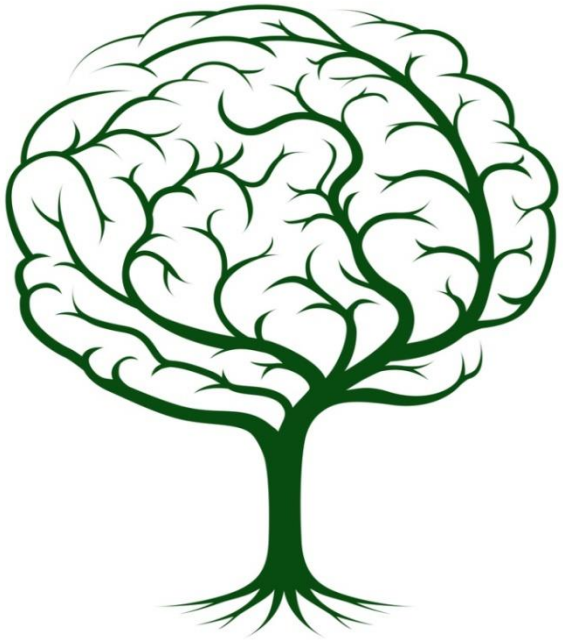
Mind over Mathematics: Conveying and Cultivating a Growth Mindset

Cindy Bryant
LearnBop Director of Learning
cindy@learnbop.com
573-247-2462
@MoMathgal
@LearnBop



Agenda/Investigations

- How does mindset impact achievement?
- What role does mindset play in productive struggle?
- What does productive struggle look like in the classroom?
- What are some strategies, resources, and tools we can use to encourage the development growth mindset and productive struggle?

- Why did you become so good at it?
- How did you become so good at it?

Famous Failures

https://youtu.be/Y6hz_s2XIAU

A. Demoted from news anchor position	Oprah Winfrey
B. Cut from his high school team	Michael Jordan
C. Unceremoniously removed from own company	Steve Jobs
D. Teachers said would never amount to much	Albert Einstein
E. Fired from position for lack of imagination and having no original ideas	Walt Disney
F. Dismissed from drama school with a note that read, "too shy to put best foot forward"	Lucille Ball

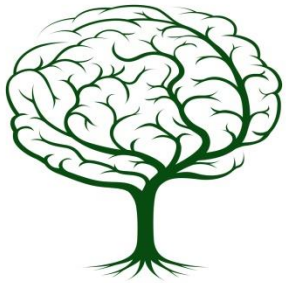
The Best of the Best!

Expert - a person who has made all the **mistakes** that can be made in a very narrow field.

Niels Bohr

Geniuses- those who make great creative contributions, cannot be explained by talent alone, but rather by **deliberate practice they devote** to their field.

Ericsson, Charness, Feltovich, & Hoffman



Mindset Matters

- **FIXED** mindset teachers and students believe intelligence is fixed and it cannot be altered.
- **GROWTH** mindset teachers and students believe that intelligence can increase by receiving the appropriate feedback and guidance when a mistake is made.

Mind Over Mathematics

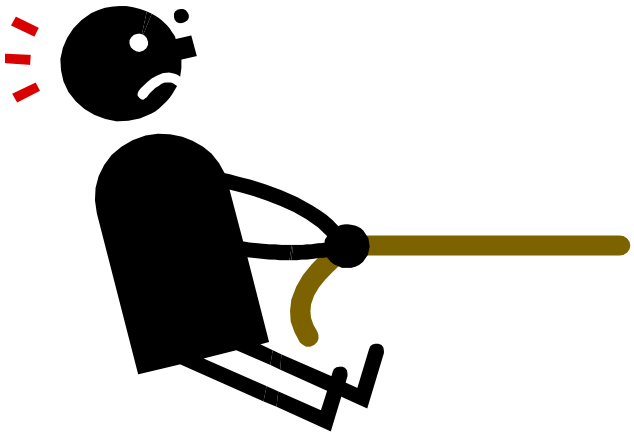
50 minutes of teaching a single idea, not about math, but about the brain!

