Growth Mindset in Math

Note. These materials were produced for the WA STEM partnership coaching meeting on 1/10/18, 1/11/18, and 1/12/18.

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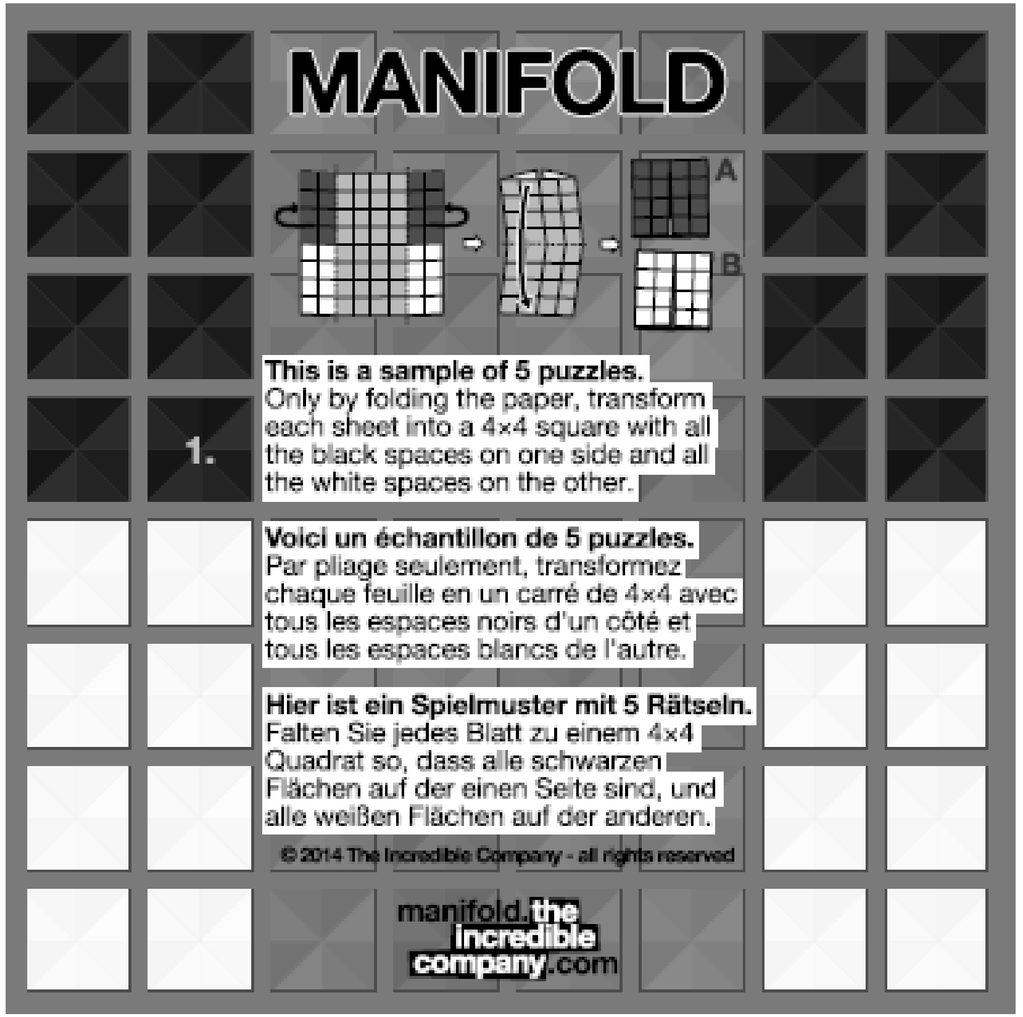
Icebreaker: Manifold Puzzles

1. Find the Manifold Origami Puzzles on your table.
2. Read the directions on puzzle number 1 and give it a try.
3. Once you've completed puzzle 1, try another one. The higher the number on the puzzle, the more challenging it will be.



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Icebreaker: Manifold Puzzles

Introduce yourself to a partner and discuss with each other:

- *What was your initial reaction to the puzzles?*
- *Did you feel confident you could get better at the puzzles as you worked on them?*
- *What kind of internal self-talk did you have as you worked on the puzzles?*

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Learning Objectives

By the end of this session, you will be able to:

Reflect on your mindset about math.

Consider how fixed and growth mindsets impact students' learning and engagement in math.

Learn and practice strategies to promote growth mindsets in math classrooms.

