Welcome to The World Famous Learning Extravaganza!

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1. Create a table tent with your name on it.

2. On a sentence strip, please write a sentence that describes one way in which you are smart at mathematics. Post your sentence strip to the wall.

Everyone can learn mathematics: Smashing Math Myths
Agenda

- Smashing 4 Math Myths
- Finding Four Fours Lesson
- Ordering Numbers Tasks
- Closure/Feedback
Smashing 4 Math Myths

1. Some people are “math people” and some are not.
2. Making math mistakes means something is wrong with you.
3. Being fast at math is much better than being slow at math.
4. Math is boring & monotonous.
Math Myth #1

Some people are “math people” and some are not.
Arizona Mathematics Achievement Gap

- NAEP Math Scores (4th and 8th grade)
- Low Performing Schools (Title 1): 28% average proficiency
- All Other Schools: 64% average proficiency
Why this gap?

- Some people are just better at math??
- Some people are math people??
- Some people got the “math” gene??

- None of these reasons explains why it’s girls and minorities who end up on the wrong side of the gap.
The body in the brain

- A homunculus is used to describe the relative amount of space our body parts occupy in the brain.

- In a model of motor functions, some parts are much bigger because we use them much more, or with more accuracy.
The more we use a part of our body, the more space our brain needs to control or interpret it.

In fact, by learning the brain may have to change the space it uses to account for new abilities.
People who play music have been found to have auditory centres that are BIGGER than normal.

The ‘sound’ area of their brain grew through practicing their music.
All of the areas of the brain...like sound, communication, problem-solving...

are made of cells called **NEURONS**

They transmit information all around the brain.
Neurons pass information through CONNECTIONS with other neurons at SYNAPSES.
Learning helps our neurons GROW. The more we learn, the more connections they make.
When thinking happens....

- A synapse fires in the brain.

When learning happens....

- Similar pathways of neurons fire over and over
Learning changes brain structures!

- Deep learning causes changes in the structures of the brain

**JUST ONE EXAMPLE:**

- London Black Cab Drivers
  - Demonstrate knowledge of 25,000 streets, 20,000 landmarks and the connections between them.
  - Enlarged hippocampus at the end of training – and when they stop being drivers, hippocampus shrinks back
  - So tremendous changes in the brain resulting from learning... and from stopping learning
Why this gap

- Some people are just better at math?
- Some people are math people?
- Some people got the "math" gene?
- None of these reasons explains why it's girls and minorities who end up on the wrong side of the gap.

The ACHIEVEMENT GAP is, in large part, a PARTICIPATION GAP.
Your “smartest” students

- Are those who participate the most.
- But they may not always be (are probably not always) the ones with the best ideas.
- When these few students over-participate, they lose opportunities to challenge their brains by making sense of their peers’ ideas.
- Others lose opportunities to try out their ideas and challenge their brains.
Take Away Message:

- It turns that everyone is born with the innate ability to do well in math.

- Our brains can change in amazing ways when challenged. So, this means that **EVERYONE** can change their brain structures by working on challenging ideas.
Finding Four Fours

- **Individual Brainstorming**
  - Honors students’ need to think first before collaborating

- **1 Task Card per Group**
  - Requires everyone to engage with the task card
  - Builds in equity

- **Can Pass or Get Help from Group Members**
  - Lowers the affective filter and invites total participation
Math Myth #2

Making math mistakes in math means something is wrong with you.
So Wrong!!!

- When you make a mistake in math your brain grows - synapses fire in your brain.
  - In fact, your brain grows when you make a mistake but when you get work right no brain growth happens.
  - When you make a mistake you don't need to get the right answer, you just need to struggle and think about the mistake, for synapses to fire.
  - That is because struggle and hard thinking are times when our brains grows the most.

- This is why it's important in math class for students to work on hard problems that encourage struggle and mistakes, as these are the most important times for students’ brains to grow.
Successful People Versus Unsuccessful People

- There is a lot of evidence of the importance of mistakes in life too. It turns out that what separates the more successful business people from the less successful business people is that the more successful people have made more mistakes.

