Constructing a Growth Mindset Environment: Using Psychological Interventions to Support IBL Pedagogies

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Beliefs and Psychology

A "User's Guide" to Growth Mindset Interventions

1. Reading and Autobiography Assignment
2. Course Policy on Supportive Language
3. Assign an Open Problem
4. Reflective Essay About Homework
5. End-of-Course Reflective Essay

What (most) students believe

In my experience, (most) students in K-12 and postsecondary mathematics courses believe that:

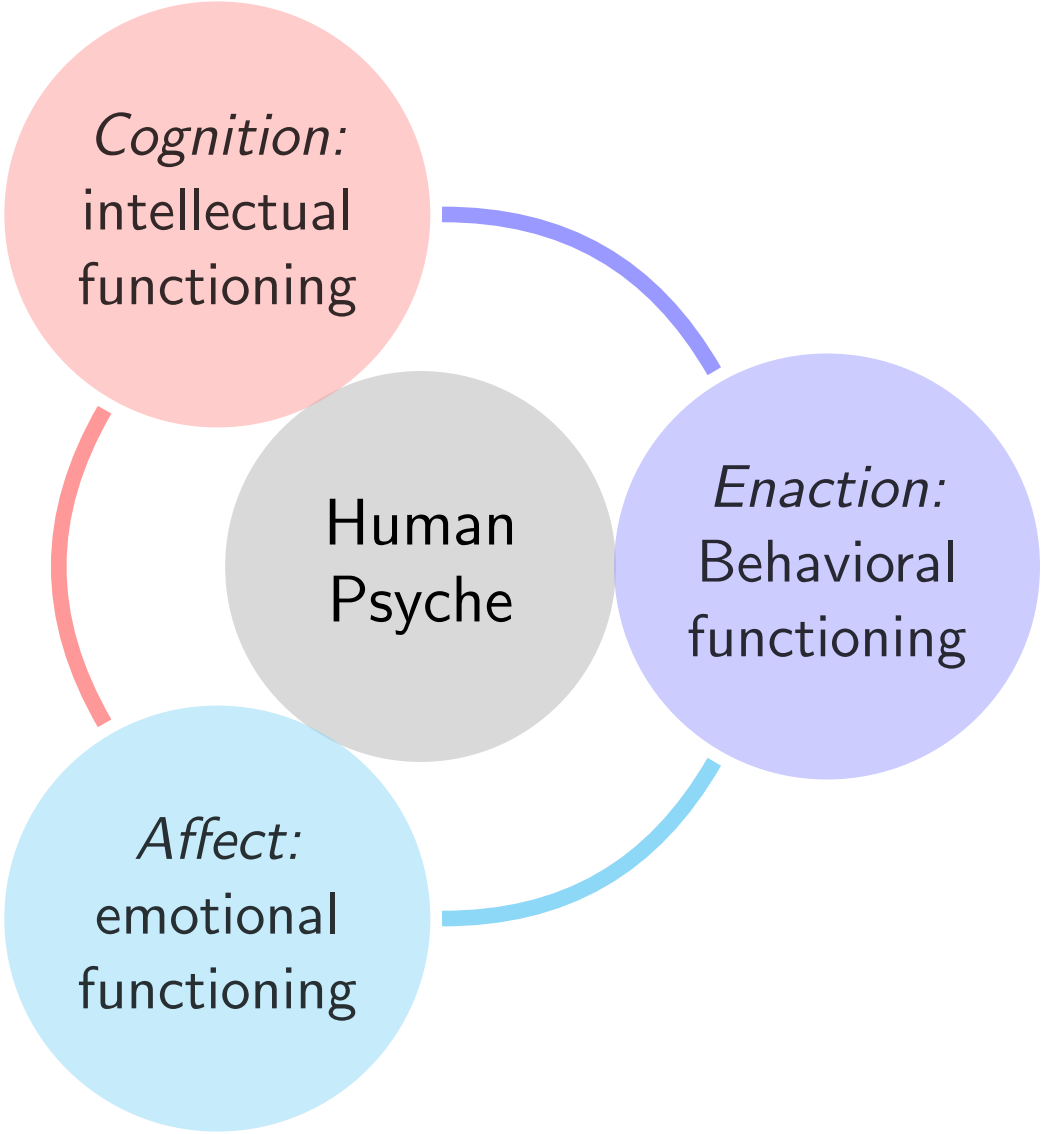
- All math problems have known answers,
- Failure and misunderstanding are absent from successful mathematics,
- Their instructor can always find answers to problems, and
- Regardless of what instructors say, students will be judged/assessed based on whether or not they can obtain correct answers to problems they are given.

As long as students believe this story, it is hard to motivate them to develop quality mathematical practices.

One of the strengths of IBL methods is that they challenge, through public dialogue and activities, students' misunderstandings and unhelpful beliefs about the nature of mathematics.

What IBL methods *might* not *explicitly* do is frame these activities as part of a broader picture involving the nature of intelligence and the process of successful learning.