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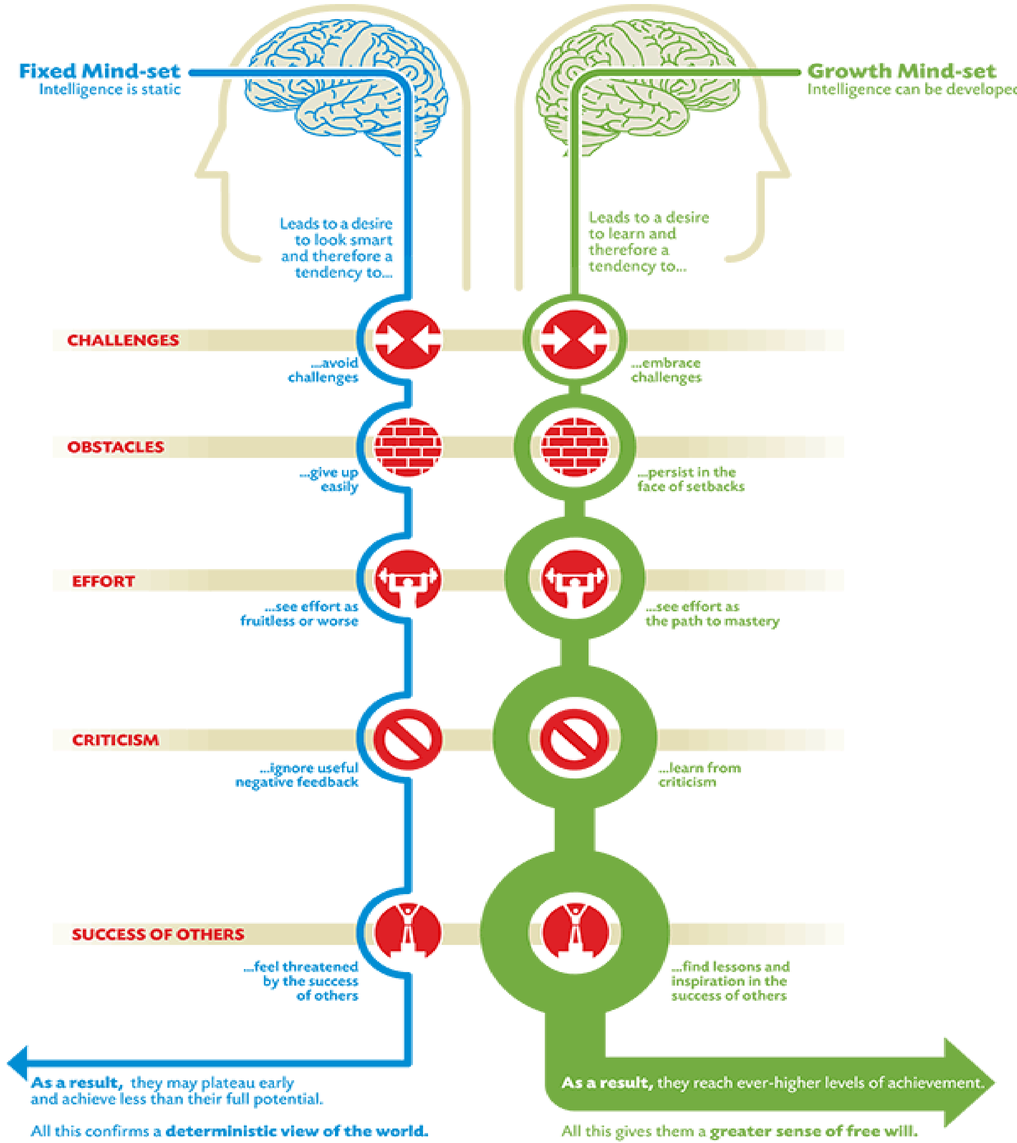
What Are Mindsets?

Fixed Mindset

Intelligence and ability are fixed qualities from birth that cannot be changed significantly.



Growth Mindset

Intelligence and ability can be developed with effort, strategies, and support.

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Fixed vs. Growth Mindset

Bad grade on a quiz

Fixed mindset

"I failed because I'm dumb."

Growth mindset

"Maybe I need a new strategy."

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Different Mindsets for Different Topics

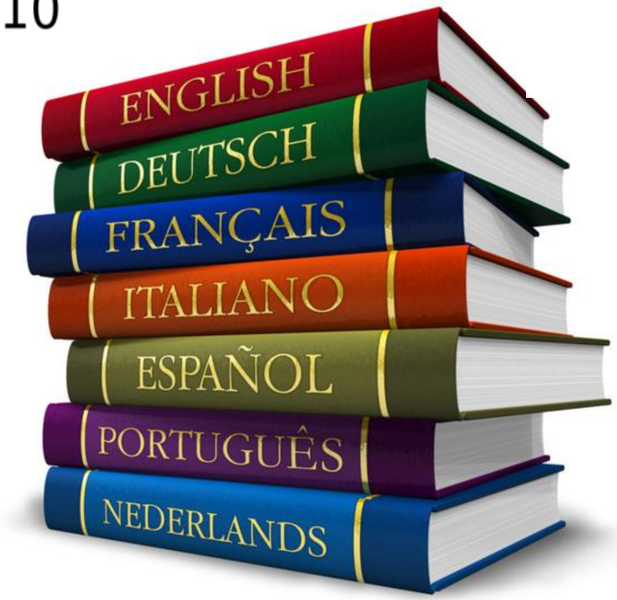
$$2 > -3 \qquad \infty \qquad +\!\!- \qquad \times \qquad \div$$

$$0.999\ldots = 1$$

$$\pi \approx 3.14 \qquad 5^2$$

$$\sqrt{2} \qquad 1 + 2 \cdot 3 \qquad (1 - 2) + 3$$

$$5(2 + 2) \qquad 101_2 = 5_{10}$$



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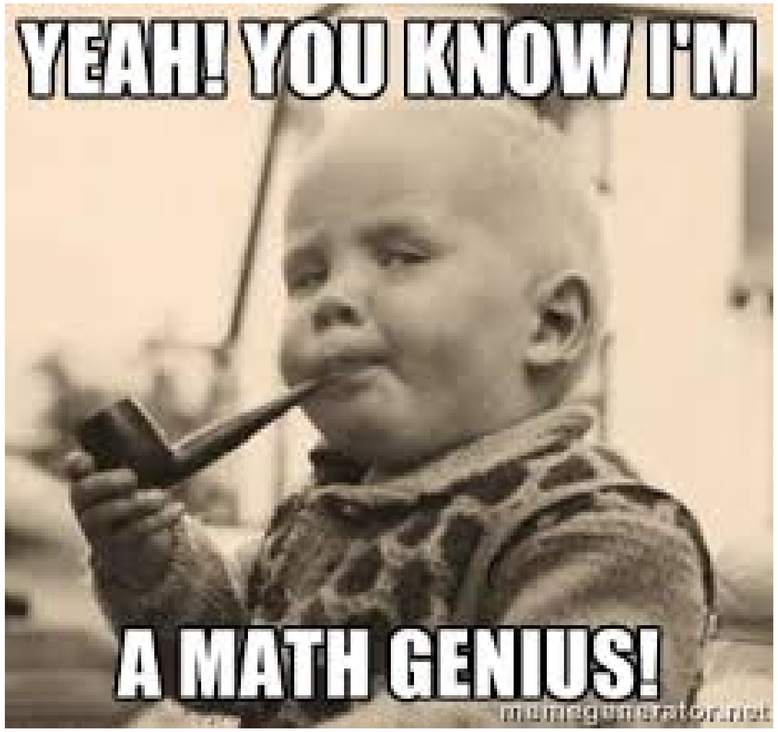
Mindsets and Math



- Students develop math skills incrementally over many years.
- However, many people believe math ability is innate—it's naturally easy for a math "genius" but not for anyone else.