Mindsets and Math/Science Achievement. Carol Dweck. www.opportunityequation.org

Struggle

For deeper learning to take place, struggle is not optional – it's neurologically required.

Daniel Coyle

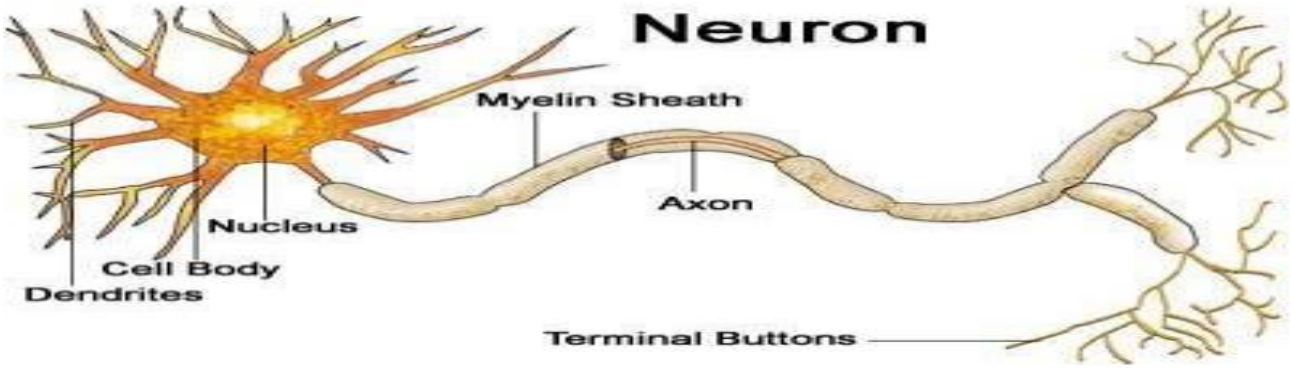


Myelin: White Matter, Matters!

Firing and optimizing circuits grows myelin!

- Targeted mistake-focused practice is the best way to build a good circuit.

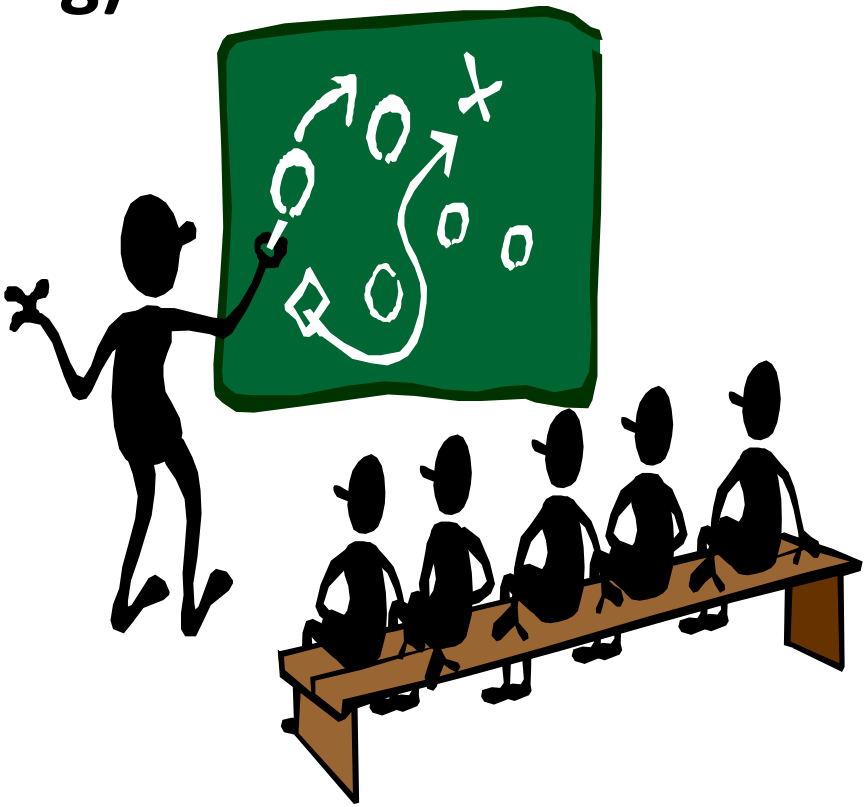
- Wrapping myelin around big circuits requires immense energy and time.



