

Productive Struggle:

*The Difference Between Experienced
and Inexperienced Problem Solvers*

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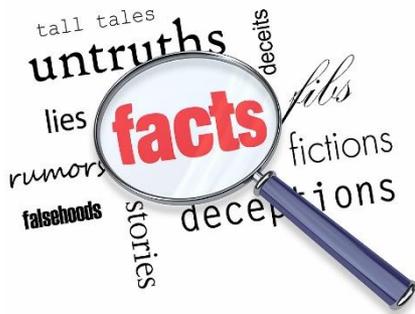
Productive Struggle



1 (low) - 5 (high)

The effort to make sense of something, to figure something out that is not immediately apparent.

Hiebert & Grouws, 2007



Productive Struggle Fact or Fiction

Decide which of the following statements about productive struggle are fact (true) and which are fiction (false).

1. Low cognitive demand tasks do not cause students to struggle.
2. Student struggle is often viewed negatively as a learning problem that teachers should try to prevent.
3. Deeper learning cannot occur if students struggle.
4. Productive strugglers do not ask questions.
5. Unproductive strugglers often rely on memorization of words, processes, diagrams, etc. rather than on understanding.
6. The teacher plays a key role in fostering and promoting productive struggle.

Two Types of Problem Solvers

Inexperienced
Problem Solvers...



DON'T know what to do when they don't know what to do!

Experienced
Problem Solvers...

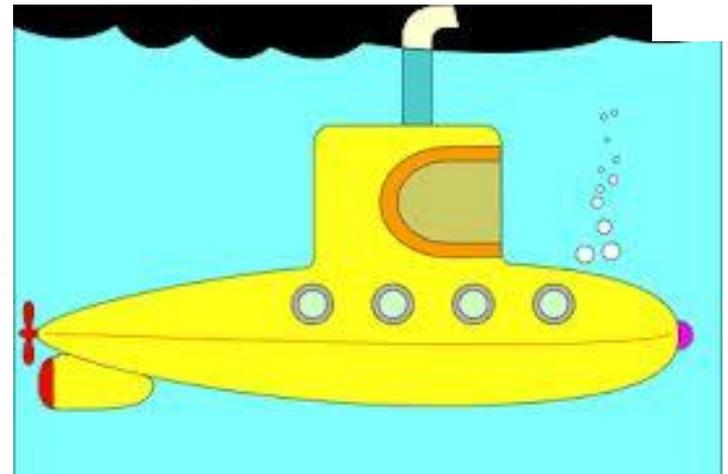
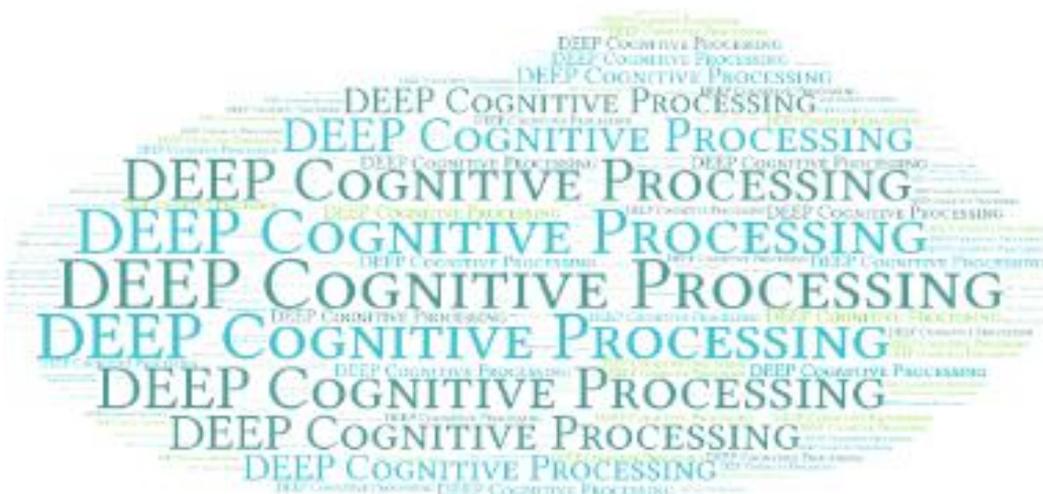


DO know what to do when they don't know what to do!