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Students' Mindsets Influence Behaviors and Achievement

Academic Mindset

Academic Behaviors

Academic Outcomes

Adapted from Farrington (2013)

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Growth Mindset Is an Academic Mindset

Farrington's Four Key Academic Mindsets:

1. I belong in this community
2. I can succeed at this
3. **My ability and my competence grow with my effort**
4. This work has value for me

This is Growth Mindset

Adapted from Farrington (2013)

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Growth Mindset and Math

Student mindset predicts math success

- Students with growth mindsets had better math grades and test scores than students with fixed mindsets.
- Students with growth mindsets transitioned more successfully from elementary to junior high school math.

Blackwell, Trzesniewski, & Dweck (2007)

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Growth Mindset and Math

Studies with many different kinds of students have found a robust relationship between mindset and math achievement.

- A study of virtually all grade 10 students in Chile found students' mindsets predicted their language and mathematics achievement.
- Although low-income students had lower test scores overall, low-income students with growth mindsets performed as well as students with much higher incomes.

Claro, Paunesku, & Dweck (2016)

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How Does Growth Mindset Impact Math Achievement?

When students have a growth mindset, they are more likely to:

- Believe that effort pays off. (“The harder you work at something, the better you will be at it.”)
- Set learning goals for themselves. (“The main reason I do my schoolwork is because I like to learn new things.”)
- Believe effort-based strategies will help them overcome failures. (“If I got a bad grade, I would work harder.”)

Blackwell, Trzesniewski, & Dweck (2007)

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How Does Growth Mindset Impact Math Achievement?

When students have a growth mindset, they are LESS likely to:

- Attribute failures to things they cannot control (“The test was unfair.”)

In sum, the research suggests that students with growth mindsets are willing to put in effort even when they struggle or fail, and they stay focused on what they can learn. These behaviors result in better math performance over time.

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How Does a Fixed Mindset Impact Learning?

Research using scans of electrical activity in the brain (event-related potentials or ERPs) shows that students with fixed and growth mindsets have different patterns of brain activity.

- Students with fixed mindsets have stronger reactions to negative feedback (e.g., learning they got a quiz question wrong) ...
- ... yet, spent less time attending to feedback that would help them learn (e.g., less time thinking about the correct answers once they were provided) **and** learned less.

Mangels, Butterfield, Lamb, Good, & Dweck (2006)

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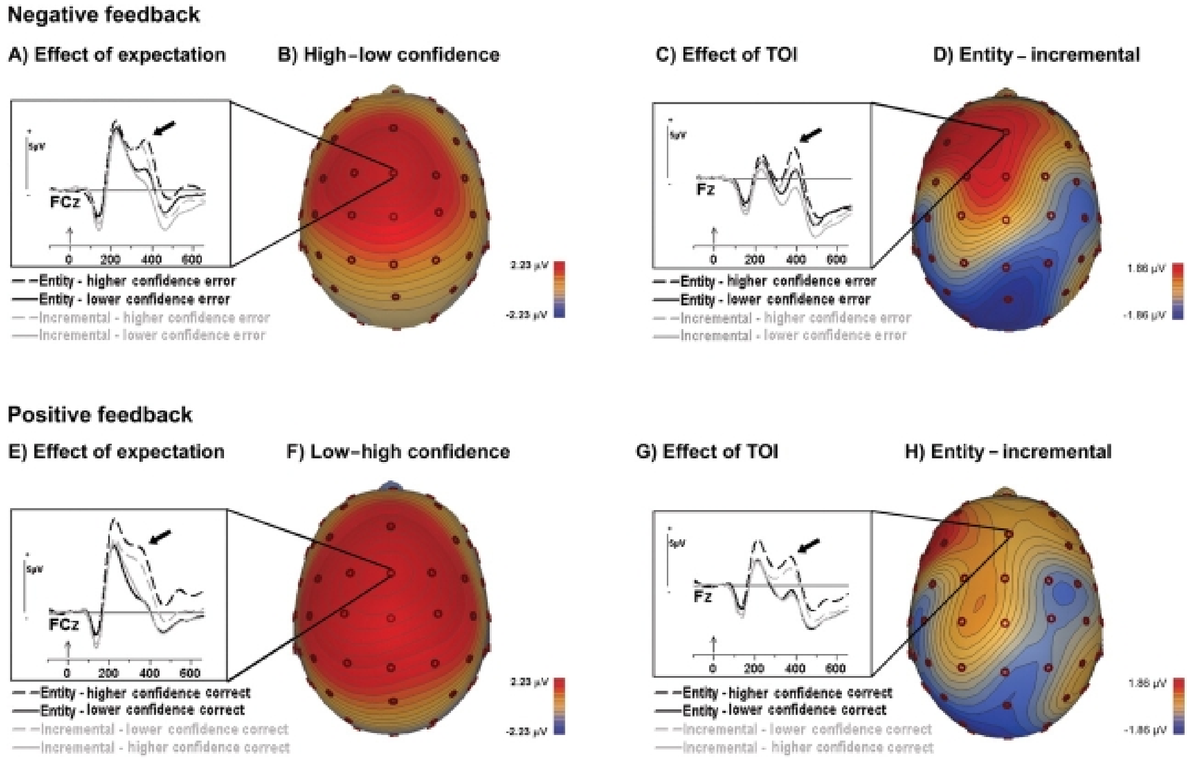
How Does a Fixed Mindset Impact Learning?

These results illustrate that student beliefs about intelligence influence their learning, because those beliefs change how they focus their attention and the effort they make to remember new material.



