Mindsets and Mistakes in Mathematics: Changing teachers’ and students’ beliefs about mistakes

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- Stanford University -
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How do you measure someone’s mindset?

- “You can learn new things, but you can’t really change your basic intelligence.”
- “Your intelligence is something about you that you can’t change very much.”

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Somewhat Agree</th>
<th>Somewhat Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
Consequences of growth vs. fixed mindsets

<table>
<thead>
<tr>
<th></th>
<th>Fixed mindset</th>
<th>Growth mindset</th>
</tr>
</thead>
<tbody>
<tr>
<td>goals</td>
<td>look smart</td>
<td>learn</td>
</tr>
<tr>
<td>values effort?</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>response to challenge</td>
<td>give up</td>
<td>work harder</td>
</tr>
<tr>
<td>achievement</td>
<td>lower</td>
<td>higher</td>
</tr>
</tbody>
</table>

Blackwell, Trzesniewski, & Dweck, 2007
Mindsets and performance: New research from a whole country

Susana Claro  
Dave Paunesku

Claro, Paunesku, & Dweck, in prep
Mindsets and performance: New research from a whole country

Claro, Paunesku, & Dweck, in prep
Changing performance: Underperforming students earning As, Bs, & Cs in core classes

Paunesku, Walton, Romero, Yeager, & Dweck, in prep.
What can educators do?

Mindset and Mistakes in Mathematics
Why math?

• People are likely to have a fixed mindset about math
  – e.g.,”I’m just not a math person.”

• Important in the wake of the CCSS
  – CCSS are much more rigorous than the previous standards.
  – Students who hold maladaptive beliefs about struggle will be not be prepared for learning with the new standards.
Growth Mindset for Math

Goals:

• Teachers
  – Promote a growth mindset
  – Promote positive beliefs about mistakes
  – Change how they respond to mistakes

• Students
  – Change mindsets
  – Improve performance
Participants

• High school math teachers in SFUSD
• 71 started program, 50 finished
  – Control: 38 teachers started, 33 finished
  – Treatment: 33 started, 17 finished

• Differential attrition possibly due to greater demands of treatment program
• Randomization procedure led to higher likelihood of contamination
# Design

January (beginning of semester 2)  
About 1 week later (each session ~1 week apart)  
April through end of year

<table>
<thead>
<tr>
<th>Teacher Condition</th>
<th>Student Session 1</th>
<th>Teacher Sessions</th>
<th>Student Session 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment</strong></td>
<td><strong>Pre-survey</strong></td>
<td><strong>pre-survey + mindset</strong></td>
<td><strong>Post-survey</strong></td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td></td>
<td><strong>pre-survey</strong></td>
<td><strong>Follow up measures</strong></td>
</tr>
</tbody>
</table>
Growth Mindset for Math
Welcome!

In this program, you will learn practical, research-based advice to help you cultivate a *growth mindset* in your students. The goal is to help your students stay motivated in the face of challenging work, like that required by the new Common Core. This course consists of five sessions. Click on the links below to access each session.

- **Session 1**: Mindsets and how the brain grows with learning
- **Session 2**: Valuing challenges and mistakes as opportunities to learn
- **Session 3**: Tasks that promote a growth mindset, challenge, and productive mistakes
- **Session 4**: Assessment and feedback that fosters a growth mindset
- **Session 5**: Wrap-Up
In the study by Moser and colleagues at Michigan State University, students with a growth mindset (who view mistakes as opportunities to learn) had different patterns of brain activation after making mistakes than individuals with a fixed mindset.

Students with a growth mindset showed greater brain activity associated with awareness of and processing of mistakes. Importantly, this brain activity was associated with improved future performance, or rebounding from mistakes. In the figure below, warmer colors (red, orange) indicate greater activity than cooler colors (green, blue).

In the video on the next page, Carol Dweck provides an example of a student with a particularly positive approach to mistakes.
Create the norm that you love and want mistakes.

Don't just praise mistakes - explain why they are important.

Give work that encourages mistakes.
Students solve a challenging problem on notecards.

The teacher finds her "favorite no" and leads students through what the student does right, and what mistakes they made.

This activity shows students the importance of learning from mistakes.
Activity sample: Favorite mistakes

Adapt the "favorite no" activity you watched earlier in this session for your classroom.

Go through a set of student work, quizzes, or test papers and look for your 'favorite mistake.' An ideal mistake for this exercise is one that shows some conceptual misunderstanding that a lot of students may learn from and that you can discuss with the class. Explain to your class why it is your favorite, what the class can learn from it, and continue to talk through it with your students.