Deep vs Surface Processing Skills



SURFACE*PROCESSING SURFACE*PROCESSING
SURFACE*PROCESSING
SURFACE*PROCESSING



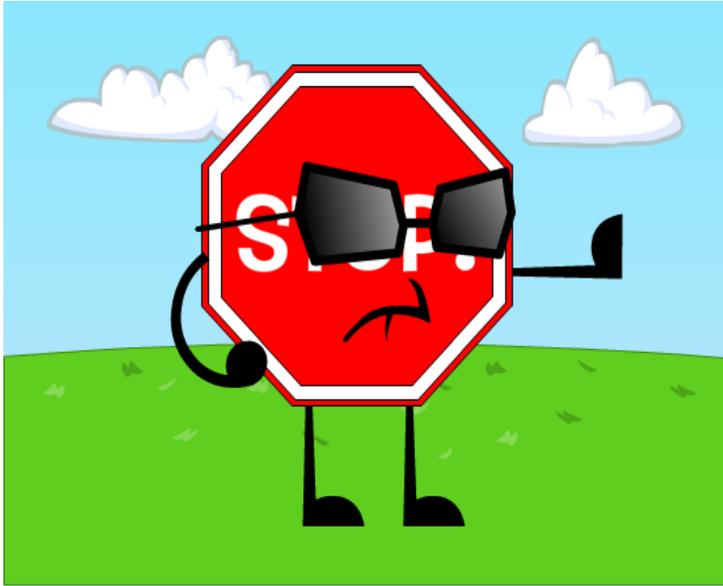
Mathematical Habits of Mind



- Enable us to reason about the world from a quantitative and spatial perspective, and to reason about math content (Levasseur & Cuoco, 2009).

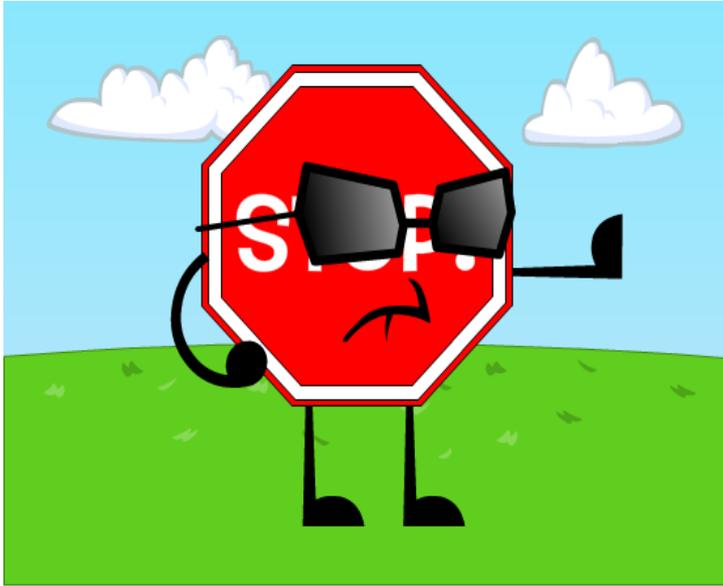
A composite of many skills, attitudes, and likings, enable us to behave intelligently when confronted with a problem to which the immediate answer is unknown.

Productive Struggle Barriers



How do we inhibit or withhold struggling from our students?

Productive Struggle Barriers



We...

- slow down
- hurry up
- group by ability/
arbitrary factors
- show
- answer
- ask

NCTM, *Principles to Action*

Unproductive Beliefs	Productive Beliefs
<p>Students possess different innate levels of ability in mathematics, and these cannot be changed by instruction. Certain groups or individuals have it while others don't.</p>	<p>Mathematics ability is a function of opportunity, experience, and effort – not innate intelligence. Mathematics teaching and learning cultivate mathematics abilities. All students are capable of participating and achieving in mathematics, and all deserve support to achieve at higher levels.</p>
<p>Mathematics learning is independent of students' culture, conditions, and language, and teachers do not need to consider any of these factors to be effective.</p>	<p>Effective mathematics instruction leverages students' culture, condition, and language to support and enhance mathematics learning.</p>
<p>Students living in poverty lack the cognitive, emotional, and behavioral characteristics to participate and achieve in mathematics.</p>	<p>Effective teaching practices (e.g., engaging students with challenging tasks, discourse, and open-ended problem solving) have the potential to open up greater opportunities for higher order thinking and for raising the mathematics achievement for all students, including poor and low-income students.</p>

