

# TEACHING STATEMENT

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When I taught my first class in the Fall of 2014, I thought all I had to do in order to be an effective teacher was to explain the material clearly, and maybe repeat the key points a few times. I quickly learned there was much more to it than that.

Here's one of my many learning moments. I had a student, call her Emma, who was near the top of my trigonometry class. Clearly, my explanation of the material wasn't an issue for her. One day, I gave the class an unfamiliar problem (to derive the formula for the projection of one vector onto another) and asked them to discuss it with their neighbors. When I walked up to Emma a little later, I was surprised by her anguished expression.

"What are your thoughts on this problem, Emma?" I asked.

"I literally have no thoughts," she confessed.

Having taught seven courses and hundreds of students at a variety of levels, I can safely say that most students are a lot like Emma—even when they understand the material, they're afraid of exploring further on their own. This sort of anxiety can prevent students from challenging themselves and causes an aversion to unfamiliar mathematics—both of which make learning difficult. Further, I believe that one of my primary roles as an educator is to raise students who can make informed choices about the complex mathematics in their lives. This is not possible for someone who refuses to engage with unfamiliar mathematics. Thus, addressing this anxiety is my priority. Once the anxiety is under control, I can focus more on communicating the mathematics. Along the way, I emphasize the humanity of mathematics, in order to both address anxiety and help students stay motivated.

In order to address this anxiety, we need to know where it's coming from. I believe the answer lies in mindsets. From surveys I take of students at the beginning of each semester, I've learned that students typically come into the classroom thinking that mathematical ability is innate—i.e. that there are "math people" and "non-math people." As Professor Carol Dweck shows in her research on mindsets, this can lead students to associate mathematics with intense anxiety. They worry that any failures they make in the math classroom reflect poorly on their characters, or perhaps they have a fatalistic view that they weren't born as "math people" and thus don't bother trying. I've also noticed students tend to believe that mathematics is just a set of algorithms to be followed, at least at the lower level. Together, these two ideas can lead a student to fear any sort of mathematical exploration. The whole point of exploration is you don't always know what your next step should be. If a student thinks of mathematics as an inherently algorithmic process, she will assume that something is going wrong when she can't immediately see the next step in solving a problem. If she thinks something is going wrong, then she feels like she isn't a "math person," and mathematical success feels hopelessly out of reach. Even in more advanced students, having a fixed mindset is harmful as it makes them afraid of asking for help. Many graduate students can relate.

I begin to address my students' anxiety by asking them to write a short essay on their feelings about math on the first day of class. Later, I use their responses as a launching point to discuss mindsets and I share some of the struggles I've had in my own mathematics career. I say to them, explicitly, that I don't see their performance in my class as a reflection of their intelligence, or of any innate worth they have as people. Rather, their grade in my class reflects their understanding of the material, and nothing more. I occasionally ask my students to reflect on readings about the psychology of studying mathematics.

In line with this “growth mindset” philosophy, I give my students self-evaluations to fill out after each exam. I emphasize that the purpose of these reflections is to learn from our past mistakes and evaluate our study habits. This emphasis on learning from our mistakes has proven to be helpful for many of my students. One student e-mailed me after my most recent Calculus II course to say the following: “I just wanted to say thank you for the class and how you approached it. [...] After the first test regrade and the evaluation of my study habits, I was able to find the energy to work twice as hard and made it a goal to do better. I feel like I did so, and I am proud with the work that I produced after the first test. Today, I changed my emphasis [from geology] to geophysics and will be taking Calc 3 this Fall. I wouldn't have had the confidence to do it without this class and your help.”

Another way I make mathematics interesting and approachable is by emphasizing the humanity of mathematics. Every theorem was discovered by someone trying to answer a question they found compelling. Thus, a piece of mathematics can only feel esoteric and inscrutable to us if we don't know the story behind it. For this reason, I always introduce new topics in class with a natural question that we want to answer, and I include historical notes when possible. For instance, students enjoy learning that the theory of rings was born from an attempt to prove Fermat's last theorem. This is also a good opportunity to highlight important women and people of color in the history of mathematics.

Moreover, I treat my students as humans. I make sure to learn all their names and I take them for their word—if they say they missed a homework assignment because their car broke down, I believe them and allow them to turn it in late. I've also learned to hold office hours in a “neutral” space, because students can feel intimidated about showing up to my office. Thus I have “Two Creek Tuesdays,” during which students can find me at the Two Creek cafe on campus. These office hours have been well-attended, and they have become another place where students can collaborate on homework.

Compared to managing student anxiety, I find that teaching the actual mathematics and problem solving skills is much more straight-forward. One way I get students to explore mathematics and challenge themselves is through group quizzes. I give them half the time required to finish the quiz on their own, and I allow them to use whatever resources they want to complete the quiz. This is helpful both because explaining mathematics is an effective way to learn it, but also because it contributes to a welcoming classroom environment.

I also have my students write detailed solutions for some of their homework problems. I instruct them to write as if they're explaining how to solve a problem for someone who's a week behind in the class and provide examples of good and bad mathematical writing. This gives me a vehicle for assigning challenging and open-ended problems. It also allows me to emphasize that mathematics is fundamentally about understanding and explaining ideas and not just manipulating symbols.

My hope is that teaching students to fearlessly engage with mathematics will benefit society as a whole. As Cathy O'Neil writes in *Weapons of Math Destruction*, our society blindly trusts algorithms to make decisions for us every day, and this often ends in disaster. This comes from a wide-spread belief that an understanding of mathematics is only meant for a privileged few. By teaching people to see mathematics as accessible and not mysterious, and by showing them that studying math can be empowering, we can get them to a place where they're confident enough to try to understand and think critically about the mathematics that affects their lives. In this way, we as mathematicians can make the world a little more just.