Mangels, Butterfield, Lamb, Good, & Dweck (2006)

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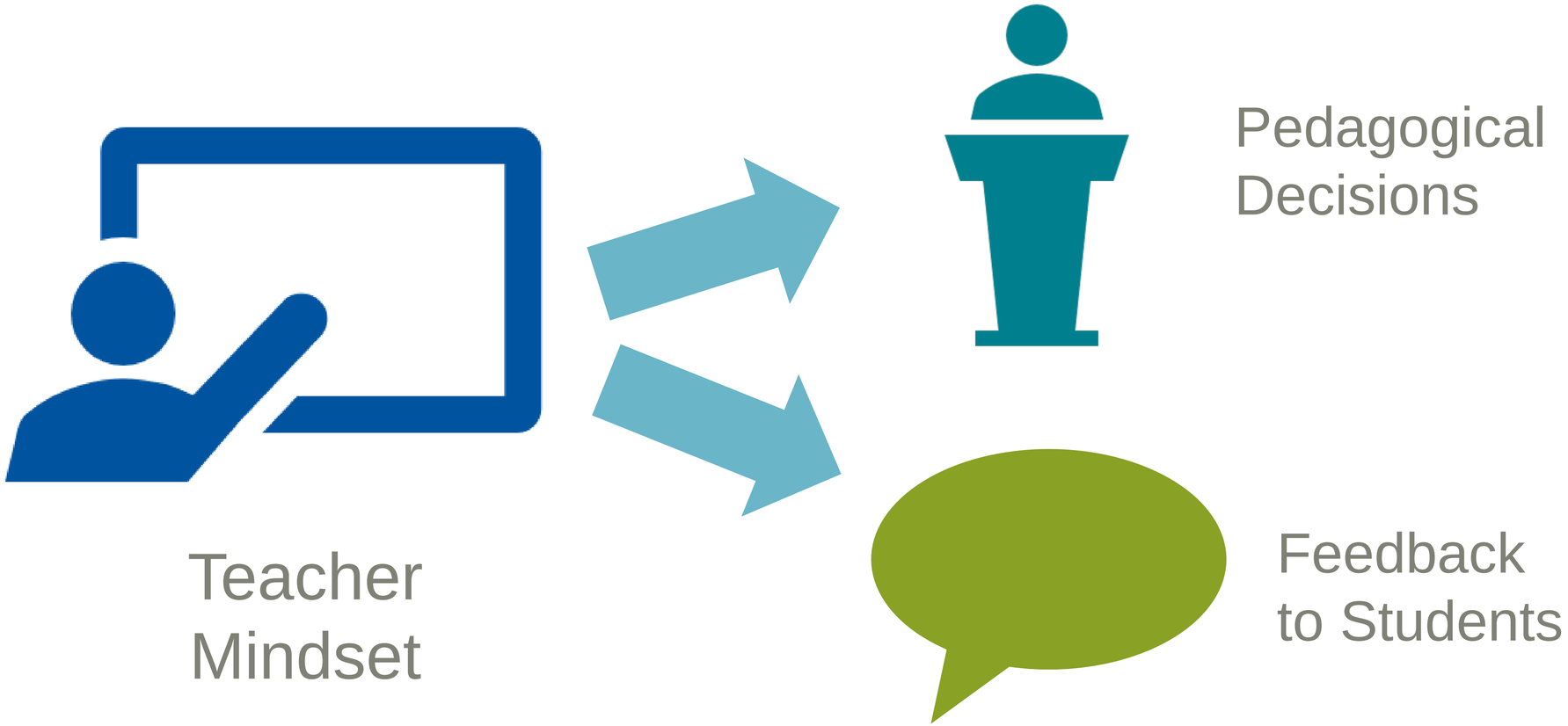
Influence of Teacher Mindsets



How Do Teacher Mindsets Impact Students?

Teachers' mindsets influence their *pedagogical decisions*.

- When a student is struggling with math, a teacher with a fixed mindset may change their pedagogy from *challenging* to *comforting*, such as assigning less math homework to the student.

Rattan, Good, & Dweck (2012)

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How Do Teacher Mindsets Impact Students?

Ability grouping or tracking implicitly communicates that teachers have a fixed mindset about students' intelligence and even potential.

- British students placed in tracked math classes said school felt like a "*psychological prison*" that "*breaks all [students'] ambition*" because it "*almost formally labels kids as stupid.*"
- Even very young students noticed ability grouping, such as one kindergarten student who said "*All the clever students have gone into a different class now.*"

Boaler (2005; 2013)

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How Do Teacher Mindsets Impact Students?

Research has found that students in heterogeneous classes achieve more than students in ability-grouped classes

- When an American school district stopped using ability grouping in middle school math classes so that all students took rigorous math classes:
  - More students took advanced math classes in high school
  - More students passed their math classes
  - Students earned higher scores on the state math exam
  - The achievement gap between white and minority students narrowed dramatically
- These results were consistent whether students started middle school with high or low math achievement.

Burris, Heubert, & Levin (2006)