Productive Struggle Boosters



Teacher

- Growth mindset
- Struggle is part of the learning process
- Process praise

Tasks

- Engaging
- High cognitive demand
- LFHC
- Relevant and interesting

Tools

- Standard
- Non-standard

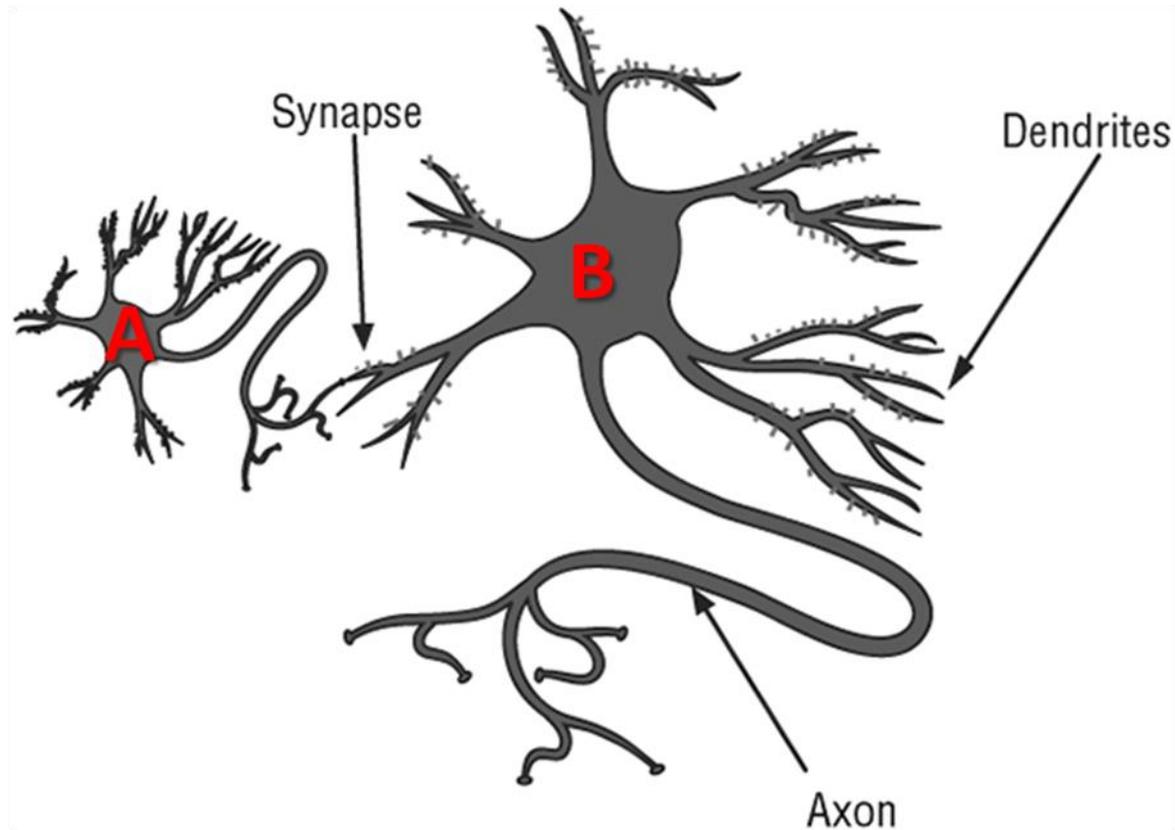
Struggle & Failure



Can be painful without being shameful.

Should be accepted as part of the learning process rather than an outcome.

Struggle = Brain Growth!



Moser et al. 2011



Developing Mathematical Habits of Mind

<i>Standard 1</i>	<i>Standard 2</i>	<i>Standard 3</i>	<i>Standard 4</i>	<i>Standard 5</i>	<i>Standard 6</i>	<i>Standard 7</i>	<i>Standard 8</i>
Make sense of problems and persevere in solving them.	Reason abstractly and quantitatively.	Construct viable arguments and critique the reasoning of others.	Model with mathematics.	Use appropriate tools strategically.	Attend to precision.	Look for and make use of structure.	Look for and express regularity in repeated reasoning.
<ul style="list-style-type: none">• MPs 1 and 6 – overarching habits of a productive mathematical thinking• MPs 2 and 3 – reasoning and explaining• MPs 4 and 5 – modeling and using tools• MPs 7 and 8 – seeing structure and generalizing							