Essentials of Deliberate Practice

(*The Talent Code* by Daniel Coyle)

- **Deep practice (chunking)**
- **Ignition (inspire)**
- **Master Coaching 9**



Practice & Learning

We climbed Mount Everest on a Tuesday morning.

Gn inromya Dseut Anotser ev e Tnuomde bmilcew.

Productive Struggle

Productive Persistence = Tenacity + Good Strategies

Carnegie Foundation

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

Hiebert & Grouws, 2007

Opportunities for delving more deeply into understanding the mathematical structure of problems and relationships among mathematical ideas, instead of simply seeking correct solutions.

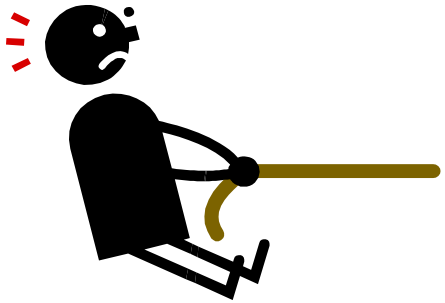
NCTM, *Principles to Actions*

Effortful practice that goes beyond passive reading, listening, or watching – that builds useful, lasting understanding and skill.

Hiebert & Grouws, 2007

Productive Struggle

What are some behaviors that productive strugglers exhibit in the classroom?



Powerful Practices:

Fostering Growth Mindset & Productive Struggle

The teacher:

- creates a climate that supports mathematical thinking and communication
- responds in a way that keeps the focus on thinking and reasoning rather than only getting the right answer

Process vs Person Praise: Instead of praising students for their talent or smarts, teachers should praise students for:

- The strategies they use
- The specific work they do
- Their persistence or effort

The students are:

- accustomed to explaining their ideas and questioning solutions that don't make sense to them
- not afraid to take risks and know that it is acceptable to struggle with some ideas and to make mistakes
- recognize that mistakes are a means to learning and not an end

Mindset Analysis Questionnaire: Read each statement and check the column that best describes you. **(Answer as your students would!)**	Strongly Agree	Agree	Disagree	Strongly Disagree
1. You are either good at math or you aren't and you can't change it.				
2. You can only do well in math if you are clever.				
3. Your memory affects how good you are in math.				
4. Learning new mathematical skills does not mean you are changing your ability.				
5. You can do a lot to change how clever you are.				
6. You can do a lot to change how well you understand mathematics.				
7. If you can answer a question quickly you are good at math.				
8. How many answers you get right on a test shows how good you are at math.				
9. Practice exercises are the best way to learn new mathematical skills.				
10. Watching a teacher do examples is the best way to learn new mathematical skills.				
11. Trying a problem you don't know how to solve is the best way to learn new mathematical skills.				
12. The class you are in tells you how good you are at math.				
13. I prefer to work on questions that challenge me rather than questions that I find easy.				

Autobiography

Carol Dweck says that all the world's parenting advice can be distilled to two simple rules: pay attention to what your children are fascinated by, and praise them for their effort.

What are your students fascinated with?

Mathematical Tasks

There is no decision a teacher makes that has a greater impact on students' opportunities to learn and on their perceptions about what mathematics is than the selection or creation of the tasks with which they engage students in studying mathematics (Lappan and Briars, 1995).

Problem Solving Strategies

Allowing students to approach solving problems in different ways using different strategies helps them to better understand mathematics, develop mathematical fluency, and see mathematics as worthwhile and doable. Doing so sets the stage for transferring conceptual knowledge to new situations (Many, Fyfe, Lewis, & Mitchell, 1996).