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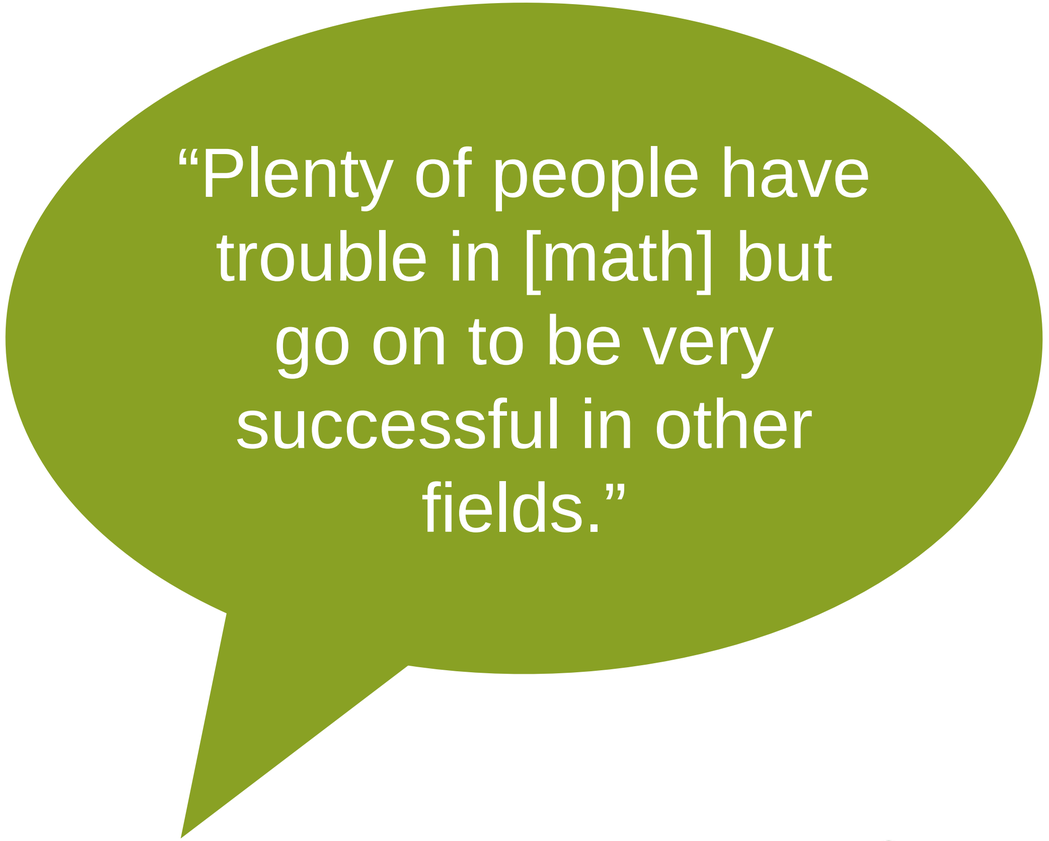
How Do Teacher Mindsets Impact Students?

Teachers' mindsets also influence their *feedback to students*.

- When a student is struggling with math, a teacher with a fixed mindset may try to *comfort* the student instead of giving them strategies to succeed in math.



Rattan, Good, & Dweck (2012)

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How Do Teacher Mindsets Impact Students?

Math students who received "comforting" feedback believed the teacher had low expectations for them in math, had lower motivation, and had lower expectations for success in math.

Rattan, Good, & Dweck (2012)

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How Do Teacher Mindsets Impact Students?

Praising students' *intelligence* instead of their *effort* has negative consequences:

- Students become more focused on performance than on learning (proving it rather than *im*proving it)
- They demonstrate less task persistence, less enjoyment, and lower performance when they experience setbacks, compared to children who are praised for their effort
- They describe their own intelligence as a fixed entity they cannot change

Mueller & Dweck (1998)

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How Do Teacher Mindsets Impact Students?

Fixed mindset

"I failed because I'm dumb."

You're just better at art than at math.

Growth mindset

"Maybe I need a new strategy."

You put a lot of work into that project.

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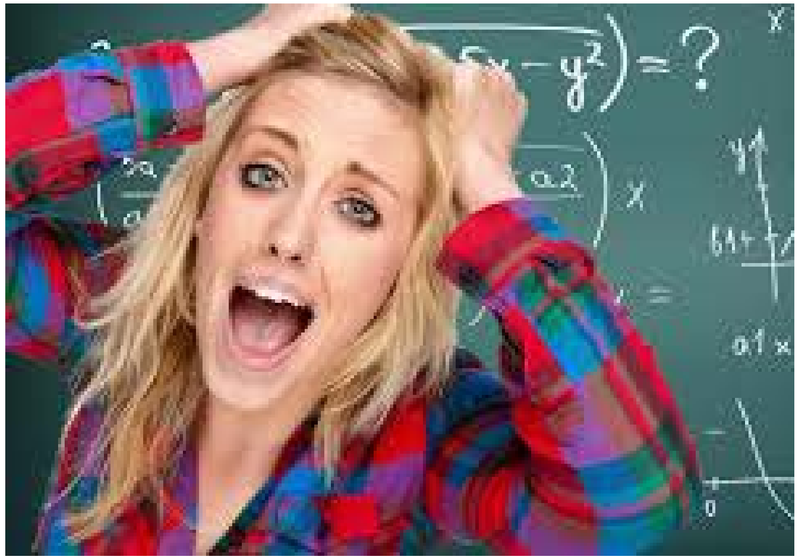
Math Stereotypes and Mindset

When teachers or students believe in stereotypes about math ability, they are endorsing a *fixed mindset* about math in which some people are naturally more capable at math and others are not.

> Stereotypes "may constrict children's aspirations and shape their future academic goals and identities" – Cvencek et al. (2015)



Gendered Perceptions of Math

"*Boys do not pursue mathematical activities at a higher rate than girls do because they are better at math. They do so, at least partially, because they* ***think*** *they are better*."

—Shelley Correll

Girls and Math

- Sociocultural stereotypes associating STEM with males act as barriers that prevent girls from developing interests in STEM, and this starts at a young age.
- Counteracting stereotypes can increase girls' interest in STEM by increasing their confidence and making them feel like they belong in math.

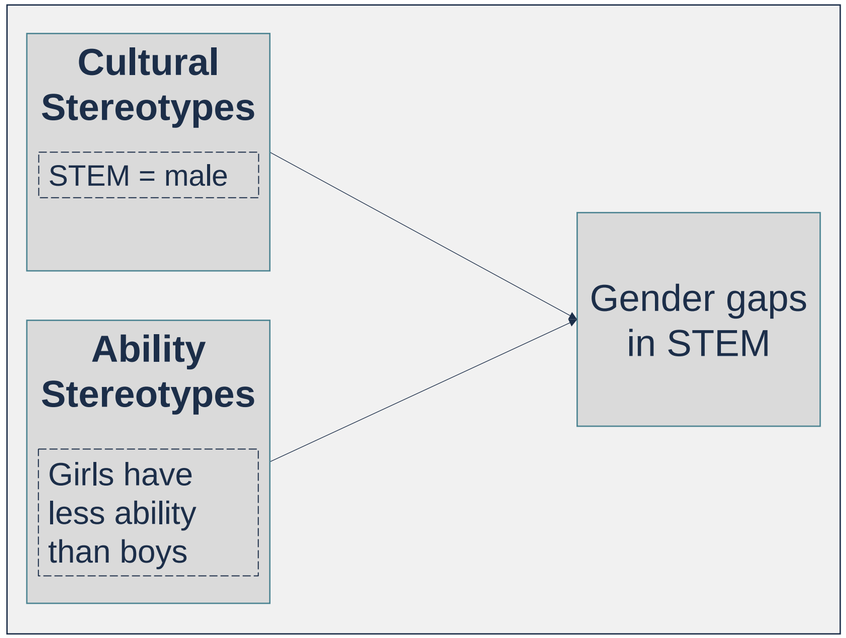


Figure adapted from Cheryan, Master, & Meltzoff (2015)

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“Just Try Harder” Sends a Mixed Message to Students

You just need to try harder.