<http://www.edutopia.org/blog/mathematical-habits-of-mind-cindy-bryant>

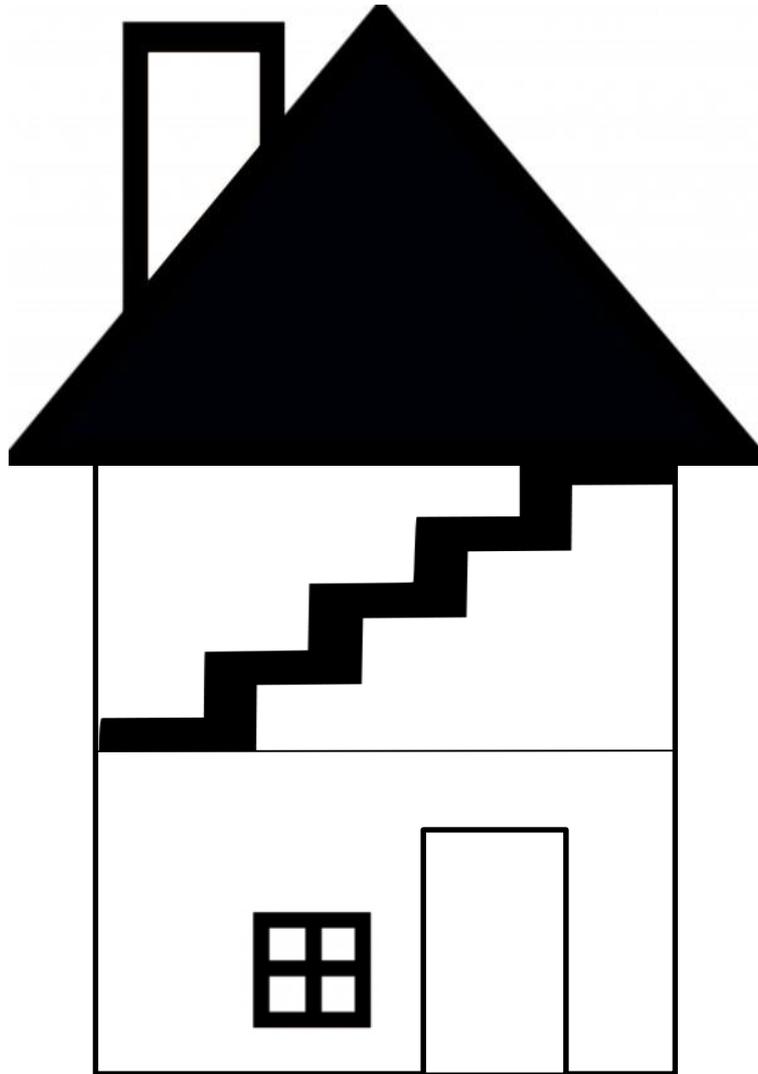
Can you find a pattern/order to
these numbers?

8, 5, 4, 9, 1, 7, 6, 3, 2, 0

eight, five, four, nine, one, seven

six three two zero

Low Floor High Ceiling Tasks



A few small steps and you're in...

- Lots of possibilities for activity – unproblematic or challenging
- Limited only by-
 - the space in the room
 - the height to which you can rise

Four Fours Fun

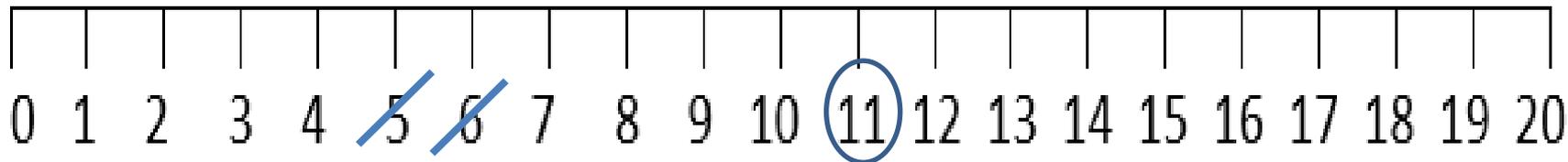
Can you find every number between 1 and ____ using exactly four fours and any operation?



