Teaching Statement

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I am continually learning how to enable my students to freely and enthusiastically engage with deep mathematics. Each course has different goals and each group of students creates a unique classroom environment. This combination demands that I am flexible in the ways that I challenge students to engage with math.

Injecting energy into my classes helps motivate students to engage more deeply, inviting students to look and see the beauty and power of mathematics for themselves. This is a unique gift I can give my students. I especially enjoy the instances when self-proclaimed "math-haters" begin to appreciate the math, or when a student decides to add a math minor.

> "Love that you didn't forget about those of us who don't grasp as quick and didn't make us feel stupid about it. I loathe math but you made me appreciate it." –Student, Calculus for Biological Scientists

I care about my students as learners, but also as people. Showing grace[1] to my students gives them the freedom to genuinely engage with challenging math without the need to prove themselves. When their identity isn't tangled up in their performance, they are able to more freely engage with deep mathematics with the possibility that they will not understand easily or immediately. This is where true learning can happen. I know students sense this freedom when they are willing to volunteer possibly incorrect or incomplete thoughts in class that other students can then help refine. Learning every student's name early and using them often, celebrating thoughtful questions or attempts at solutions, and gently addressing misconceptions when a student speaks up in class communicates value to my students. Normalizing struggle and emphasizing that misconceptions are opportunities to learn helps students develop resilience.

After my first semester teaching in 2011, I received student feedback saying that although I was knowledgeable and enthusiastic, I needed to work on explaining things to students who were struggling. I took this feedback seriously and adjusted how I thought about building the intellectual flow of a class, for example in choosing illuminating examples that build on themselves. As I developed as a teacher, I worked to engage students more actively in class. I learned to incorporate small activities and I would break up lectures to have students discuss a question with a neighbor or work through an example. I integrated some more open-ended activities, for example, using manipulatables to start a discussion about symmetry and to introduce group tables in my Applied Math for Chemists course.

> "[She] seems very passionate about mathematics. She also seems to truly care that her students do well, which is refreshing." –Student, Calculus for Biological Scientists

While I had seen positive effects incorporating some strategies that better engaged students, I was bothered that I was still leaving weaker students behind and the mathematical conversations in my classroom were dominated by a few eager voices. I have become convinced that structuring my classroom so that I am engaging with students as *they* engage with mathematics is an effective way to address this concern. The evidence is compelling and highly motivating that teaching techniques that seek to actively engage students are an effective step in working to close achievement gaps for underrepresented and underprepared students. "[T]he impact of [approaches that engage students in mathematical problems] on previously low-achieving students' grades is sizable and persistent." [1] There is also compelling evidence that such techniques improve students' conceptual understanding of the material [3].

I attended a workshop in the summer of 2018 which empowered me to implement more aspects of an active learning paradigm. This has been stretching me personally because I had spent

[1] I'm thankful for Francis Su, who has eloquently spoken to the math community about grace in teaching. [5]

considerable effort honing my lecture skills, and was comfortable with lecturing. Nonetheless, I decided to make a more concerted move away from lectures that fall in my linear algebra class. Specifically, students prepare beforehand by reading short sections in the text and working on some basic practice problems. Lectures were very brief and pointed. Most of class time is spent engaging with peers on more challenging or conceptual problems, with some guided discussion. I have continued teaching in this way in my special topics course, and now in Calculus II. The level, material, and students in each class have been drastically different, which demands I adjust my techniques for each class.

I have been encouraged by what I am seeing in these classes. Even an initially skeptical student told me that that the way this course is taught helps him understand the material more clearly. If I am facilitating a large group discussion, students raise their hands so that I can make sure that more voices are heard and I have a much larger portion of my class that participates on a daily basis. Students are learning how to ask each other mathematical questions and refine ideas. They are engaged with how the material builds on itself. At the end of one class, a student approached me with a conjecture, which was on a topic we would be covering later in the week. With his permission we began the next class with a discussion of his conjecture, which needed a little refinement. I think this was a meaningful mathematical experience for the entire class; another student commented in a midsemester reflection, "It really made me think a lot more carefully about the meaning of each word in the statement."

I am encouraged by the effects of these changes. In future courses I teach, I plan to continue to adjust and implement these methods. This will necessarily look different for each course. With input from colleagues who visit my classroom, discussions with others who are trying new teaching techniques, and insight from education researchers, I am well supported to continue to try new techniques in my classroom for the sake of improving student learning.

Course Development. In addition to my commitment to improve as a teacher, I have had the opportunity to work on developing the curriculum for several courses. One such course was a two-semester applied math course sequence for chemists, which has been formally adopted at CSU. This has been developed jointly with the Chemistry department to replace the second and third courses in the calculus sequence by courses that focus on the math that chemists need for Physical Chemistry. The course includes topics in traditional Calculus II and III with an emphasis on differential equations, but also includes topics such as linear algebra, group theory, and linear operators.

Part of the development involved developing course materials so that others in the math department could easily teach it. I left a complete set of developed lesson plans, in-class activities, Matlab extensions, and assignments for the next instructor (with helpful notes on the chemistry). We have written about this course in the *Journal of Chemical Education* [4].

At the University of Arizona, I have designed and taught a senior level undergraduate special topics course: Introduction to Algebraic Topology with Applications. This course was an accessible introduction to the field to students who have a background in linear algebra. There is no standard undergraduate textbook in this filed, so more development was required for course materials. I continued using pointed lectures, assigned readings, and both large and small group discussion on problems. By the end of the course, several students were able to implement these methods on problems in their research labs.

I have enjoyed building these courses and would be excited to work on other courses in the future. I recently found a textbook for a mathematical modeling course aimed at first-year students which, for example, would be a fun course to implement. I also think that there is a lot of potential for introductory data science classes.

Mentoring. Mentoring students on mathematical projects and in professional capacities is important for the overall health of the mathematical community. I participate in mentoring in

several capacities. I mentor small groups of undergraduates on their capstone mathematical modeling projects. It's a joy to work with students as they learn how to work through scientific papers, take open ended problems and form questions, and take steps to extend results.

I am also working to facilitate peer mentoring on a larger scale. While the causes for the STEM gender gap are multifaceted, complex, and still under investigation, there is literature to suggest that a lack of a sense of belonging and self-efficacy contribute to the attrition of women in STEM [2]. Together with a colleague, I have developed and launched a Women in STEM Mentorship Project which groups first year women in STEM fields with upper class women.

They meet biweekly for a year and work through a mentoring curriculum that we developed, designed to build a sense of social and professional belonging, resilience, and self-efficacy in the face of challenges. We also hold a monthly seminar where senior women scientists share their experiences. There are currently 20 mentors and 70 mentees in the program. The program is in its first year, so we don't have data on retention of women yet, but the initial response from mentors and mentees has been very positive. While the program is aimed at Women in STEM, a good portion of the mentoring curriculum could easily be adapted for a wider audience.

Conclusion. As I continue to grow as a teacher, the most important thing remains that students are engaging deeply with the mathematics. I am sure that as research in math education continues I look forward to continuing to invest in students and enthusiastically working with them to help then catch a glimpse of the beauty of mathematics.

"I'm going to school to be a math teacher & I am absolutely sure that I will carry with me the patience, humility, passion, encouragement & style I have learned from you in the way you teach." –Stacey Clear, Calculus I and III

References

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