I DID try hard, but I still don’t get it. I must not be cut out for this.

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Growth Mindset & Equity

It is imperative that growth mindset is not oversimplified to just telling students they need to work harder.

- Hard work on the part of students from traditionally marginalized communities is not enough to overcome systemic racial, gender, and economic oppression.
- Telling students to “just try harder” places the burden of effort only on their shoulders.
- Praising effort when students aren’t learning sends the message that learning isn’t the objective—effort is.

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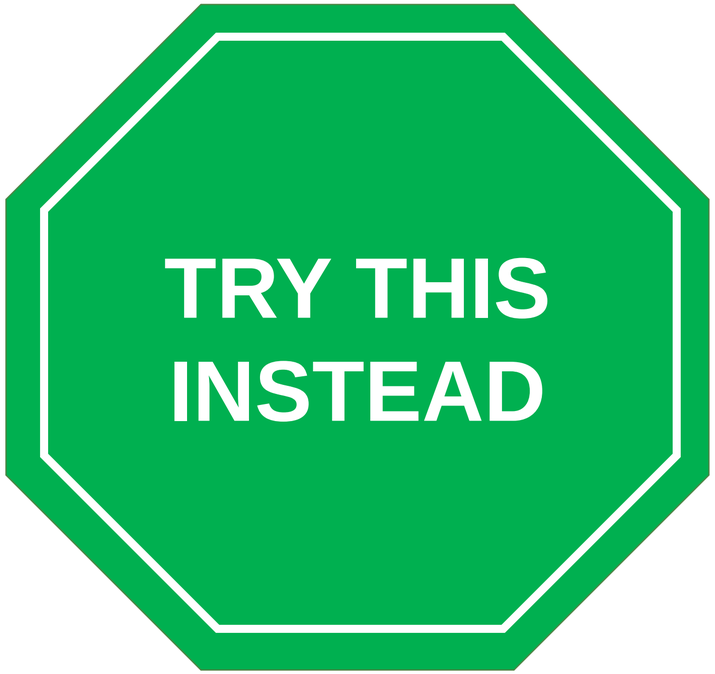
Growth Mindset & Equity



- Keep the focus on effort *in the service of learning*.
- Encourage students to seek out and try new strategies or seek assistance from others when they're stuck.
- When students are trying but not learning, appreciate their work so far, but then talk about what they can try next.

Dweck (2015)

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Growth Mindset & Equity

Fostering a growth mindset can help change student engagement in STEM:

- Influences the motivation and aspirations of aspiring clinicians in organic chemistry.
- Positively impacts minority students confronting stereotypes about their race and perceived intelligence.

Sally Ride
First American Woman to Visit Space

Grant & Dweck (2003); Aronson, Fried, & Good (2002)

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Research Jigsaw, Part 1

1. Find the Jigsaw Readings handout. Select the research study you're most interested in.
2. Move to the poster paper with the corresponding study number (1–4).
3. Read the study summary independently.
4. With this group (your "expert" group) discuss and write notes on the poster paper:

How would you describe this research and its implications?

What relevance does this have to you and your role?

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Research Jigsaw, Part 2

- Now mix it up! Create new groups with each poster number (1–4) and study represented.
- Have one volunteer from each expert group spend 2 minutes summarizing what they learned about the study they read and discussed.

Break

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Classroom Strategies to Promote Growth Mindset

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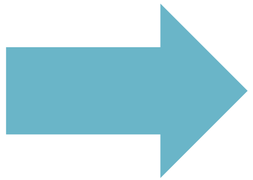
Key Strategies

- Create a positive classroom climate for learning and math.
- Give feedback that promotes effort and learning.
- Teach about how learning happens in the brain.

Positive Climate Ideas



Positive classroom climate:

- Everyone can learn
- Mistakes are learning experiences
- Help is available
- Effort is expected

Positive student academic mindset:

- Failure or mistakes are part of my learning process
- Practice makes me smarter
- My effort pays off

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Positive Climate for Math

Create the norm that making mistakes is OK

- Let students know that you embrace mistakes as part of the learning process. Have students present their mistakes on the board—other students often have made the same ones and can learn by example.
- Explain why mistakes are important—they are chances to learn and get smarter.
- Assign work that encourages mistakes—if students aren't making mistakes, then the work is not challenging enough for them.

Adapted from:
https://www.mindsetkit.org/topics/celebrate-mistakes/3-ways-to-celebrate-mistakes-in-class

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Positive Climate for Math

Create non-stereotypical environments for math learning:

- Make classrooms—even computer and science labs—more welcoming with plants and wall art (especially images of non-stereotypical STEM role models, such as women and people and color).
- Use social media to show the diversity of people working in STEM.

Master & Meltzoff (2017)

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Positive Climate for Math

Teach about and celebrate diverse STEM role models, sending the message that it is normal—not exceptional—for STEM practitioners to be diverse.

Mathematician
Maryam Mirzakhani

Astrophysicist
Neil deGrasse Tyson

Master & Meltzoff (2017)

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Key Strategies

- Create a positive classroom climate for learning and math.
- Give feedback that promotes effort and learning.
- Teach about how learning happens in the brain.

