Growth Mindsets in Math

Facilitator's Guide

Time: 120 minutes
Facilitators: Instructional coaches or teacher leaders who work with elementary school teachers
Audience: Upper elementary school math teachers

Background Reading

- Blackwell, L., Trzesniewski, K., & Dweck, C.S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and intervention. *Child Development, 78*(1), 246–263. http://eric.ed.gov/?id=EJ754583
- Dweck, C. S. (2006). Is math a gift? Beliefs that put females at risk. In S. J. Ceci & W. Williams (Eds.), *Why aren't more women in science? Top researchers debate the evidence* (pp. 47–55). Washington, DC: American Psychological Association.

Session Outcomes:

By the end of the session participants will be able to:

- Reflect on their 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.

Materials and Supplies

- PowerPoint slides
- Four pieces of poster paper, each pre-labeled with a key word from one of the four articles in the Mindset Research handout listed below. See the Facilitator Note in the activity for more detail.
- Markers
- Time-keeping device
- Separate stacks of sticky notes, enough for each table group of participants. Each stack has two examples of praise for person/intelligence and two examples of praise for process/effort (one statement per sticky note). See the Facilitator Note in the activity for more detail.
- Handouts (enough for each participant)
    - Manifold Origami Puzzles (see prep instructions on page 3)
    - Two Mindsets
    - Mindset Research
    - Teacher Guide: You Can Grow Your Intelligence
    - You Can Grow Your Intelligence article (student handout that accompanies the teacher guide)
    - Mindset Quiz (for optional bonus activity)

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Session at a Glance

Timing	Segment	Key Activities
15 minutes	Welcome and Introductions	Participants complete Manifold Origami Puzzles and discuss the experience of solving them. This helps participants get to know each other and prepares them for the session.
30 minutes	Overview of Mindsets	Growth mindset is defined and described, including its relationship to equity.
20 minutes	Activity: Mindset Research Review	Participants work in groups to examine recent research on mindsets and to discuss its implications for math instruction.
10 minutes	Break	
40 minutes	Classroom Strategies to Promote Growth Mindset	Participants explore, discuss, and practice applying research-based strategies for promoting student growth mindset in math.
5 minutes	Closing Reflection	Participants reflect on what they learned in the session and think about how they will apply it in their work.
(15 minutes)	(Optional Bonus Activity: Mindset Quiz)	(This optional activity prompts participants to assess whether they have a growth or fixed mindset, then share the results with a partner. It can be used as a pre-training activity, an alternative icebreaker activity, a post-training "homework" activity, or as a complement to the training session, as time and interest permit.)

Timing	Topic/Steps/Activities	Facilitator Notes	Resources/ Materials
15 minutes	**Welcome and Introductions** 1. Introduce self. 2. Display the first icebreaker slide and direct participants to Manifold Origami Puzzle, handout 1, which has "Manifold" written across the top, directions, and the number 1 on it. 3. Ask them to try puzzle number 1 and then move on to another puzzle. The higher the number on the puzzle (4, 10, 20, 30), the more challenging it will be. 4. When the majority of participants have completed at least two puzzles, ask them to find a partner and introduce themselves. 5. Ask pairs to discuss their experience of solving the puzzles by answering the prompts provided on the second icebreaker slide: • *What was your initial reaction to the puzzles?* • *What kind of internal self-talk did you have as you worked on the puzzles?* • *Did you feel confident you could get better at the puzzles as you worked on them?* 6. Display and review the session learning objectives.	Direct participants to the Background Reading to deepen their understanding. The directions for the Manifold puzzles are always the same: 1. Only fold the paper (no tearing or cutting). 2. End with a 4 x 4 square with all black spaces on one side and all white spaces on the other side. As pairs talk about their experiences, listen for comments such as "I'm not good at puzzles" or "I get frustrated with things like this."	Slides: Icebreaker: Manifold Origami Puzzles (2 slides). Materials: One page of Manifold puzzles for each participant. Cut out the five puzzles before the session, cutting in line with the guidelines around the margins. It's easiest to make the vertical cut—roughly in the center of the page—first. Slide: Learning Objectives.
30 minutes	**Overview of Mindsets** 1. Point participants to the handout with Dweck's mindsets model. 2. Walk through the slides defining and describing growth mindset using the key points that follow. *Defining Growth Mindsets (2 minutes)* **Key Points** ➢ The research on growth mindsets has been pioneered by Dr. Carol Dweck, a psychologist who wanted to understand how		Materials: Two Mindset handouts. Slides: What Are Mindsets? Fixed vs. Growth Mindset. Different Mindsets for Different Topics.