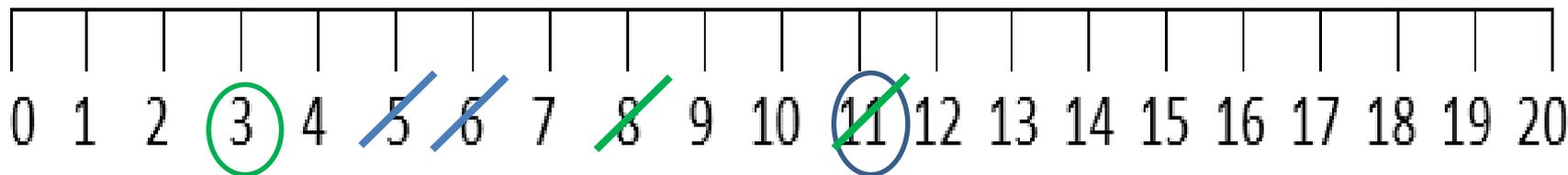
<https://www.youcubed.org/task/the-four-4s/>



Small Steps to PS...



$$5 + 6 = 11$$



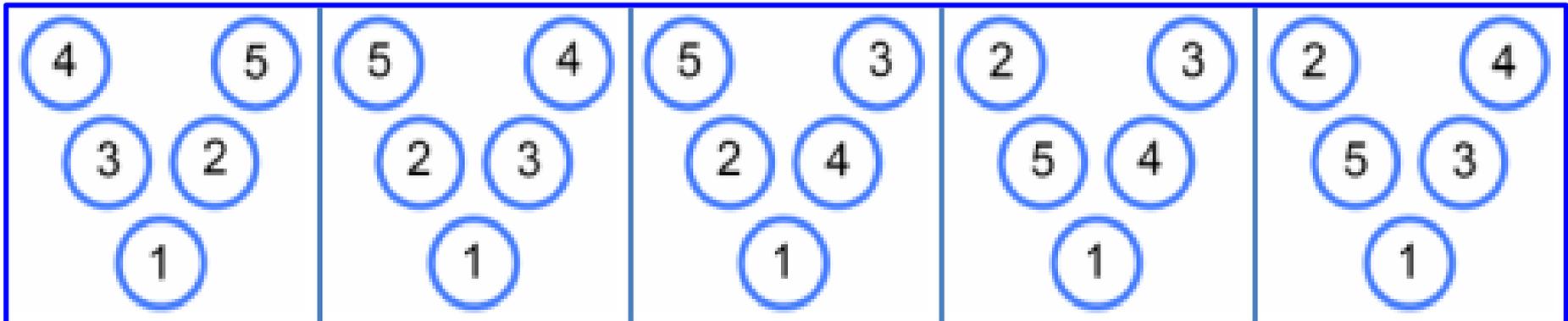
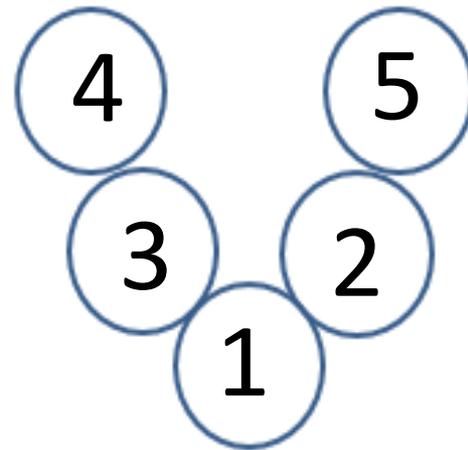
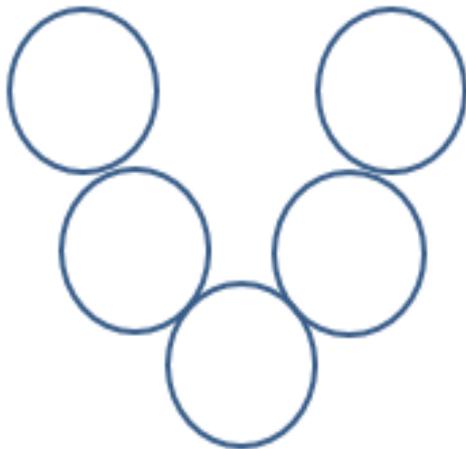
$$11 - 8 = 3$$