You may prefer you make it anonymous so you can build up a mistake-friendly culture in your classroom. After the class is comfortable making mistakes, and understands how much they can learn from mistakes, you can start asking students to volunteer mistakes that the class can work through.
Key measures targeted by teacher intervention

• teachers’ mindsets (2 items)
  
  “You can learn new things, but you can’t really change your basic intelligence.”

  “Your intelligence is something about you that you can’t change very much.”

• teachers’ worries about student mistakes (2 items)

  “I worry that my students feel dumb when they make mistakes in math.”

  “I feel uncomfortable when my students make mistakes publicly.”

• teachers’ mistake promotion (2 items)

  “I emphasize to my students that making mistakes is a key part of learning math.”

  “I assign work that is challenging, knowing that most of my students will make mistakes on it.”
Teacher mindset:
Teachers in the treatment group were more growth after the intervention relative to the randomized control group.

Completers: \( t = 3.55, p < .005 \)
LOCF (Las Observation Carried Forward): \( t = 2.82, p = .01 \)
All analyses control for baseline mindsets.
“My classes actually had very challenging work during these last 2 weeks - computing % in 6th grade, simplifying exponents in 7th grade, and piecewise functions in 8th grade. The day after I completed the first session, every class was in a tizzy because what we were doing was "so hard." I had to do lots of coaching to convince students that they would get this material. For the most part, my "talk" to students is always about working hard, persisting, and that I know they'll get it if they put the effort in. However, I did find with some students, I make less of an effort to tell them this. In all cases, these are students who I feel are terribly misplaced in the program I teach (accelerated mathematics for gifted and talented students.) I've observed their performances in non-math classes - they are gifted - but in mathematics they really struggle. I suspect these students have a disability in mathematics. Numbers make no sense to them. They look at 2.67 + 3.89 and estimate the answer is 5 and can't see why someone else would estimate 6.5; they find that someone running the mile ran it in 600 mph and aren't bothered about the result, even when I ask them about it. They have memorized the procedures to compute with fractions, solve proportions, solve equations, but if I ask them to extend this idea to a new concept, they can't. I realized through this exercise that mentally I don't expect as much from these students as I do from the rest of my class. I don't specifically tell them to keep at it because I know they'll get it, rather I gloss over them in class. In my brain (and heart) I say to myself they really aren't going to get this concept like I want them to get it, so I know I back off from prodding them as much as I might prod the rest of my class. This really isn't ok and this activity has forced me to see the signals I'm sending them vs. other students.”
Teachers’ worries about student mistakes:
Teachers in the treatment group were less worried about student mistakes after the intervention relative to the randomized control group.

Completers: $t = 2.31, p = .03$
LOCF (Las Observation Carried Forward): $t = 2.27, p = .03$
All analyses control for baseline mindsets.
“If the work is too easy or not challenging, then students are not learning as much as they could. Learning occurs from challenge and mistakes. It's okay if a student isn't there "yet", as long as we continue to convey the message that if they keep trying, they will understand. Keep challenge the new norm.”
Teachers’ mistake promotion:
Teachers in the treatment group reported responding more positively to mistakes after the intervention relative to the randomized control group.

Completers: $t = 1.94, p = .06$
LOCF (Las Observation Carried Forward): $t = 1.68, p = .1$
All analyses control for baseline mindsets
“I tried to use mindset language when launching a task and to encourage students as they worked through the task. In the launch of the task, I told students they would be investigating a new pattern of exponential growth, and that it would be more challenging and thus presented them with an opportunity to become smarter at math and have a deeper understanding of exponential functions. As students struggled with their equations, I told groups, I can see you're struggling and so I know you are making important connections and improving your understanding.”
Summary

• Overall, teachers reported more positive and less negative attitudes toward mistakes in math.

• Why no measurable difference between the groups of students?
  – Translation: Perhaps teachers couldn’t translate the advice.
  – Time: Perhaps there wasn’t enough time for students to pick up on the change.
  – Culture change/contamination: Perhaps all students changed their opinion because there was a change in school culture.
Thank you!

• Stay in touch:
  – Email me: clromero@stanford.edu or carissa.l.romero@gmail.com
  – Follow us on twitter: @pertslab
  – Like us on facebook: facebook.com/pertslab
A MATH WARM UP: HOW WOULD YOU APPROACH THIS PROBLEM?

Suppose you are 6 feet tall and you walk around the Earth's equator.

How much farther does your head travel than your feet?
SFUSD Math core curriculum
A rich math task takes time to solve and lends itself to collaboration and multiple perspectives. Robust use of these tasks creates the context in which students build multiple representations and communicate their reasoning.
SFUSD Math core curriculum

Patricia Martinez Tejeda (left), Kismot Rakkat (center) and Phung Nguyen team up to solve a math problem in Mai-tien Nguyen's 4th grade class at Redding Elementary School. Photo: Paul Chinn, The Chronicle
Thank You
Thank you!

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