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	people respond to failure. ➢ In her research, Dweck examined traits that allow some people to cope with failure rather than crumble. During her studies, she realized it wasn't that some people coped with failure better than others, but rather that they embraced failure as a necessary step to learning and to eventual success. ➢ From her research, Dweck identified two belief systems that people tend to fall into: fixed mindset [define fixed mindset] or growth mindset [define growth mindset]. ➢ With a fixed mindset, intelligence and ability are viewed as fixed qualities that one has from birth and that cannot be significantly changed over time. ➢ With a growth mindset, intelligence and ability are viewed as dynamic elements that can be developed over time with effort, strategies, and support. ➢ Mindsets can vary depending on the domain. Most of us have a combination of fixed and growth mindsets, depending on the particular skill or attribute in question. *Mindsets and Math (10 minutes)* ➢ In the United States, many people believe that math skills are somehow very different from other types of skills and that only certain people—math geniuses—are born with innate math abilities. ➢ It's common for people to say, "I'm a math person" or "I'm not a math person," as if they simply do or do not have the possibility of learning or "being good at" math. 3. Pause to have participants respond to the following key questions to reflect on the material presented so far. **Key Questions** • Have you heard anyone say, or have you said yourself, "I'm just not a math person"? Or perhaps you thought or heard someone say, "I'm not good at puzzles" at the beginning of today's session.		Slide: Mindsets and Math.

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	• What kind of mindset about math does such a comment reflect? ➢ Camille Farrington is an influential researcher on the noncognitive factors that allow students to do well in school and life. Farrington uses the term "academic mindsets" to capture all the attitudes and beliefs students hold about themselves as learners. In her review of many studies on noncognitive factors, Farrington concludes that more positive academic mindsets promote academic perseverance and a range of academic behaviors, such as studying hard and attending class, which in turn lead to better learning or academic outcomes. ➢ Today, we will focus on one dimension of an academic mindset: the belief that one's ability and competence can and will grow with time and effort. In other words, growth mindset. ➢ Many other researchers have studied mindsets and their impact on student success. They have found that mindset matters a great deal in academics and math, especially once math becomes very challenging (as in middle school or junior high). ➢ Student mindset predicts math success. Students with growth mindsets have better math grades and test scores than students with fixed mindsets. Students with growth mindsets transition more successfully from elementary school to junior high school math. ➢ Students with growth mindsets learn more, get better grades in math, and do better on standardized math tests than students with fixed mindsets. Research has found this to be true for many different kinds of students. For example, a large study in Chile found mindset predicted student performance on the national exam. Interestingly, having a growth mindset seemed to help low-income students (who tend to do worse on standardized tests, on average) perform as well as students from much wealthier families. ➢ When students have a growth mindset, they engage in positive behaviors and have other beliefs that serve them well in school: • They believe effort pays off. • They focus on learning things (rather than simply trying to appear like they know things). • They use effective strategies to learn or recover from		Slides: Students' Mindsets Influence Behaviors and Achievement. Growth Mindset Is an Academic Mindset. Growth Mindset and Math (2 slides). How Does Growth Mindset Impact Math Achievement? (2 slides). How Does a Fixed Mindset Impact Learning? (2 slides)

