MINDSET OUTSIDE THE CLASSROOM: DEVELOPING A GROWTH MINDSET IN MATHEMATICS IN THE CONTEXT OF TUTORING

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Mindset: A personal belief about ability

Growth mindset: Personal qualities, such as the ability to learn, can grow over time.

vs Fixed Mindset

Growth mindset is associated with positive learning outcomes.

Fixed mindset in a field is associated with fewer female PhDs.
• Fixed mindset: You are either mathematical or you are not.
• Growth mindset: Everyone can become mathematical.
• Fixed mindset is prevalent among mathematics faculty.
• Mathematics growth mindset is associated with academic growth, retention, and equity.
• Many mathematics students have a fixed mindset.

• A teacher who holds a fixed mathematics mindset believes that some students are good at math while others are not and often fails to challenge students who appear less able to learn mathematics than others.
• Indiana University – Purdue University Indianapolis (IUPUI) is an urban university that began 50 years ago as a joint venture of Indiana University and Purdue University.
CONTEXT

• Mostly commuter campus
• Grants IU and PU degrees
• 29,000+ students
• The IUPUI Mathematics Assistance Center (MAC) provides tutoring for all students enrolled in 24 mathematics courses.

• The MAC is funded by student fees.
**CONTEXT**

• MAC tutors are students who have been successful in the courses they are tutoring, who demonstrate content knowledge through a rigorous test, who demonstrate strong people skills through a personal interview, and who have been trained specifically in tutoring skills.
CONTEXT

This intervention targeted both the students visiting the MAC, and the MAC tutors during the Fall 2020 and Spring 2021 semesters.

• 8543 student visits
• 68 tutors
• Tutoring at the MAC during Academic Year 2020 – 2021 was mostly virtual.
• Tutors spend much time with students.
• Tutors need to enrich their teaching skills.
• Tutors often themselves need to develop a growth mindset about those they tutor.
• Growth mindset in tutors is likely to develop an environment of growth in the tutoring center.
• Long-term mindset interventions appear to be effective.
Goal: Tutors in the mathematics tutoring center will use research-supported language and teaching strategies to encourage the adoption of a growth mindset in mathematics by the students they are tutoring

- Train tutors in meaning of growth mindset.
- Give tutors specific approaches to encouraging growth mindset.
- Ask tutors to implement the strategies and report their implementation.
- Collect data to determine the effectiveness of the intervention.
• Barbara Johnson, Mathematics Faculty

• Kenda Hamersley, Assistant Director of the Mathematics Assistance Center

• Claire Richardson, MAC tutor and manager, senior elementary education major
• Internal IUPUI Curriculum Enhancement Grant
• Matched by Mathematics Department
• Funded:
  • 1 hour of paid training per semester for each tutor
  • Hourly payment for student researcher
1. Development and implementation of a curriculum to train MAC tutors about growth mindset and its importance in mathematics

2. Development and implementation of short interventions for tutors as they worked with students designed to encourage the development of growth mindset.
• The definition and importance of growth mindset
• Highlights of growth mindset research
• How to encourage the development of growth mindset
• Introduced and discussed during two one-hour required training sessions at the beginning of each semester
• Five brief, specific moves
• Based on growth mindset research
• Tutors were asked to implement these during their interactions with students.
• Monitored through tutor self-reporting and reinforced through regular emails throughout the semester
1. Target Growth: SPEAKING GROWTH MINDSET (YET)

- **INTERVENTION:** Ask students to reword fixed mindset statements with growth mindset statements. Offer help with the wording but encourage students to verbalize the statements themselves. Just adding “yet” to the end of a statement is a good start.
2. Target Growth: REASONING AND CONVINCING ARGUMENTS

• INTERVENTION: Ask students to explain why their answer is correct – how they know they are right. Encourage use of mathematical language.
3. Target Growth: SELF-EFFICACY

• INTERVENTION: Encourage students to take one course of action; for example:
  
  • Write down one step you can take toward success.
  
  • List areas in your life that are under your control. Choose one area and write a plan to adjust that area to better fit your circumstances.
  
  • List what you do know that relates to this problem. Try a concept map.
  
  • Write down a reasonable study plan for the rest of the week.
4. Target Growth: MULTIPLE REPRESENTATIONS

- **INTERVENTION:** Encourage students to represent a problem visually, create their own context for the problem, or try their own approach to solve a problem.
5. Target Growth: EXPLORATION

- **INTERVENTION:** Encourage students to describe relationships and patterns.
1. Surveys

- Source: Modified from Carol Dweck
- Sample question: You are either good at math or you aren’t and you really can’t do much to change it.
- Given:
  - Tutors: Beginning of each semester, end of second semester; almost all tutors
  - Students: Beginning and end of each semester; convenience sample
2. Semi-structured interviews

- At end of each semester
- Convenience Sampling
- Students
  - Attitudes toward mathematics
  - Stories of effect of tutors and tutor center
- Tutors
  - Attitudes toward interventions
  - Stories of using interventions
• COVID
• Buy-in
• Data collection
• Compare means from mindset surveys before and after intervention
  • No discernible differences
• Qualitative analysis of interview data
• When tutors used the interventions we designed to encourage growth mindset, students responded positively with increased effort and self-efficacy.