STRIKE IT OUT! <http://nrich.maths.org/7701>

Magic Vs

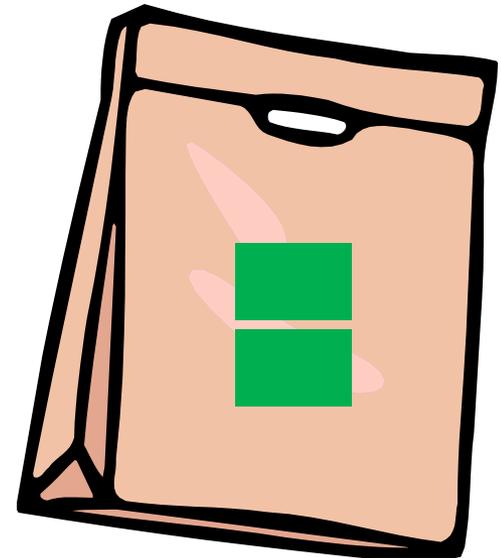
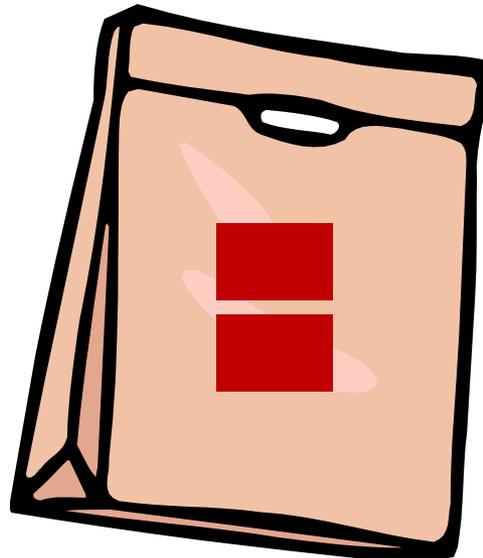
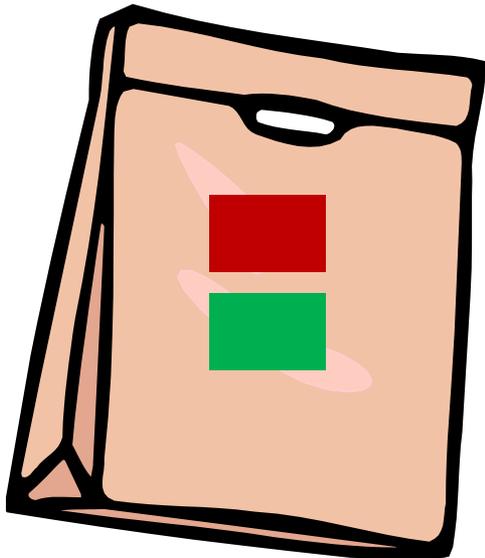
<https://www.youtube.com/watch?v=-JrZcMbsNdA>

Place each of the numbers 1 – 5 in the V shape so that the two arms have the same total.



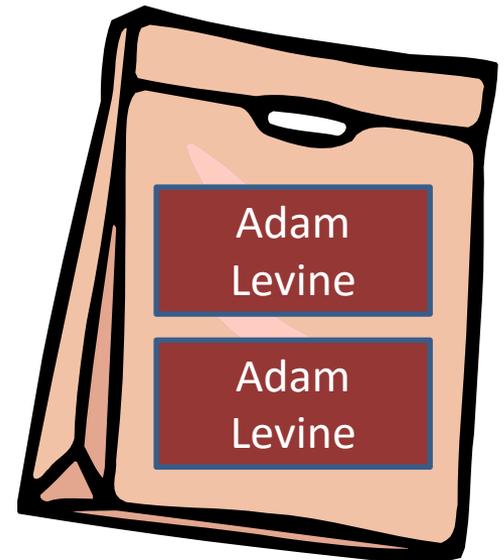
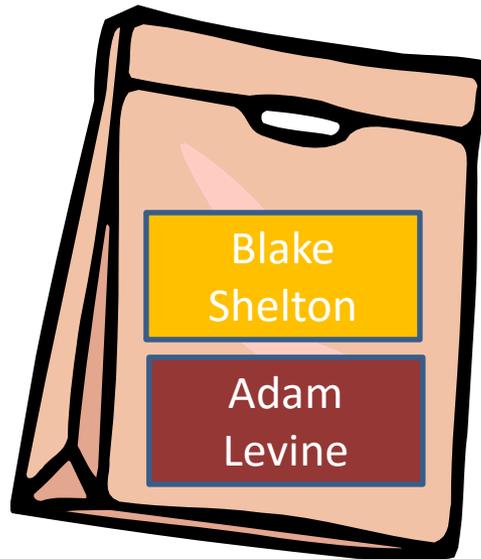
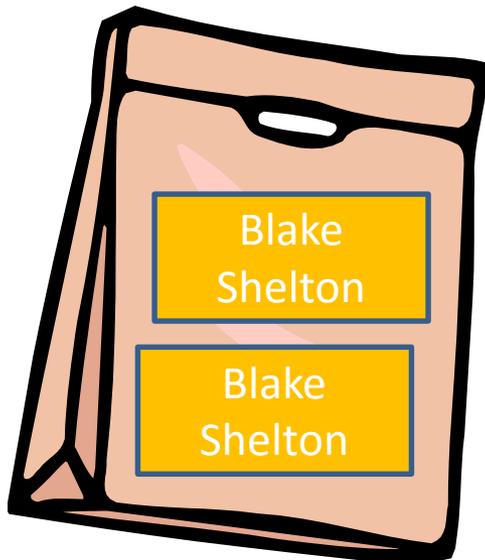
It's in the bag...

