GROW MATHEMATICAL MINDSET SO CONCEPTUAL REASONING AND PROBLEM-SOLVING CAN BLOOM IN YOUR CLASSROOM!





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OBJECTIVES:

Participants will:

- Identify the key actions for teaching mathematics for a growth mindset.
- Understand the shifts in brain and learning science due to discoveries in neuroplasticity, and will apply those ideas to creating growth mindset-oriented classroom norms.
- Know the key considerations for choosing non-routine, complex problems (math tasks) for effective core instruction.



ACTIVITY:

- •On your paper write down as many words as you can in 60 seconds that describe your math experience as a student.
- •Now take your piece of paper and crumple it up.
- Take the crumpled up paper and throw it to the front of the room while expressing all of your feelings you had while making a mistake in math.
- Next-retrieve your paper, smooth it out, and trace all the crumpled lines on the paper with a colored marker.
- •The newly drawn lines are the representation your brain growth.
- •Keep your paper so it can remind you of the importance of mistakes.





THE BRAIN AND MISTAKES

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•Every time a student makes a mistake, a synapse fires.

•The synapse appears to fire when the student is struggling, even if they are unaware they are making a mistake.

•When that student becomes aware they made a mistake, a second synapse fires.

•Mistakes are not only beneficial for learning, but they make the brain grow.

•Brain growth is greater for those with a growth mindset

Moser, J.S., Schroder, H.S., Heeter, C., Moran, T.P., Lee, Y.-H., 2011. Mind your errors: evidence for a neural mechanism linking growth mindset to adaptive post-error adjustments. *Psychological Science* 22, 1484 – 1489.

JASON MOSER STUDY

- Psychologist Jason Moser studied the neural mechanisms that operate in people's brains when they make mistakes (Moser et al., 2011).
- Jason and his group found something fascinating. When we make a mistake, the brain has two potential responses.
- The first, called an ERN response, is increased electrical activity when the brain experiences conflict between a correct response and an error. Interestingly, this brain activity occurs whether or not the person making the response knows they have made an error.
- The second response, called a Pe, is a brain signal reflecting conscious attention to mistakes. This happens when there is awareness that an error has been made and conscious attention is paid to the error.



Brain activity in individuals with a fixed mindset and a growth mindset Source: Moser et al., 2011.

- Moser's study produced two important results.
- First, the researchers found that the students brains reacted with greater ERN and Pe responses—electrical activity—when they made mistakes than when there answers were correct.
- Second, they found that the brain activity was greater following mistakes for individuals with a growth mindset than for individuals with a fixed mindset.
- The study also found that individuals with a growth mindset had a greater awareness of errors than individuals with a fixed mindset, so they were more likely to go back and correct errors. (Mangels, Butterfield, Lamb, Good & Dweck, 2006)

MESSAGING MISTAKES

The classroom is a risk-taking, MISTAKE VALVING environment

- Students share ideas even when they are wrong
- Peers seek to understand rather than correct
- Students feel comfortable when they are stuck or wrong
- Teachers and students work together when stuck
- Tasks are low floor/high ceiling
- Students disagree with each other and the teacher

WHAT'S YOUR APPROACH TO MISTAKES IN THE CLASSROOM?

•Turn to your partner and discuss how each of you handle mistakes in your classroom

•Be ready to share out

- •Now thinking about the approach you use for mistakes what messages are students hearing?
 - Turn and Talk
 - Share Out





SHIFTING OUR THINKING

Historical Understanding

We're born with a certain amount of intelligence and it isn't something that can be changed

Talent is something you're born with, not something you can develop

New Understanding

Intelligence can increase or decrease depending on how you spend time exercising your mind

Learning new things can increase your underlying intelligence





"That must have been the paradigm shift."