• Support for this claim comes from interviews with tutors.

• For example, one of the simplest interventions we suggested was to use the phrase “not yet” to reword a student’s frustration with not being able to solve a problem. One tutor who used that strategy said that students would then try the problem again with a better attitude.
Some tutors who used the growth mindset interventions we designed found that their understanding of mathematics was changed.

For example, one tutor said that they realized much of learning math was about motivation, not knowledge.
• The results of this project reinforce the importance placed in literature on teacher mindset. The tutors who embraced the growth mindset interventions saw the results of their modeling growth mindset in their students’ responses.

• The results also reinforce the importance of a long-term effort to develop growth mindset, since many more tutors attempted to implement the growth mindset interventions in the second semester of this project than in the first.
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• Intervention documents can be accessed at
  https://drive.google.com/drive/folders/1drMvGmy7_mWTSfadsp2-0v_xGjSEfHb9?usp=sharing
1. **Target Growth: SPEAKING GROWTH MINDSET (YET)**

It is vital that students speak to themselves in “growth mindset” language. Fixed mindset language includes statements like “I’m just not good at math” or “I can’t do this.” Growth mindset replaces those with statements like “I can get better at math” and “I can’t do this yet, but I will work at it.” As students work diligently and grow mathematically, they will be able to do or understand what seems now difficult or confusing.

**INTERVENTION:** Ask STUDENTS to reword fixed mindset statements with growth mindset statements. Offer help with the wording, but encourage students to actually verbalize the statements.

*Everyone can grow their mathematical understanding. Can you reword that statement to include your own growth? Can you restate that using the word “yet”?*

2. **Target Growth: REASONING AND CONVINCING ARGUMENTS**

A foundation of mathematics development is justifying the conclusions reached. In order for new mathematical discoveries to be published, other mathematicians must agree that the author’s work is valid. Students’ ability to explain why their work is correct will grow as their mathematical vocabulary, conceptual understanding, and experience expands. The logic and reasoning developed through growth in mathematics can be used to find solutions to problems in many other areas of work and study.

**INTERVENTION:** Ask students to explain why their answer is correct – how they know they are right. Encourage use of mathematical language.

*How would you convince a classmate that your answer is correct?*

3. **Target Growth: SELF-EFFICACY**

Because individuals with a growth mindset believe that they are capable of learning anything, they tend to have an internal sense of control or a strong sense of self-efficacy. If they succeed, they credit their own hard work, and if they fail, they blame themselves for not having done more. Believing that one is in control of one’s own learning is a powerful step toward success in mathematics.

**INTERVENTIONS:** Encourage students to take one course of action.

*Write down one step you can take toward success.*
*List areas in your life that are under your control. Choose one area and write a plan to adjust that area to better fit your circumstances.*
*List what you do know that relates to this problem. Try a concept map.*
*Write down a reasonable study plan for the rest of the week.*
4. Target Growth: MULTIPLE REPRESENTATIONS

There are often many ways to represent, or model, a situation mathematically. While, in algebra, we often use expressions and equations to model and solve problems, graphs and other visual representations are often just as important. There can be more than one way to visually represent a situation as well.

Multiple representations in mathematics allow us to view a problem from different perspectives. These representations often result from differences in the backgrounds and interests of those modeling a situation. The diverse experiences, abilities, and creativity that students bring to problem-solving contribute to their growth, and to others’ growth, in mathematical thinking.

INTERVENTION: Encourage students to represent a problem visually, create their own context for the problem, or try their own approach to solve a problem.

Do you see another way to approach the problem?
Can you draw a picture to show what is going on in the problem?
Can you write a “story” for the problem?
That’s great. I hadn’t looked at it that way before.

5. Target Growth: EXPLORATION

When in the middle of a mathematics course, it’s easy to look at mathematics as a series of definitions to learn and skills to master. In reality, mathematics is a science of exploration and discovery. In a mathematics course, students are studying the discoveries of earlier mathematicians, but in the process they can also explore questions, connections, and relationships that you encounter. When learning a new topic, it is always helpful to ask “what if” and “why” and look for patterns and other relationships. When students see patterns and make connections themselves, they are growing mathematically.

INTERVENTION: Encourage students to describe relationships and patterns.

What relationships (or patterns) do you see between [similar problems, various algorithms or theorems, or information in the problem]?