There are two tiles in each bag. All bags are labeled incorrectly. Without looking inside the bag, you may select one tile from any one of the three bags to help determine how to switch labels in order to correctly label the bags. Which bag would you select the one tile from?



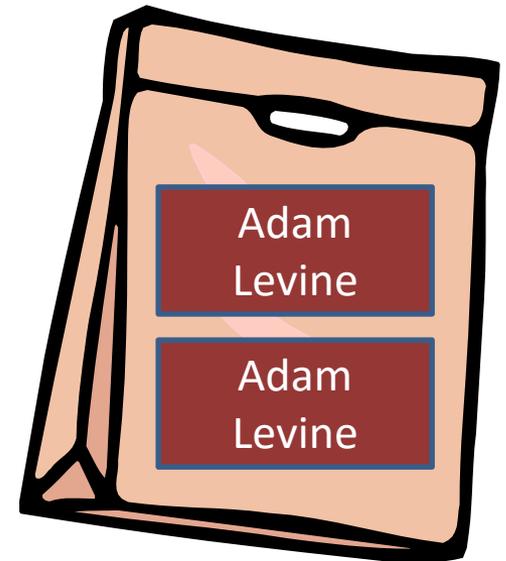
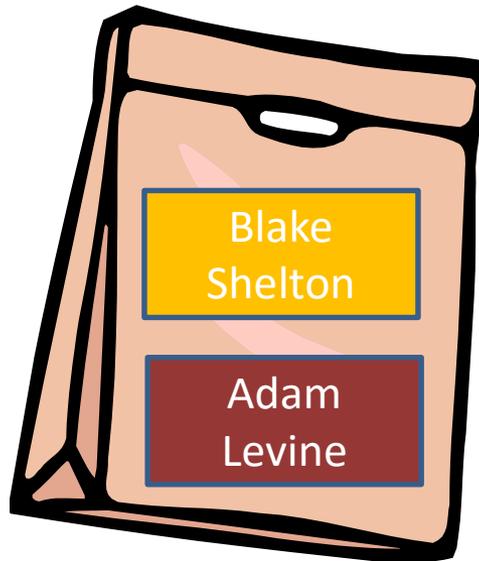
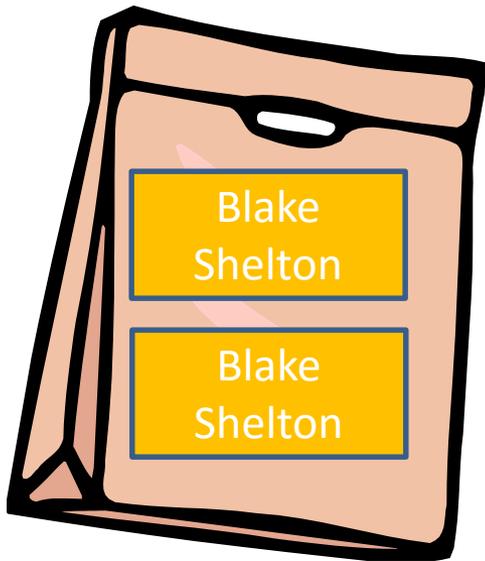
It's in the bag...

Jordan has a chance to win tickets for two concerts if she can relabel the mislabeled bags correctly. Without looking inside the bag, she may select one ticket from any one of the three bags to help her determine which labels to switch in order to correctly label the bags. Which bag should she select the one ticket from?



Note: This simple organizer can be used to help students focus on each bag. I ask them what tiles could actually be in the mislabeled bags.

It's in the bag...