Mathematical Tools

Effective teachers know that using a variety of mathematical tools shapes the way that students think and helps build conceptual understanding of the hows and whys of mathematics (Fuson et. Al. 1992)

What's the pattern/order to these numbers???

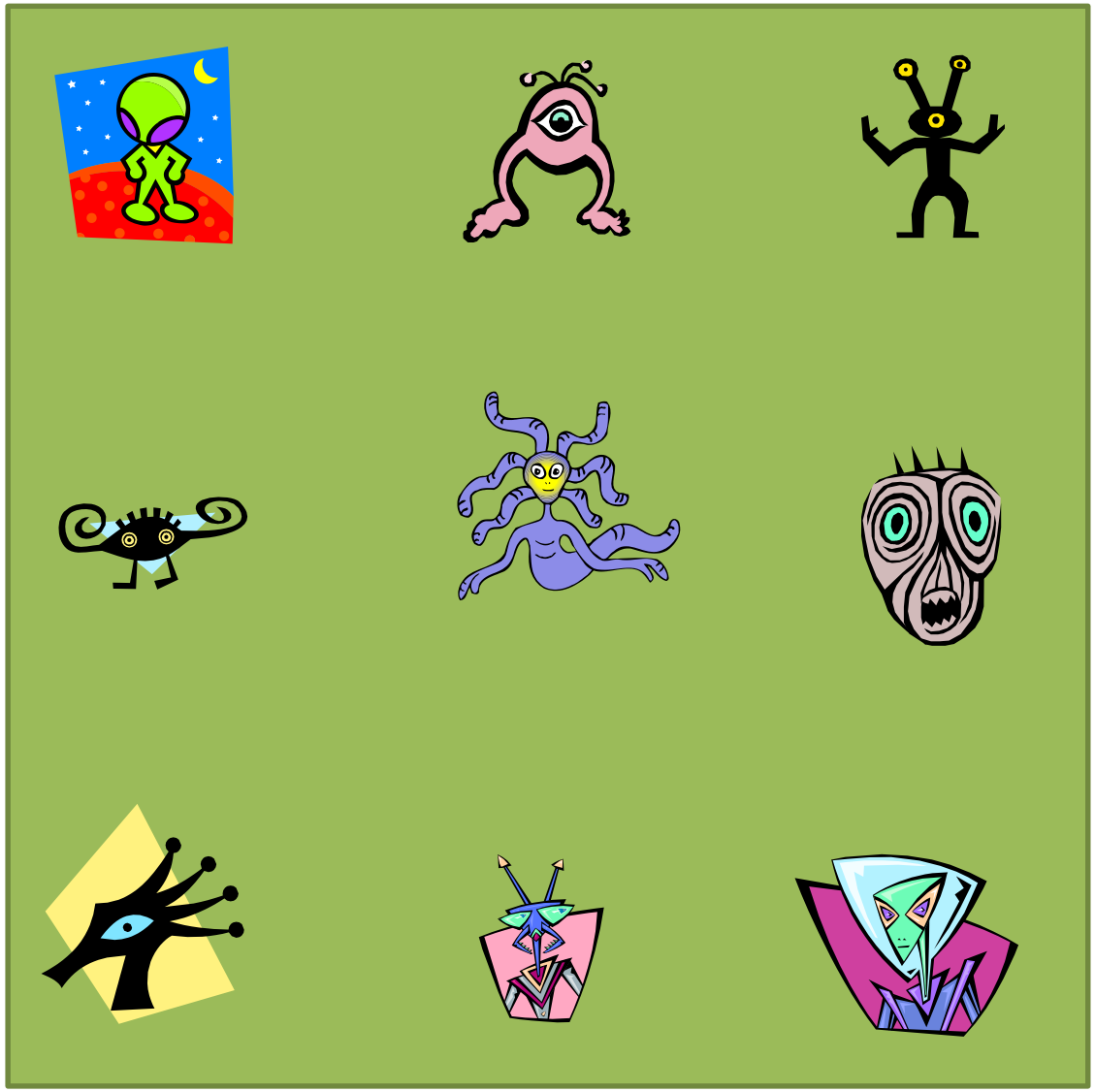
8, 5, 4, 9, 1, 7, 6, 3, 2, 0

Eight, Five, Four

Nine, One, Seven

Six, Three, Two, Zero

Cartoon Critters



Each of the Critters wants their own space. Can you draw two quadrilaterals around the critters to give them each their own separate space?

