

I entered Mathematics and Theoretical Computer Science because playing with and discovering “truths” is one of the most fun social activities I’ve found. And one of the only things more fun for me than sharing a social activity that I love with someone, is introducing them to it.

Leading people to the ‘Aha!’ moments I’ve gotten to experience, especially communally, is the reason I’ve taken on so many extracurricular teaching activities and why I have created a STEM-based conference for the Queer, Trans, and People of Color community in the San Francisco Bay Area, a group largely excluded from enjoying these truths. As for *how* I teach, if I had to boil my teaching philosophy down to one question it would be this:

Where is the thinking happening in the room?

If most of the thinking is happening at the front of the room, at the board, then I’ve done something wrong. The bulk of the thinking should not be happening in my or any one student’s head, and most of my teaching focus is directed to *spreading the thinking around the room*.

Techniques. I spent my graduate program’s first two Summers returning to my diverse teaching-focused undergraduate university, California State University Sacramento, to co-teach an NSF LSAMP program crafted to re-introduce math as a creative and social activity to incoming underrepresented STEM students. The underrepresented populations in this program outscored the campus’ majority populations in Calculus for the last 20 years. I learned and practiced many techniques to spread thinking around a room here.

For example, to begin distributing thinking through a room I need to first know what type of thinking is happening. A simple way to do this, when digesting a string of reasoning, is to tell the class to talk to a neighbor about their response to a question I posed. This serves two purposes. First, it allows students to verify their thinking so that they’re more confident to raise their hand later as well as allowing students to bounce thoughts off each other, leading them to understanding neither would have gotten alone. But, second and most importantly, it serves as an information gather for *me*. By walking around the class and listening and engaging with groups, I get a much better picture of what is being understood and what is not, where insecurities with the material are, which directions people are thinking in and their partial progress, etc.

Returning to the board, I will have a *much* better sense of how thinking is flowing in the room and where I can guide it. This is where I process the students thoughts and proofs onto the board. If there was a step where I observed that people universally reached the right answer, I could give some communal validation by reaching that step on the board and asking for the answer to be called out in unison. If there were gaps in understanding, I already know which steps to not take for granted, allowing me to, if I saw students discussing reasoning that would lead the class’s thoughts in the right direction, craft pointed questions that would prompt those students to share those discussions.

This sort of processing of the class’s thinking can be very interactive and can greatly help with the common difficulty of having a few students who will gladly and *fully* answer all questions intended for the class. By asking questions such as “Who would like to share what they first did to make headway?” I open the floor to low-stakes partial reasoning. If the only student to raise their hand is one that often answers, say Maria, and they begin to give the whole answer, I would have to pause them, repeat the first step they said, make it visible on the board, and then ask “And who thinks they know what Maria would have done next?” This validates Maria as having known more than I let them share while allowing the class to have a chance to think at each step of reasoning, spreading thinking around. It further allows students who didn’t know where to start or had only a piece of the reasoning a chance to catch up and still contribute.

At its best, though, a walk-around can give me a sense of students as individuals: what types of concepts are particularly exciting to one person, which person has correct answers but is not confident in them, which people are particularly good at helping their peers along, etc. In one of my Summers with the LSAMP program, there was a student with the correct answer but was shielding her work from view and was not confident in it while another student in her group was much more vocal in convincing the group of his approach. After processing one method at the board, we asked if anyone got the answer using a different route. She raised her hand and we were able to process her approach on the board. Another Summer a similar thing happened with another woman and, while she didn’t raise her hand to give her approach, when someone else gave it, she excitedly exclaimed “Oh, I had that! I was right!” These are great moments.

These moments compound, so that students who may often be thought to just “not get it” can be less stymied by insecurities, which often correlates with marginalized identities. Stereotype Threat, the fear of upholding a stereotype by performing poorly and being a “representative” of a marginalized group, and its studied effect of actually worsening performance is very real and something I’ve experienced. Swaths of

lecture may pass by while a student is internally preoccupied with wrestling with how their performance and academic preparation reflect their identity. Paying attention to individual students and their progress and spreading the flow of thinking to where it's needed most can make all the difference.