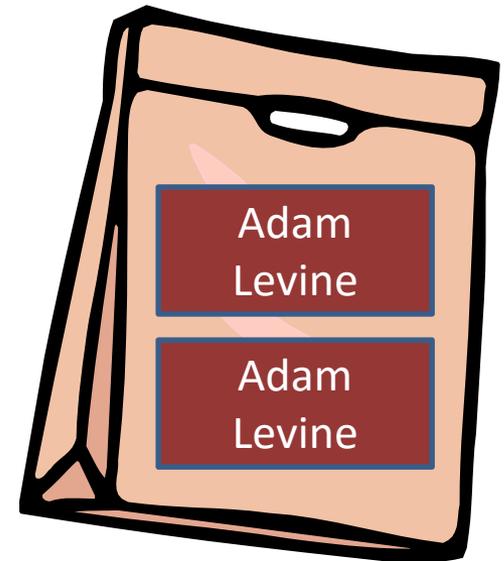
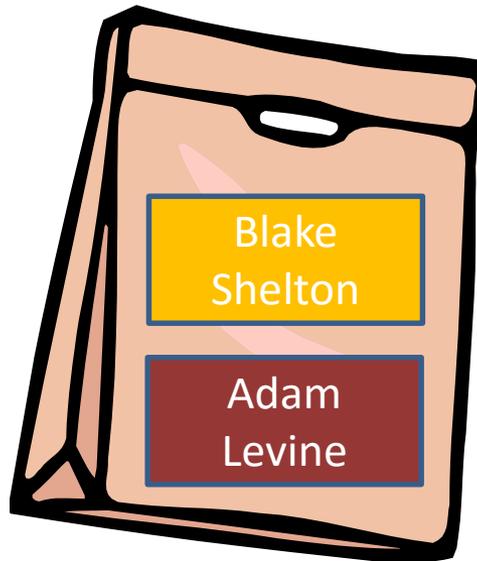
Note: Once students have provided the possibilities for tiles in each of the bags, I ask them what name they'd have to draw out of the first bag (on the left) to know for certain what names are in the bag, then follow with the same question for the second and third bags.

It's in the bag...

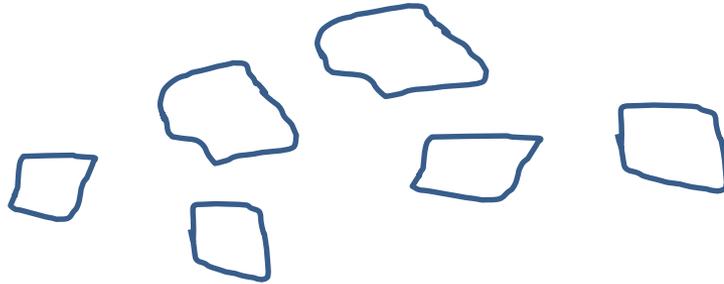
- Blake, Adam
- Adam, Adam

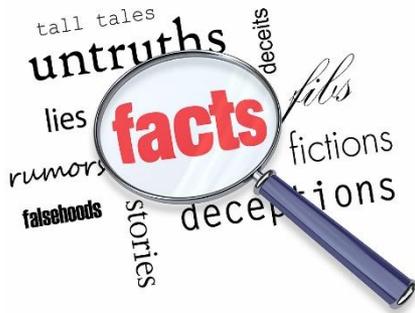
- Blake, Blake
- Blake, Adam

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- Blake, Blake



A simple case of an Experienced Problem Solver...





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Decide which of the following statements about productive struggle are fact (true) and which are fiction (false).

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2. Student struggle is often viewed negatively as a learning problem that teachers should try to prevent. **Fact**
3. Deeper learning cannot occur if students struggle. **Fiction**
4. Productive strugglers do not ask questions. **Fiction**
5. Unproductive strugglers often rely on memorization of words, processes, diagrams, etc. rather than on understanding. **Fact**
6. The teacher plays a key role in fostering and promoting productive struggle. **Fact**

Resources

- <https://www.youcubed.org/>
- <http://illuminations.nctm.org>
- Rich Mathematical Tasks
http://www.darke.k12.oh.us/~carl_jones/FOV2-00108031/?OpenItemURL=S020A5934
- <http://www.edutopia.org/blog/growth-mindset-common-core-math-cindy-bryant>
- <http://www.edutopia.org/blog/mathematical-habits-of-mind-cindy-bryant>
- <http://www.edutopia.org/blog/film-festival-math-video-resources>
- *Creative Problem Solving in School Mathematics* ISBN-13: 978-1882144105 ISBN-10: 1882144104 Edition: 2nd
- www.learnbop.com



QUESTIONS???

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To extend learning about productive struggle beyond the Annual Meeting check out <http://meetings.nctm.org/meetings/2016annualmeeting/> (scroll for photo)

OR

<http://meetings.nctm.org/tag/bryant-cindy/>