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	mistakes, such as working harder when they get a bad grade on a test. • They are much less likely than students with fixed mindsets to exhibit helplessness when they suffer a setback—they don't blame the test for being unfair when they fail, they double down on their effort to improve. ➢ As mentioned above, research on mindset has found that students with fixed mindsets tend to learn less, get worse grades, and do worse on standardized math tests compared to students with growth mindsets. Research that uses brain scans to study electrical activity in different parts of the brain has backed up these findings. ➢ A study by Mangels and colleagues had students take a computer-based quiz while wearing EEG electrodes on their heads to measure brain activity. After the quiz, the students were given their quiz results one question at a time—they were informed if they'd gotten the question right as well as given the correct answer. Students were then given a surprise re-test of the same questions. ➢ Students with fixed mindsets had strong reactions to negative feedback (they'd gotten a question wrong). They spent less time—and seemingly devoted less mental energy to—looking at the correct answers when they were given. Ultimately, they learned less than students with growth mindsets, as demonstrated by their scores on the surprise re-test. Thus, students' beliefs about intelligence—their mindset—changed their level of attention and effort to remember information. 4. Pause to have participants respond to the following key questions to reflect on the material presented so far. **Key Questions** • Think about your hobbies and interests. What's a topic about which you have a growth mindset? How do you know you have a growth mindset about it? • Now think about something you don't like to do. Do you have a fixed mindset about your abilities related to that? If so, how do you know you have a fixed mindset about it?		

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	Research on Teacher Mindsets (8 minutes) ➢ We all have mindsets, and our mindsets vary from topic to topic. Teachers have mindsets about different topics, including math. They might believe they're "not a math person" and mistakenly apply that fixed mindset to the math learners in their classroom. Or they might have a growth mindset about math and apply that instead. ➢ Teachers can have growth or fixed mindsets about math. When teachers have a fixed mindset about math, they respond in particular ways to students who are struggling with math: • They change their pedagogy so that math won't be as challenging to students. They tend to comfort students who are struggling, instead of challenging them to learn math. • They may use ability grouping, which implicitly communicates to students that the teacher has particular expectations for them. • They change their feedback to comfort students who are struggling. This comforting feedback is meant to make the students feel better about their struggles with math, even to the point of counseling students away from engagement in math or math-related fields. ➢ Students in ability-grouped or tracked classes are aware that they've been placed at a particular level based on a teacher's perception of their ability. Students often feel that they've been labeled as "stupid" when they've been placed in a lower group, and they may lose their ambition for academic success. ➢ When a school district abandoned tracking in middle school math so that all students—instead of just high achievers—took a rigorous three-year sequence of math courses from grades 6 through 8, all students benefitted. More students took advanced math classes in high school, and more students passed their math courses. Students did better on the state math test. In fact, the achievement gap between white and minority students narrowed dramatically after a single year. ➢ Students who receive "comforting" feedback are not, in fact, comforted by it. Instead, such students:		Slides: Influence of Teacher Mindsets. How Do Teacher Mindsets Impact Students? (7 slides)

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	• Believe the teacher has low expectations for them in math. • Have lower motivation. • Have lower expectations for success in math. ➢ Another kind of problematic feedback is praise for intelligence (which includes praise for ability or for the person having the intelligence/ability). Students who are praised for their intelligence, rather than their effort: • Focus on performance rather than learning (proving it rather than improving it) • Show less persistence, less enjoyment, and lower performance when they suffer setbacks, as compared with students who are praised for effort • Describe their intelligence as something that they cannot change *Mindset and Equity (8 minutes)* ➢ We have certain stereotypes about who is or isn't good at math. Students become aware of stereotypes by grade 2. If a child is going to endorse the stereotypes (believe they are true), that tends to happen by grade 7. For instance, if you ask children to "draw a scientist," the vast majority of boys and girls, of any race/ethnicity, will draw a White male. ➢ Stereotypes about math include: • African American and Latino students care less about school and are less intelligent. • Boys are better at math than girls. • Asians are better at math than others. • Even "positive stereotypes," such as Asians being "model minorities," are harmful because not all Asians will match the stereotype (they may struggle with math) and because people assume stereotypes are relational—if one group is good at something, then other groups must be bad at it. ➢ Stereotypes can have a huge impact, and gender stereotypes about math likely play a big role in the gender disparities that persist in math and math-intensive fields like science and engineering.		Slides: Math Stereotypes and Mindset. Gendered Perceptions of Math. Girls and Math. "Just Try Harder" Sends a Mixed Message to Students. Growth Mindset & Equity (3 slides).