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Give Formative Feedback, Not Grades

Students learn more when they are given descriptive, formative feedback.

- Students given grades **or** grades with descriptive comments learned less and were less interested in working more than students who were only given comments about their work.

Butler (1988)
https://www.mindsetkit.org/topics/assessments-growth-mindset-math/assessments-for-learning-encourage-growth-mindset

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Praise the Process, Not the Person

Different types of praise promote different mindsets

Fixed Mindset

Praise about the person/their intelligence

You must be smart at these problems.

Growth Mindset

Praise about the process/effort

You must have worked really hard at these problems.

Mueller & Dweck (1998)

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Praise the Process, Not the Person

Person/Intelligence

Great job! You must be smart at this!

See, you *are* good at English. You got an A on your last test.

I know you are a talented student in general—it's just not the case that everyone is a math person.

Process/Effort

Great job! You must have worked really hard.

You really studied for your English test and your improvement shows it.

I know you can solve this problem because I remember last month when we worked on common denominators. That was hard, but you did it! Let's talk about a new strategy you can try to solve this math problem.

https://www.mindsetkit.org/topics/praise-process-not-person/dos-donts-of-praise
Rattan, Good, & Dweck (2012)

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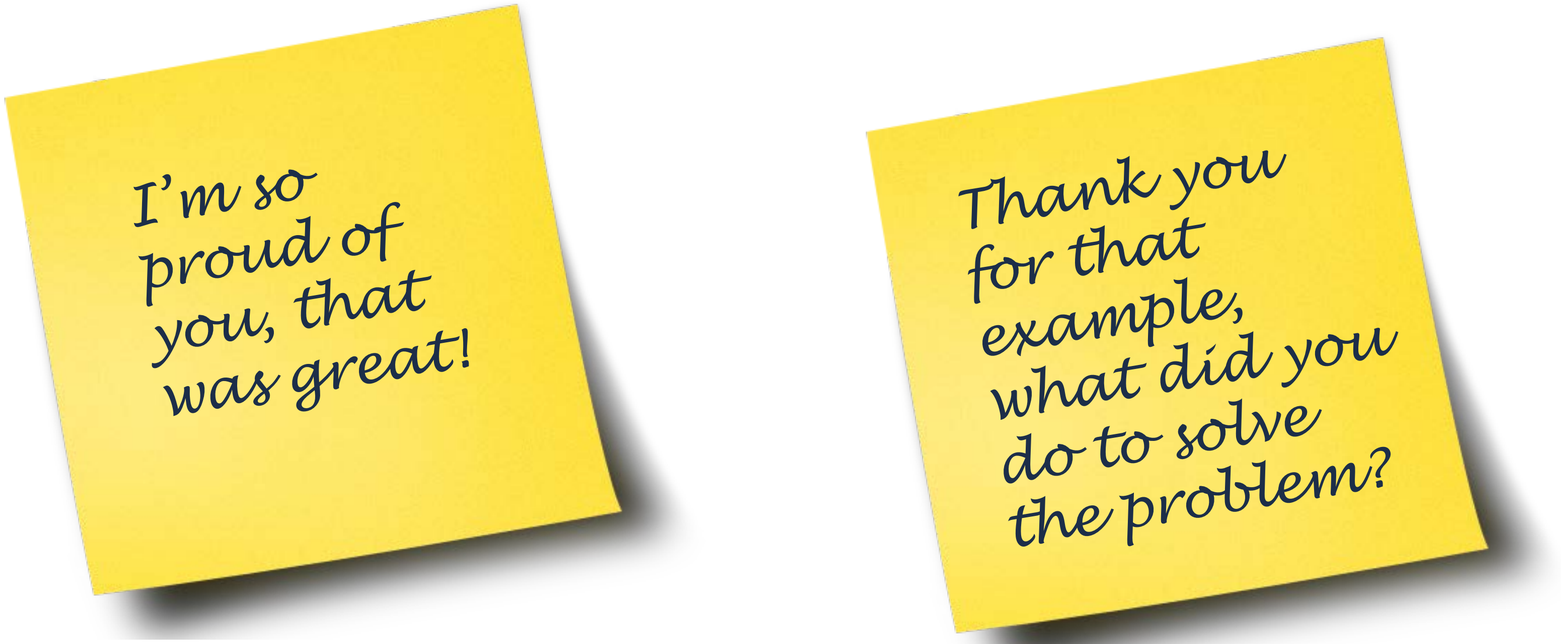
Activity: Improving Praise

- Find the sticky notes with examples of praise.
- Discuss each example as a group. Would it promote a growth mindset or a fixed mindset?
- Revise examples as needed to promote a growth mindset.



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Key Strategies

- Create a positive classroom climate for learning and math.
- Give feedback that promotes effort and learning.
- Teach about how learning happens in the brain.

How Does Learning Happen?

Our brains change as we learn—they grow new connections between neurons, creating networks of interconnected neurons.

People who have learned more or have more experience have denser networks of neurons in their brains.

Yeager et al. (2016)

How Does Learning Happen?

"Most people don't know that when they practice and learn new things, parts of ***their brain change*** and get larger, a lot like the ***muscles*** do. This is true **even for adults**. So it's not true that some people are stuck being "not smart" or "not math people." ***You can improve*** your abilities a lot, as long as you ***practice*** and ***use good strategies***."

