

TEACHING PHILOSOPHY

Teaching mathematics is an opportunity to show students a beautiful subject, and to empower them to use it effectively. To this end, I have two main goals as an educator. I teach students to *think critically*, and to wield the power of mathematical formalism to ask and answer their own questions. I also develop their self-confidence and willingness to *take intellectual risks*. These skills help build their mathematical maturity, and are extremely important beyond my classroom.

To accomplish this I focus on specific and practical principles in my teaching, which I have listed below. I have just begun my teaching career, and expect that I will adjust my teaching style as I gain more experience. In particular, I have yet to teach upper-year courses or courses for non-math majors, but I look forward to tailoring my teaching to best suit different kinds of students, and to the opportunity for growth that this will provide.

I recently taught MATH 235 (online) at the University of Waterloo, a second course in linear algebra for honours math majors, and I have been a substitute lecturer for a variety of courses. I have also engaged in significant high school outreach with the Center for Education in Mathematics and Computing. I include teaching evaluations and feedback at the end of this statement.

Engage students and foster an encouraging course atmosphere. To develop confidence and critical thinking skills, it is first and foremost necessary that the atmosphere in my classroom is actually conducive to learning and thinking; I do this in two ways.

First, I break down the instructor-student barrier, so that students feel comfortable asking questions. At minimum, this means knowing my students' names and backgrounds; at the beginning of the term I ask each student to submit a reflective response about themselves and what they hope to get out of the course. I follow this up with regular reflective responses throughout the term, asking them to reflect on their perceptions of the course and mathematics. I respond seriously to each student, creating a dialogue that lasts throughout the term. This continued dialogue ensures that students are aware that I care deeply about their success. It also helps students overcome anxiety about performance, and focus on what matters: *learning*. Here is part of a typical response from one of my MATH 235 students, when asked if their thoughts and feelings on math have changed since the start of the term.

"I've off-and-on in the term had some anxiety surrounding whether mathematics is right for me. It wasn't until just before the final exam while explaining some concepts to a friend that I realized how much I'd gotten to learn through this course and remembered the genuine interest I had. After the final, I had the opportunity to reflect on all the moments a concept clicked for me, and I'm so incredibly grateful for all the effort that's gone into the course to make that happen for each of us."

Additionally, I engage students in my classroom by designing exciting lectures with a large participatory component, to ensure that students can gain meaningful experience with mathematics in each lecture. To this end, I usually organize a 50 minute lecture in the following way: a 5 minute review, 10 minutes of lecturing, 15 minutes working on problems, 10 minutes of lecturing, followed by another 10 minutes of problem-solving and a short wrap-up discussion. In this way, I get to discuss mathematics with individual students, and share what I find exciting or interesting about each topic. After a substitute lecture for a 3rd year honours course in abstract algebra, a student once told me: *"I can't believe how excited you were about this stuff- I had to pay attention today."*

Encourage intellectual risk-taking and willingness to make mistakes. Perhaps the single most common phrase I have heard from a student is: *"I don't know where to start."* I constantly emphasize the importance of making mistakes and being willing to try an idea without knowing whether or not it will work. Learning mathematics is difficult, so one of my main goals as an educator is to give students the confidence to be able to take *intellectual risks*: sharing the new

idea they just had with the class, or struggling on a problem without giving up early. To accomplish this, I use simple but effective group activities.

Think-pair-share activities ensure that the students spend time working on a problem with their peers in a low-stress environment. First, students think about the problem for a short time themselves, and then discuss their thoughts with someone next to them. During this time, I wander around the classroom, offering suggestions and new ideas in a positive and motivating way. I am very conscious of my choice of language, in order to encourage students to share their ideas. It is almost always possible to give positive feedback: even if an idea doesn't work, I might say "*That was a great idea— it didn't work here because ... but it might in the future!*" I also structure the problem in advance so that I can ask follow-up questions to groups that finish quickly, keeping them engaged. Afterwards, I solicit thoughts from the entire class about what did or *did not* work, emphasizing learning from mistakes rather than viewing them negatively. While students can be initially resistant, they quickly become used to this activity. I have witnessed a huge overall improvement in willingness to participate and ask questions after just a few lectures.

Another particularly effective activity is **active retrieval**: for instance, I might spontaneously ask my students to try to write down a precise definition of a normal subgroup without consulting their notes, but allow them to talk to each other. This is an easy way to build their confidence, and it nearly always re-energizes the classroom. In my experience with outreach I have found that these techniques are universal; they are equally applicable in a high school classroom as they are an upper-year course in abstract algebra.

Communicate effectively with students. Expectations about course work must be clearly made to students. Pragmatically, students have many time commitments, and it is my responsibility to set clear expectations about deadlines, what will be covered each week, and how the content will be assessed. In the online setting, this is even more important: I set deadlines early and post reminders to keep students on track. Students deeply appreciate clear communication; the most common feedback from my students in MATH 235 was that the course was extremely well organized and that this let them focus on learning. When asked what went well for them during the course, one of my students wrote this in a reflective response:

"... What I really admired was the constant communication. I have never seen such a well organized course before especially considering it was all online and the pandemic. Also thank you so much for the extra videos. They were super informative!"

If a student is falling behind, I get in contact early to see how they are managing the course work. Reaching out to a struggling student made a huge difference more than once last term; they were able to complete upcoming assignments, asked questions, and were very grateful for the support.

Build lectures that effectively complement resources. Today, students do not simply learn from lectures and office hours. Instead, they use Google, YouTube videos, and StackExchange posts to try to get immediate answers to their questions. Rather than viewing this as a problem, I encourage students to seek out different perspectives on the course material. Since students can easily find solutions to specific problems online, when lecturing in person I focus on the *strengths* of this physical medium. I make my lectures engaging, and I devote significant time to in-class exercises and group work so that I can give students useful experience with mathematics. If I find resources that do a great job of explaining a concept, I will share them with my class, or even use them to begin a lecture. A short video visualizing the gradient of a function is *memorable* and serves as an excellent springboard for the rest of a lecture.

For MATH 235, I produced short, high-quality, and tailored videos addressing specific misconceptions or difficult concepts. The students praised these videos, indicating that they got to the heart of the difficulties they were having.