Multiplication Table Code Breaker

What number does each letter represent?

A	E	C	D	J
x F	x F	x F	x F	x F
GJ	DH	GC	AB	HJ

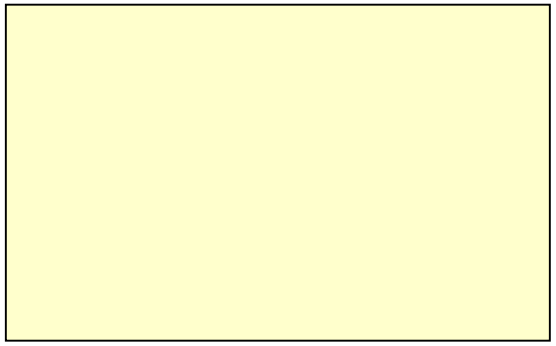
G	GB	F	H	K
x F	x F	x F	x F	x F
F	FB	AF	CH	HC

THE MIXED-UP TABLE PUZZLE

This is the multiplication table from 1 x 1 to 9 x 9.
The rows are in the wrong order and so are the columns.
Each letter stands for one of the digits 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.
Can you crack the code?

x	X	R	S	T	Q	Z	V	W	Y
Z	R	TY	TU	Z	TR	X	Y	TX	TZ
W	ZR	SY	VS	W	YV	TX	ZT	XQ	XZ
Y	ZX	XR	VU	Y	SX	TZ	TR	XZ	VY
X	TY	VZ	ZU	X	VY	R	TZ	ZR	ZX
V	TZ	ZX	TS	V	ZW	Y	Q	ZT	TR
T	X	R	S	T	Q	Z	V	W	Y
R	VZ	YX	XU	R	WZ	TY	ZX	SY	XR
S	ZU	XU	ZS	S	XS	TU	TS	VS	VU
Q	VY	WZ	XS	Q	RT	TR	ZW	YV	SX

Mathematical Tools



How could you use a simple rectangle to achieve these four things?

Just a rectangle to…

- engage learners
- promote mathematical thinking
- foster problem solving and reasoning
- Assess knowledge and understanding

Folding with Finesse!!!

Make one fold to make:

2 trapezoids

Make one fold to make:

1 triangle &
1 trapezoid

Make one fold to make:

1 triangle &

1 pentagon

Effective Questioning

POWERFUL K – 12 Generic Response Questions

- How did you work that out?
- Could you solve that another way?
- Can you summarize and/or generalize your result(s)?

Source: ***NCTM Professional Development Guidebook for Prospective on Teaching Mathematics***

Closed Questions...

vs

Open Questions...

What is the mean of 5, 11, 7, & 1?

What about this problem makes it limiting and closed? How can we make it more open?

Questions for Supporting the Development of the CCSS Mathematical Practices

How is this task similar to a previous task you have completed? How might you solve a simpler task to help with this? What helped you to be successful in solving the problem?	MP1. Make sense of problems and persevere in solving them.
What is the relationship between the data/situation and the equation? How are these answers alike? Different? Can you think of an example that would fit this expression?	MP2. Reason abstractly and quantitatively.
Why did you use [a graph] to solve it? How did you get [that equation]? What do the rest of you think about Raul's strategy? Are these strategies different or alike?	MP3. Construct viable arguments and critique the resonating of others.
How does your model (equation) connect to the situation? Where can you find [the rate] in this situation? The table? The equation? Are these two equations equivalent? Which (if any) is more efficient?	MP4. Model with mathematics.
How might a number line help you think about it? What manipulative or picture might you use?	MP5. Use appropriate tools strategically.
Can you elaborate on your explanation? Can you explain what each variable represents?	MP6. Attend to precision.
Does this problem remind you of another problem you have solved? What patterns did you notice across these problems?	MP7. Look for and make use of structure.
What patterns do you notice across these problems? How are these problems the same? Different?	MP8. Look for and express regularity in repeated reasoning.