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	➢ It is imperative to understand that encouraging a growth mindset is not about telling students they need to work harder when they are struggling. • This is true for all students, especially students from traditionally marginalized communities who are experiencing systemic racial, gender, and economic oppression. • "Hard work" is not enough to drive change, and some people have unearned privilege that allows their effort to have much more impact than the effort of those from marginalized communities. • Praising effort when students aren't learning isn't effective—it sends the message that effort is what is important, rather than learning. • When students hear "try harder" without additional guidance, students may believe they're "just not cut out for this," since they have been trying and aren't yet succeeding. ➢ A more effective approach is to keep the focus on effort *in the service of learning*. Teachers can 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, teachers can appreciate their work so far, but then talk about what they can try next. ➢ Fostering a growth mindset can help change student engagement in STEM and can help minority students confront stereotypes about their race/ethnicity and their intelligence. *Wrap Up (2 minutes)* 5. Have participants respond to the following key question as a final reflection on the material presented in this section. **Key Question** • What evidence have you seen, in classrooms and schools, that there are stereotypes about who is and isn't good at math?		

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20 minutes	 **Activity: Mindset Research Review** 1. Display the instructions slide for the first part of the activity. Note that participants will get a chance to read more about the research that is summarized on the preceding slides. 2. Let participants choose one article summary they'd like to read; There are four articles to choose from. Ask that at least two people read each article and go to their first poster. 3. Have participants go to the poster paper with the corresponding research study number and then silently read the article. This is the "expert" group for this article. Once everyone in the expert group has read the article, the group discusses the two questions on the slide. 4. After 8 minutes have passed, display the instruction slide for the second part of the activity. 5. Have the groups break up and "mix it up" by going to different posters so that experts from the first phase are at each poster. 6. Have four volunteers at each poster (one from each study) spend 2 minutes describing what they learned from the study they read. In the end, the participants at each poster should have heard descriptions of all four studies.	To prepare for the activity, hang four pieces of poster paper around the room and label them 1–4. Include a key word from the corresponding article number from the handout. Place at least two markers at each poster.	Slides: Research Jigsaw Part 1. Research Jigsaw Part 2. Materials: Pre-labeled poster paper, markers, time-keeping device, and A Closer Look at Mindset Research handout
10 minutes	**BREAK**	Be sure to set a timer.	
40 minutes	 **Classroom Strategies to Promote Growth Mindset** *Preview (2 minutes)* 1. Display the classroom strategies and key strategies slides and give a preview of the strategies that will be presented. Explain that for the rest of the session, the group is going to explore different strategies to foster growth mindsets. 2. Walk through the slides describing the following strategies using the key points provided.		Slides: Classroom Strategies to Promote Growth Mindset. Key Strategies.

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	Positive Classroom Climate (10 minutes) **Key Points** ➢ Dweck and her colleagues have used their research to create tools for teachers, parents, and students. The tools are available at *www.mindsetkit.org* and *www.mindsetworks.com*. One of the strategies they've found to be effective is to set the norm that it's OK to make mistakes. This includes: • Creating an environment in which students openly share their mistakes so that everyone can learn from them. • Explaining that mistakes are important because they provide opportunities to learn. • Assigning work that encourages mistakes because it challenges students. ➢ Other researchers emphasize that: • Classrooms and labs for STEM should be as welcoming as possible, with neutral items like plants and wall art instead of stereotypic items like Star Trek posters, sci-fi novels, and gaming equipment. • Teachers should use social media, posters, and assignments to show the diversity of people working in STEM. The key is to show that STEM practitioners themselves are diverse and that this is normal, not exceptional. 3. Have participants partner up and brainstorm ways schools can create a positive climate in math classrooms. If time permits, invite a few volunteers to share their suggestions.	You may wish to write down on poster paper some of the ideas that are shared.	Slides: Positive Climate Ideas. Positive Climate for Math (3 slides).