This is not an exhaustive set of techniques but it is how I think while I teach. Still, as I'll describe in my philosophy, the most important technique lies in recognizing that this whole experience is meant to be *fun*.

Teaching Philosophy. If I want students to feel those same “Aha!” moments I've had, they need to *have* those “Aha”s. They cannot be told how to have one, they must experience it by engaging in the social activity of math. Thus, my teaching philosophy goes the opposite direction of a math textbook: Whereas a textbook often gives a theorem, proof, and *then* examples, I instead give examples to work through until the students see a pattern, then I process a conjecture out of them onto the board, and *then* we collectively prove it so that it *becomes* a theorem. Doing math is the only way to feel what math feels like.

In this way I don't often introduce new concepts but try to find ways to draw the desired concept out of students by giving them leading examples. Thus most of my lesson preparation is focused on crafting a warm-up problem that gets the students thinking in the right “direction” along with a set of examples that will exemplify a pattern I want conjectured.

I think the most crucial part of my philosophy, though, is in recognizing all fields as social activities. This not only recognizes how people's identities play into this social endeavor but makes clear why people are in these fields: they enjoy them. I believe that finding ways to cultivate that enjoyment not only engages people the best but allows people to learn best.

For example, making carefully-chosen intentional mistakes can highlight boundary cases where the reasoning of *why* it was a mistake can solidify a deeper understanding of a concept. This is best used as a reward for when I've found that the entire class has gained a strong understanding of a concept, especially one that took a while to get them to develop. Thus, by playing the fool, the joke becomes their complicity in this game of pointing out my coy mistake and *getting* the joke corresponds to them communally acknowledging their nuanced understanding of the concept. A small amount of theater can go a long way.

While I enjoy explaining things in ‘intuitive’ ways that connect with as many people as possible, that can only happen as a *capstone* after the students have explored problems and cleared a spot in the organization of their brains, which only they can know, for it to sit in as a solidifying reward. My teaching, then, centers on cultivating an environment and experiences for students to personalize that context for a capstone to sit.

Experience. Teaching for two Summers in the NSF LSAMP program was one of the most fun experiences I've had and most of my philosophy and techniques come from my time there. I have since found many opportunities to teach during my graduate program so as to recapture pieces of this special time.

I have TAed twice at UC Berkeley in Complexity and graduate Cryptography but, while I enjoyed employing all of the above techniques and taught two full lessons in Cryptography, my teaching philosophy works best when giving *first* instruction to capture “Aha!” moments, as opposed to holding discussion *review*. I will TA Engineering Ethics & Society this Spring specifically because I will be co-teaching the course in a discussion-based way, will co-create the reading list, and will teach my own modules on ethics in Computer Science. To further enjoy the style of teaching I love, I have sought out many other avenues.

For the first two Summers of my graduate program I often drove between Sacramento and Berkeley to teach in the LSAMP program. I also spent one of these Summers as part of the Berkeley SMASH Academy, creating and teaching a five-week program to local underrepresented high school students on problem-solving and exploring pure math through Symmetry Groups. I also spent a week of that Summer driving to UC Davis to assist the COSMOS program in teaching high school students about Abstract Algebra.

After those Summers I created and taught lessons on Complexity Theory to local high school students through the Berkeley Math Circle program, I mentored a Berkeley undergraduate in Complexity Theory and derandomization for a semester in Berkeley's Directed Reading Program, and I talked with K-12 classrooms teaching them some math and exposing them to academic paths both through the Skype A Scientist program where, for the past three years, I had video calls with disadvantaged classrooms across the country, and through Oakland's Dinner With A Scientist program. Lastly, I have created, secured funding for, and co-organized a monthly conference for the Queer, Trans, and People of Color community of the San Francisco Bay Area that will debut this January and will focus on introducing this community to general STEM topics and encourage academic paths. I plan to take a version of this conference to all locations that I live.