Source: Maggie B. McGatha & Jennifer M. Bay-Williams

S = Student Expectation **T** = Teacher Action **P** = Productive Struggle Success Indicator

(Source: *NCTM Principles to Actions*)

Communicating about one's thinking during a task makes it possible for others to help that person make progress on the task.	Students are able to use tools to solve tasks that they cannot solve without them.	Ask students to explain and justify how they solved a task. Value the quality of the explanation as much as the final solution.
Give students access to tools that will support their thinking processes.	Ask students to explain their thinking and pose questions that are based on students' reasoning, rather than on the way that the teacher is thinking about the task.	Students explain how they solved a task and provide mathematical justifications for their reasoning.
Correct solutions are important, but so is being able to explain and discuss how one thought about and solved particular tasks.	Diagrams, sketches, and hands-on materials are important tools to use in making sense of tasks.	Students explain their thinking about a task to their peers and the teacher. The teacher asks probing question based on the student's thinking.

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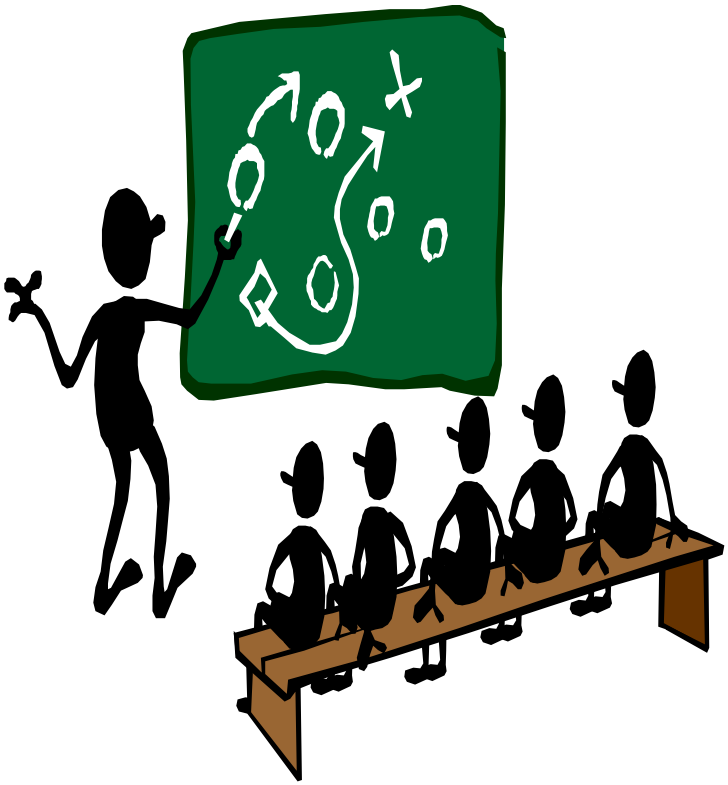
Teachers are “Identity Builders”

Robert Q. Berry, III



- You inspire and motivate students
- You arm students with multiple plays
- You transform students’ mistakes into opportunities to learn and develop skills

Resources

- Growth Mindset

  http://www.edutopia.org/blog/growth-mindset-common-core-math-cindy-bryant
- Productive Struggle

  http://web.learnbop.net/blog/two-types-of-struggle-in-problem-solving-
- Mathematical Habits of Mind

  http://www.edutopia.org/blog/mathematical-habits-of- mind-cindy-bryant
- *Creative Problem Solving in School Mathematics*

  ISBN: 0-395-34546-4
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QUESTIONS???

cindy@LearnBop.com

417-720-1748 (o)

573-247-2462 (m)

@MoMathgal