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	Give Feedback That Promotes Effort and Learning (15 minutes) **Key Points** ➢ Some research has shown that students learn more when they are not given grades at all, but instead are given formative comments that give them useful feedback. Interestingly, researchers found that students given grades or grades and comments learned less and were less motivated to work than students who received just feedback comments (no grades) on assignments. Students seemingly only paid attention to their grade, if one was given. Students with low grades were the least motivated to continue working on similar assignments. ➢ Remind participants that praise for intelligence/ability or the person having the intelligence/ability promotes a fixed mindset, while praise for process/effort promotes a growth mindset. 4. Display the slide with the improving praise activity instructions. 5. Divide participants into groups. 6. Give each group a stack of four sticky notes. Each note has an example of person/intelligence praise or process/effort praise. 7. Each group works together to identify whether a given sticky note is an example of person/intelligence praise or process/effort praise. 8. Each group then revises any sticky notes that are examples of person/intelligence praise. 9. Have the groups reflect on the activity by responding to the following key questions. **Key Questions** • What's hard about giving process/effort praise? • What can help you remember to give process/effort vs.	Prior to the session create stacks (one stack per group of participants) of sticky notes, each stack with two examples of praise of person/intelligence and two examples of praise for process/effort. For example: Person/Intelligence: • Awesome job! You solved that problem correctly! • It's OK that this task is hard for you. • You are so smart! • You got it! Process/Effort: • I like the way you tried all kinds of strategies until you finally got it. • I love the way you kept your concentration and kept working. • I can tell you've been practicing! • You've really been persistent with this problem, and I can see you're making progress.	Slides: Key Strategies. Give Formative Feedback, Not Grades. Praise the Process, Not the Person (2 slides). Activity: Improving Praise Materials: Pre-written sticky notes with examples of praise statements (see note at left).

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	person/intelligence praise? *Teach How Learning Happens in the Brain (10 minutes)*  **Key Points** ➢ The final strategy is to explicitly teach children that their brains literally change whenever they learn something—they form new connections in their brains that make them smarter. This is the neurological fact that the growth mindset is based on: Our brains grow and change when they're challenged (and thus intelligence is not fixed or unchangeable). ➢ Teach students that they can grow their intelligence, just like they can grow their muscles. Another useful analogy is that brains grow and change just like babies do as they learn and experience the world. ➢ Explain that this strategy has been tested with many different students of different ages. 10. Display the slide with the instructions for the activity. 11. Have the participants work in table groups to read through the teacher guide and accompanying student handout and complete the activity as presented in the guide. 12. Have the groups reflect on the activity by responding to the following key questions.  **Key Questions** • What, if anything, would you change about this activity to make it work in the schools or classrooms you coach in? • What other analogies for getting smarter with effort (e.g., building muscles) do you think will resonate with the students you know? *Wrap Up (3 minutes)* 13. Ask a few participants to briefly share examples of how they've		Slides: Key Strategies. How Does Learning Happen? (4 slides). Activity: You Can Grow Your B Materials: Teacher Guide: You Can Grow Your Intelligence, Student Handout: You Can Grow Your Intelligence

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	employed mindset strategies in their classrooms (or in their work with teachers).		
5 minutes	 **Closing Reflection** 1. Display the Reflection slide. 2. Ask participants to reflect on the following Key Questions and share their responses with the large group (as time permits):  **Key Questions** • 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? 3. Display the references slides and encourage participants to look up the studies listed for more information. 4. Thank participants. 5. Answer any final questions.		Slide: Reflection Slides: References (2 slides)

15 minutes	 **Optional Bonus Activity**
	
	1. Display the bonus activity slide and direct participants to the Mindset Quiz handout.
	2. Ask participants to complete the quiz and score their answers.
	3. When the majority of participants have completed and scored the quiz, ask them to find a partner.
	4. Ask pairs to discuss their results and answer the prompts provided:
	  • *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?*
		This is an optional activity. This activity works best for participants who are less familiar with the concept of growth mindset and are likely to benefit from more self-reflection.	Slide: Bonus Activity: Mindset Quiz
			
			Materials: Mindset Quiz

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