Teaching Statement

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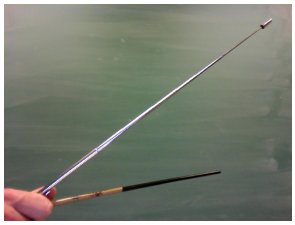
When I teach, I want my students to become confident in their ability to do mathematics. How do I pursue this goal?

First, I make myself accessible. This means that I learn the names of my students, I arrive to class early to answer questions as they trickle in, and I end each class by saying "That's it for today, but please stick around if you have more questions." My students are more confident knowing I'm invested in their learning.

Second, we discuss the pictures behind a concept. Students sometimes feel that even though they can solve the homework, they don't fully understand what is going on. I think that spending time on pictures helps here. For example, consider the equation $\mathbf{v} \cdot \mathbf{w} = \|\mathbf{v}\|\|\mathbf{w}\| \cos\theta$, where θ is the angle between vectors $\mathbf{v}$ and $\mathbf{w}$. To discuss this equation, I come to class equipped with an extendable pointer and a chopstick (pictured). The pointer is vector $\mathbf{v}$, the chopstick is vector $\mathbf{w}$, and my fist is the origin. We discuss how the dot product changes as I vary the angle between the vectors, or as I vary the length of vector $\mathbf{v}$ by extending the pointer. My students are more confident in a topic after we discuss the pictures behind it.



Third, I make our class a conversation. Talking about math can be intimidating for students at first, so joining a mathematical discussion improves their confidence (while passively listening to me talk does not). How do I invite conversation in class? Knowing my students' interests is a necessary first step. I give the students frequent opportunities to speak by asking recall questions, such as: "Subset $V \subseteq \mathbb{R}^n$ is a linear subspace if ... do you remember any of the three conditions?" I also use paradoxical questions, such as: "If $S = \{\mathbf{v_1}, \mathbf{v_2}, \mathbf{v_3}\}$ is a linearly dependent set, then can every vector in S be written as a linear combination of the other two?" Paradoxical questions lead to longer discussions — which I often nurture instead of marching on with the planned topic — as the students try to reconcile their intuition with an answer they weren't expecting.

Fourth, I prepare my board work and solution sets carefully. I want my board to read like a terse set of notes, but I don't want to spend all of class writing furiously. Therefore, I plan succinct yet clear language for my board work ahead of time. This carries over to the solution sets that I write for homeworks and exams: mathematics is a language that students learn how to speak, and by my example I help them learn to speak efficiently.

When I began as an Assistant Professor at Colorado State University in 2015, my main strength as a teacher was *compassionate organization*, by which I mean the following. I make detailed publicly available notes for each class I teach (see [1] for these notes), about 100 pages per class. In LaTeX I write solution sets for every homework, every practice exam, and every

[1] Combinatorics: `https://www.math.colostate.edu/~adams/teaching/Notes_Math301.pdf`
Linear Programming: `https://www.math.colostate.edu/~adams/teaching/Notes_Math510.pdf`
Algebra: `https://www.math.colostate.edu/~adams/teaching/Notes_Math366.pdf`
Topology I: `https://www.math.colostate.edu/~adams/teaching/Notes_Math570.pdf`
Topology II: `https://www.math.colostate.edu/~adams/teaching/Notes_Math571.pdf`

exam that I assign, including graduate classes; these solutions sets clarify my expectations for student work. Having well-written resources allows me to make my class periods more conversational — I feel comfortable devoting class time to discussing an interesting problem posed by a student, while my written resources allow the main themes of the class to remain clear. I refer to this as *compassionate organization* because my preparation sends my students the message that I am invested in their education. This message is heard: around 25 students ask me to write letters of recommendation for them each year. My students are more invested in their learning after observing how diligently I prepare for them.

My teaching has evolved and improved since 2015 in three main respects:

- **Project-based instruction.** I have twice taught the undergraduate capstone class Math 435, Projects in Applied Mathematics. In this class I include few lectures and no homeworks or exams, and instead students are evaluated based upon their performance in group projects, presentations, poster displays, and writing assignments. After growing comfortable with students learning from each other in project-based work, I have added projects and poster sessions as a component of several of my other more traditional classes. Students who have struggled through the homework assignments and exams often impress me by demonstrating their understanding through project work or presentations.

- **Incorporating research into teaching.** I have designed and taught two classes in my research area: *DSCI 475: Topological Data Analysis* for undergraduates and *Math 580a2: Introduction to Applied Topology* for graduate students. Even when teaching an unrelated class, I now set aside a class period in order to describe my research. I find this period to be one of the most interactive and inspiring class periods of the semester for my students; it has helped initiate several of the undergraduate research projects that I have led.

- **Lessons learned from online teaching.** When the pandemic moved Spring 2020 instruction online, I partially "flipped" my classroom for the first time, with short online videos replacing traditional in-person lectures. More class time was then available for problem-solving sessions with students. Students gained confidence from sharing their approaches with each other. In some ways I felt I had more time to interact with students, and to address their questions about the motivation behind the class themes. In Fall 2020 my students and I took a different approach, and instead we created 53 publicly-available videos on linear optimization that we recorded together ([2]). Now with the return of in-person instruction, I still flip a small subset of my class periods to create more blocks of class time set aside for *learning by doing*. To enable us to more easily flip a subset of undergraduate combinatorics classes, my colleagues Rachel Pries and Maria Gillespie and graduate students Kelly Emmrich and Shanon Golden and I transformed my undergraduate combinatorics notes ([1]) into a publicly available online textbook "*Counting Rocks! An Introduction to Combinatorics*" ([3]) that is accompanied by in-class worksheets and short videos.

In 2021 I was honored to receive the Faculty Excellence in Undergraduate Teaching and Mentoring Award from the College of Natural Sciences at CSU, in recognition of these efforts. I've thoroughly enjoyed my role as a teacher thus far, and I look forward to future opportunities to develop my teaching style while learning from my students and my colleagues.

[2] `https://www.math.colostate.edu/~adams/teaching/math510fall2020/`

[3] `https://arxiv.org/abs/2108.04902`