"EARTHRISE": FIRST COLOR IMAGE OF EARTH TAKEN BY HUMANS FROM LUNAR ORBIT









ESTABLISH CLASSROOM NORMS

Teacher Messages Matter



FOCUS FOR TODAY:







ESTABLISHING CLASSROOM NORMS



Brain Science 🗸 Week of iMath 🗸 Ideas & Tasks 🗸 Courses 🗸 Parents 🛛 Students 🛛 Resources 🗸 Community 🗸 📿





MATHEMATICAL PRACTICES

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



WEEK OF INSPIRATIONAL MATH

Day 1 Honoring Ideas: Wanted: Everyone's! Materials	We start this lesson with an activity that helps students learn to work well in a group. This will help students when they engage in group work for the year ahead. We then introduce a powerful inquiry task called Four 4's. This excites students so much they take it home and continue with their parents and friends! It is a great task for revisiting important number facts and relationships while engaging students in open inquiry. We have chosen it for the first day as it also helps students to feel comfortable sharing their thinking.	Content: All number operations Practices: MP1: Make sense of problems and persevere in solving them MP6: Attend to Precision
Day 2 Visualizing Numbers Made of Dots! Materials	In this lesson we share a really cool and different way of looking at numbers, which will help students <i>see</i> factors and multiples. Students are invited to look for patterns and to color code and ask their own questions about the interesting representations. This lesson created "oohs" and "aahs" throughout the room in our trial – students were fascinated by the numerical relationships they saw, often for the first time. In the extension activities investigating consecutive numbers students can receive opportunities to understand the meaning of algebraic expressions.	Content: Factors, multiples, prime numbers, number relationships, algebraic expressions and equations. Practices: MP7: Look for and make use of structure MP8: Look for and express regularity in repeated reasoning
Day 3 Folding Geometry with Brain Flip Flops! Materials	In this lesson we invite students to engage in a different type of mathematical thinking through a paper folding task. The task is interesting and challenging but students know everything they need to solve it. The students are also taught to be skeptical and to convince and reason. A 10 minute activity on visualizing is integrated into this lesson; you can watch a video of Jo teaching the visualizing activity here.	Content: Area, fractions, triangles, squares, estimation Practices: MP1: Make sense of problems and persevere in solving them MP3: Construct viable arguments and critique the reasoning of others MP4: Model with mathematics



MATH TASKS

NUMBER TALKS







TASKS

Growth Mindset Task Framework

- 1. Openness
- 2. Different ways of seeing
- 3. Multiple entry points
- 4. Multiple Pathways/ Strategies
- 5. Clear Learning Goals and Opportunities for Feedback

https://www.youcubed.org/tasks/

WHILE CREATING A MISTAKE-FRIENDLY CLASSROOM...QUESTIONING IS IMPORTANT!

- •Use questions that stimulate reasoning and thinking.
- •Emphasize problem solving, application, and the development of a variety of thinking skills.
- •Pose questions that develop conceptual understanding.



MATH TASKS & CONCEPTUAL UNDERSTANDING

One key shift in the Utah Core Standards is increased rigor. The standards encourage teachers to give <u>equal</u> attention to conceptual understanding, procedural skills, fluency, and application.

Well -crafted tasks help to guide students in their application of the Mathematical Practice Standards.



ACTIVITY:

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- •What patterns do you see?
- •What grades would they be appropriate for?
- •Turn and talk to your neighbor:
 - How might this task encourage conceptual understanding?
 - What math practice standards are being incorporated?

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CONCEPTUAL VS. PROCEDURAL



We can only compress concepts



We cannot compress methods/procedures



Adapted from: Dr. Jo Boaler's, How to Learn Math for Teachers, a MOOC course from Stanford University; http://online.stanford.edu/course/how-learn-math-teachers



Source Stanford University

Brain Science \lor Week of iMath \lor Ideas & Tasks \lor Courses \lor Parents Students Resources \lor Community \lor Q



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TURN EXERCISES INTO TASKS



AVERAGES

Closed question

The children of the Smith family are aged 3,8,9,10. What is their average age?

Open question

There are five children in the Smith family. Their average age is 9. How old might the children be?

Answer: 9 years old

Answer: multiple possibilities

MEASUREMENT - NONSTANDARD UNITS

Closed Question

What is the length of your table measured in hand spans?

Open Question

Can you find an object in the room that is 3 hand spans long?



THANK YOU FOR ATTENDING OUR SESSION!

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REFERENCES:

•https://www.youcubed.org/tasks/

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