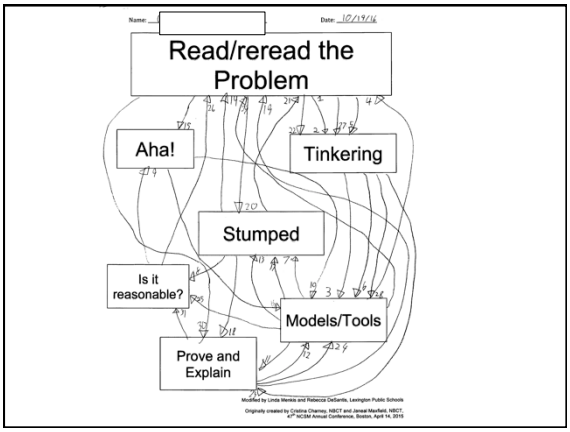


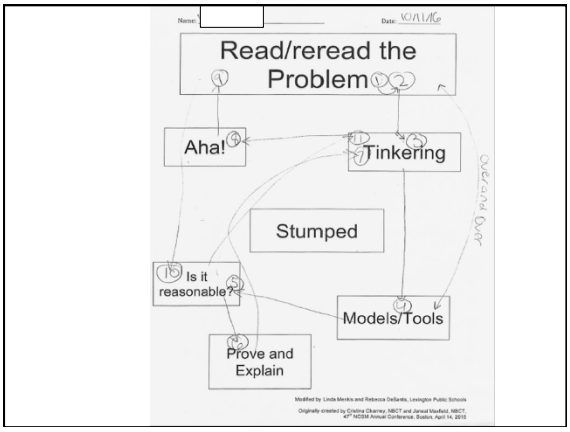
The Work Session

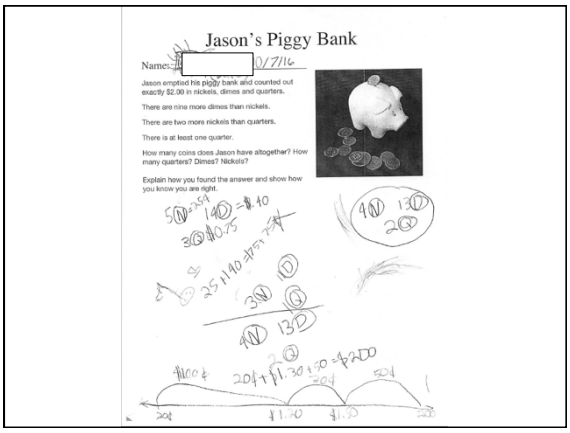
- Use a low-floor/high ceiling task (examples in your folder
- Group students in 3's or 4's –
  - 2 problem solvers
  - 1 or 2 observers
- Give guidance during the time students are working
- The work session should be long enough for students to work on the problem, not necessary for all students to finish.

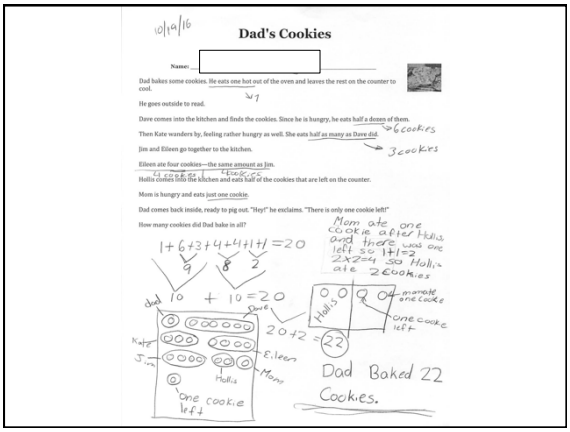
Close with a 'Congress'

- Create a Chart of all the Math Strategies that were used by students.
- Have students share their observation from being the 'Observer'
  - How many times did the problem solvers go back to 'Read and Re-read' the problem?
  - How many times did the problem solvers 'tinker'?, or 'make models'?
  - Were there more than one 'Aha' moments?









Moving Forward

- Ask students
  - "How would this tool be helpful when doing math problem solving?"

Quotes from kids-

"It can help you when you get stuck to think about what else you could do".

"You can see what you have tried and think about what else you could do".

"Problem solving is really messy!"

Questions?

- What questions do you have?
- **How do you think the Tinker Chart could be a useful tool in your classroom?**

Websites with Rich Tasks

NRich Maths
http://nrich.maths.org/frontpage

Inside Mathematics
http://www.insidemathematics.org/problems-of-the-month

Youcubed
https://www.youcubed.org

Illuminations - NCTM
https://illuminations.nctm.org/BrainTeasers.aspx

Math Forum (requires subscription)
http://mathforum.org