- When experts have studied the difference between successful and unsuccessful business people, they have found that the successful people do more of these important things.
  - Try seemingly wild ideas. Feel comfortable being wrong.
  - Are open to different experiences. Play with ideas without judging them.
  - Keep going through difficulties. Are willing to be go against traditional ideas.
The Iceberg Illusion

Success is an iceberg

SUCCESS!

What people see:
- Dedication
- Goal
- Hard work
- Good habits

What people don't see:
- Persistence
- Failure
- Sacrifice
- Disappointment

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Math Myth #3

Being fast at math is much better than being slow at math.
Fast Versus Slow

Something else that's really important about math:

- Being good at math does not mean being fast at math.
- In fact, mathematicians who we could think of as the world's top math people are some of the slowest math thinkers.
- Many mathematicians are not usually fast math thinkers. They're deep mathematical thinkers.
Timed Tests and Math Anxiety

Many undergraduates have been traumatized by their math experiences.

When asked what led to their math aversion, many talked about timed tests in second or third grade as the major turning point when they decided that math was not for them.

As long as we keep putting students under pressure to recall facts at speed we will not erase the widespread anxiety and dislike of mathematics that pervades the United States.

The best way to learn math facts is to:

- offer conceptual mathematical activities that help students learn and understand number relationships.
Strategy Users

Brain researchers studied students learning math facts in two ways.

- working out $17 \times 8$ by thinking about $17 \times 10 = 170$ and subtracting $17 \times 2 = 34$
- memorization of the facts ($17 \times 8 = 136$).

They found that those who learn through strategies achieved “superior performance” over those who memorized.

- Strategy Users solved test questions at the same speed as memorizers and showed a better ability to transfer their knowledge to new problems.
- Automaticity should be reached through understanding of number relationships, achieved through thinking about number strategies.
The PISA team

- issues international mathematics tests every 4 years
- collects data on students’ mathematical strategies

Data from 13 million 15-year olds across the world show that:

1. The lowest achieving students are those who focus on memorization and who believe that memorizing is important when studying for mathematics. This idea starts early in classrooms and is one we need to eradicate.

2. The highest achievers in the world are those who focus on big ideas in mathematics, and connections between ideas. Students develop a connected view of mathematics when they work on mathematics conceptually and blind memorization is replaced by sense making.
Math Myth #4

- Math is a boring and monotonous subject.
Math Messages In Our Heads

1. Math is a lot of methods and rules that have to be remembered.
2. An individual subject best learned alone with a book or a teacher.
3. All about right and wrong answers – not interpretation
4. No opportunities to be creative
5. It’s about being fast with numbers.

But…

High achievers in math don’t know more math, they interact with numbers flexibly and they talk about math – low achievers do not.
Mental Math = Brain Growth

Let’s try something:

Think about the problem $12 \times 15$. How would you solve this in your head?
Number Flexibility

Number flexibility is really important!

Another thing that is really important, both in being a powerful math communicator and in understanding more deeply, is to engage in something called mathematical reasoning.

- A lot of people think of math as an individual, solitary activity, but collaborating, talking about math, is really important in your learning of math and it is the way math is used in most companies in the world.
- When you talk about math you have access to a different level of understanding than when you just read questions or work through them on your own.
Total Participation

- Everyone must participate in authentic and important ways.
  - **No instructional fringe huggers or hitchhikers**

- The tasks must be challenging and revolve around important mathematics.

- The tasks must require students to talk about mathematics.
Ordering Numbers Task

1) 64, 39, 44, 20, 25, 94
   _________________

2) 38, 23, 95, 20, 30, 58
   _________________

3) 23, 96, 64, 63, 25, 79
   _________________

4) 18, 85, 32, 33, 77, 17
Closure

Shaping Up Summary

I used to think... but now I know...
References


Boaler, J. (2013). Ability and Mathematics: the mindset revolution that is reshaping education. FORUM, 36, 1, 143-152.


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Today’s materials located here:

- PowerPoint
- 3 Sets of Lesson Plans and Materials Including Finding 4 Fours
- Ordering Numbers Tasks
- Classroom Norms for Growth Mindsets