Modern psychology frames the human psyche as a three-stranded model.



Carol Dweck's theory of mindsets

Carol Dweck is a psychologist at Stanford who studies how beliefs influence motivation. Her book *Mindset* was published in 2007 and has had a substantial impact in education and beyond.

- The belief that each individual has an innate, fixed ability in a given area is referred to as a *fixed mindset*.
- The belief that individuals are capable of continually developing their abilities through persistence and effort is referred to as a *growth mindset*.

Undergraduate calculus study

Good, Rattan, and Dweck, 2012
Journal of Personality and Social Psychology

- Study of the effect of mindset on female math students' sense of belonging in mathematics.
- Female students who perceive growth mindsets in their environment have a stronger sense of belonging in math than students who perceive an environment dominated by fixed mindsets.
- Female students who themselves hold growth mindsets are more likely to perceive the same in their learning environments.

Undergrad pre-med chemistry study

Grant and Dweck, 2003
Journal of Personality and Social Psychology

- For students with fixed mindsets, typical skewed male-female difference in performance in first-semester chemistry (males outperform females).
- For the students with growth mindsets, the gender difference in performance was decreased, and females earned the higher final grades.
- Researchers equated for entering ability by controlling for student SAT scores.

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1. Reading and autobiography assignment

During the first week of class, assign an article by Dweck and a 1-page autobiographical essay.

I have used Dweck's articles "The Secret to Raising Smart Kids" and "Is Math a Gift? Beliefs that put females at risk" for this with success.

I assign a grade to the essay based on completion only, completely ignoring the quality of the writing, editing, or ideas. The goal is to get students to reflect and be honest, not necessarily to train them to write well. If students respond to the prompt in a relevant manner, they get full credit.

2. Course policy on supportive language

After students read the Dweck articles, introduce the following course policy:

Students are not allowed to make disparaging comments, at any time or for any reason, about themselves, their mathematical ability, their peers, or the abilities of their peers. Here are example statements that are prohibited, along with acceptable replacement phrases.

- I can't do this $\rightarrow$ I am still learning how to do this
- That was stupid $\rightarrow$ That was a productive mistake
- This is impossible $\rightarrow$ There is something interesting and subtle in this problem
- I'm an idiot $\rightarrow$ This is going to take careful thought
- I'll never understand this $\rightarrow$ This might take me a long time and a lot of work to figure out
- This is terrible $\rightarrow$ I think I've done something incorrectly, let me check it again

3. Assign an unsolved problem as homework

Unsolved problems I've used:

- Collatz Conjecture
- Erdős-Strauss Conjecture
- Lagarias's reformulation of the Riemann Hypothesis

For more on this idea, see my blog post at the AMS blog *On Teaching and Learning Mathematiscs*:

http://blogs.ams.org/matheducation/2015/05/01/famous-unsolved-math-problems-as-homework/

Prompt for unsolved problem

This is a famous unsolved problem in mathematics. Work on it for a while — the goal isn't for you to solve this, but rather to get a feel for the problem. Create an essay by recording your thoughts and attempts as you work. Focus on responding to the following questions: What did you try to do? Why did you try this? What did you discover as a result? Why is this problem challenging? (Seriously, write down everything you're thinking and every idea you try, even if it doesn't go anywhere.)

It's good to grade this probem generously content-wise —the goal is for students to be rewarded for demonstrating persistence and good mathematical processes.

4. Reflective essay about homework

A few weeks after giving the unsolved problem on an assignment, have students type 1-3 pages about what they found most and least challenging in the homework so far, and what their most and least favorite homework problems have been. You can ask them to directly link to Dweck if you want, or leave it more open-ended to see what connections they make on their own.

Grade based on completion.

In my classes, the vast majority of students write about working on the unsolved problem.

5. End-of-course reflective essay

Assign as the final homework assignment this short essay prompt. Grade is again based only on completion.

- What were *six* of the most important discoveries or realizations you made in this class? In other words, what are you taking away from this class that you think might stick with you over time and/or influence you in the future? What have you experienced that might have a long-term effect on you intellectually or personally?
- These can include things you had not realized about mathematics or society, specific homework problems or theorems from the readings, etc. These can be things that made sense to you, or topics where you were confused, points that you agreed/disagreed with in the readings or class discussions, issues that arose while working on your course project, etc.
- Explain why these six discoveries or realizations are important to you.

Thank you for listening!

Questions?

Please contact me with questions or ideas:
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A quote from a student

I did have a favorite assignment, and that was the unsolved problem. This confuses me a bit because the problem was the essence of theoretical which, as I said before, can give me some trouble. But maybe since there was not really a correct answer I felt like I could attack it from whatever angle I wanted to without consequence. Now that I think about it, this should probably be how I approach all the theoretical problems. Instead of trying to find the correct answer right off the bat, I should write down what I know to be true about the problem and get a better understanding of it first. Anyway, I just really enjoyed how this problem challenged me to come up with my own way of approaching the problem and how I did not feel any pressure to find the correct answer.