– Excerpt from *You Can Grow Your Brain* by Lisa S. Blackwell and David S. Yeager

Visit Mindsetworks.com for more information about articles and other activities

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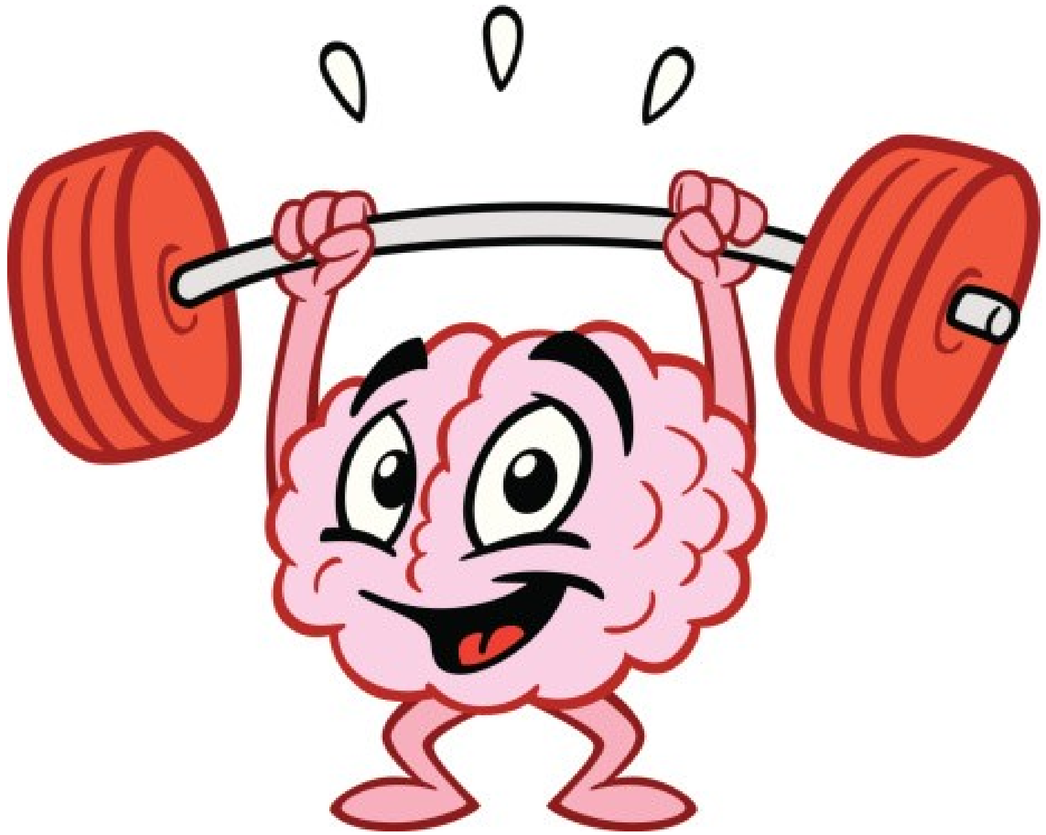
How Does Learning Happen?



Several research teams have tested strategies for teaching students how their brains grow and get smarter when they're challenged—similar to how muscles respond to physical exercise—and that students are in charge of this growth process.

Blackwell, Trzesniewski, & Dweck (2007)
Yeager et al. (2016)

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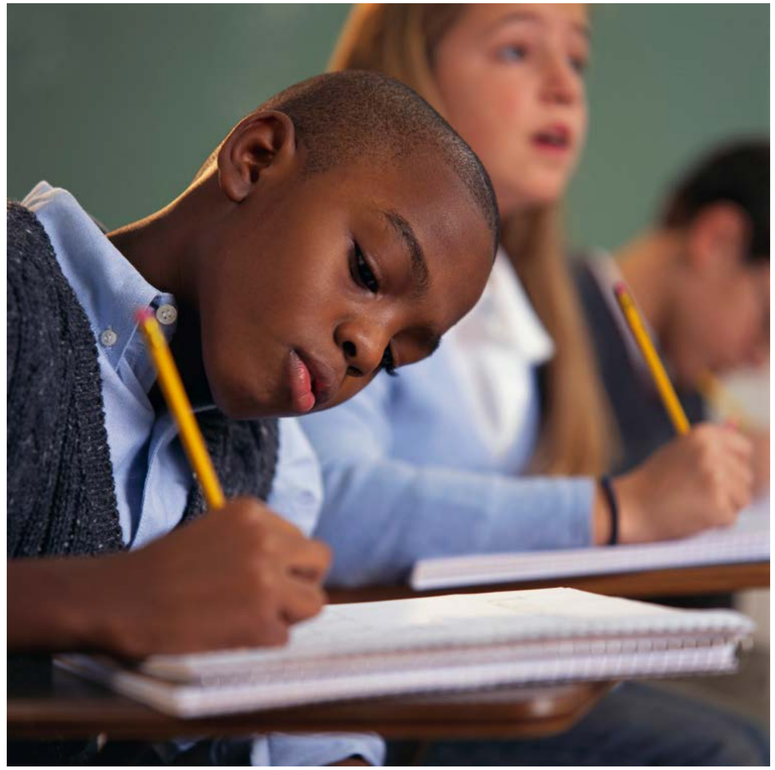
How Does Learning Happen?

Another useful analogy for teaching this concept to children is that babies start out ignorant but become smarter over time as they learn more things about the world.

Blackwell, Trzesniewski, & Dweck (2007)

Activity: You Can Grow Your Brain

1. Students read the *You Can Grow Your Intelligence* article.
2. Students think about something they couldn't do very well, but then they practiced and got better at it.
3. Students write a letter of encouragement (a short paragraph) to an imaginary future student who is struggling in school and feeling "dumb" as a result.



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Reflection

What stood out for you, increased your knowledge, or changed your thinking during this session?

What is one thing you learned or discussed today that you will take back and apply to your work with teachers and/or your classroom?

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Bonus Activity: Mindset Quiz

1. Please fill out the Mindset Quiz, score your responses, and read about your score using the handout provided.

2. Next, discuss the following questions with a partner:

   What stood out to you about your score?

   Think about your experiences as a math student. What mindset about math do you have, based on those experiences?

   How could a teacher's personal mindset about math influence their math teaching?

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About REL Northwest

RELs partner with practitioners and policymakers to use data and evidence to help solve educational problems that impede student success. We do this by:

- **Conducting rigorous research and data analysis**
- **Delivering customized training, coaching, and technical support**
- **Providing engaging learning opportunities**

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Contact Us

Education Northwest

101 SW Main Street Suite 500

Portland, OR 97204-3213

www.educationnorthwest.org

@educationnorthwest

@educationnw

1.800.547.6339

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