Teaching Philosophy

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> *If you want to build a ship, don't drum up people to collect wood and don't assign them tasks and work, but rather teach them to long for the endless immensity of the sea.*
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> – Antoine de Saint-Exupéry

A passion for teaching and student mentorship drove my initial pursuit of higher education. Courses in mathematics education and teaching internships with daily feedback from a faculty member gave me unique opportunities to build upon my interest, and helped me to develop a pedagogical method focused on creating a narrative of the mathematics.

Goals

In general, my teaching goals are...

...to create and maintain a culture of learning.

As an instructor, I feel it is my obligation to create a welcoming environment in which students feel comfortable and encouraged to talk about mathematical concepts. Although it can take a great deal of time and energy to develop this, it's been my experience that students (and myself!) appreciate the end result. One thing that fosters this culture of learning is mutual respect. I'm quick to give positive reinforcement, and I'm careful to use language that is inclusive and treats my students as intellectual equals.

Another part of creating this environment is active engagement and discussion during class time. It has been my experience that many students are unable to communicate big-picture ideas, and I work hard to change that during my time with them. It's common to hear me say something like: "Yeah, keep talking..." or "What do you mean by that?". Having students defend their statements forces them to develop the language needed to communicate their argument, and doing this during class time provides supplemental explanations to the other students in the class.

...to provide clear but flexible course structure.

With the exception of my first year as a graduate student, I have been an independent instructor throughout my teaching career; so at the start of each semester, a good deal of my effort is put toward structuring the overall course in a manner that shows clear organization to my students. During this process, I'm not afraid to restructure the content from the way

it is standardly taught or how it is organized by the textbook. A good example of this comes from my experience teaching linear algebra. The textbook starts its coverage of general $n \times n$ determinants with the definition; however, I thought that this might detract from the students' conceptual understanding. Instead, I chose to motivate our discussion with the geometric interpretation of the determinant as it relates to area and volume.

On a daily basis, I strive to accomplish this goal by crafting detailed lesson plans. I prepare a new set of notes for each class day, regardless if I've already taught the course before, because I find doing so refreshes the material in my mind, puts my mental state closer to that of my students, and helps me to remember connections from day to day. Since I'm in the right "head-space", this also gives me increased flexibility to change each lesson based on student questions and interest.

...to set lofty but realistic expectations.

I deeply believe in setting high expectations for my students; and in every course (no matter the level), I find students will work hard to hit those expectations if they are well communicated and at a consistent level throughout the course. Moreover, it has been my experience that students will match the time and energy I put into the course. If they can tell I am well prepared each day and that I've put thought into structuring their assessments, they respond with the like.

That being said, it is also important to be fair. This means setting realistic goals that respect the students' background and time, and it means providing the support they need to achieve my expectations and being readily accessible to them for questions.

...to mentor students beyond my classroom.

A good teacher acknowledges his or her influence beyond the classroom and extends their passion to the entire student-instructor relationship. At many times during my teaching career, students have looked to me as a guide to the world of higher education; I have shown students how to respond to emails and answered questions about applying for college and graduate school. I try my best to serve as a role model to my students and use my own experiences to augment their knowledge and the opportunities afforded to them.

...to continuously improve.

I want to excel at teaching; and in order to make that happen, I must constantly evaluate and adjust my daily instruction, my course organization, and my idea of what it means to be a teacher. As such, I often seek out professional development from numerous sources. First and foremost, I regularly ask for advice from colleagues – especially on courses that I have never taught before. I actively choose to attend conferences and presentations that are centered around mathematical education; and perhaps most importantly, I pay particular attention to student feedback during and after each course.

Pedagogical Method

My primary mode of daily instruction is what I like to call "conversational lecture" – a casual form of lecturing that closely resembles guided discovery and relies heavily on encouraging student participation and personal responsibility. In my classroom, students are on a journey to uncover the mathematics; and I am there to ask worthwhile questions, provide appropriate examples and counterexamples, and suggest effective strategies to think about the concepts. My teaching style can be characterized by the following phrases:

- Lecture and guided discovery hybrid.
- Instruction driven by instructor and student questions.
- Holistic and motivating examples.
- Emphasis on creating a narrative of the mathematics and expressing formal concepts in natural language.

In a standard lecture, I come to class with a story that I want to explore with my students. It usually takes the form of some overarching question or a series of smaller questions; and by looking at well-constructed examples, my students are frequently able to guess at the bigger picture before I draw attention to it. It is pretty common to hear me say "Alright, let's write that down." or "Let's formalize what we just said." Those are cues to my students that our example just hit on some universal truth (i.e., a definition or theorem). With this tactic, I hope to build their problem-solving skills and promote comprehension of abstract concepts by grounding them in concrete experiences. I have found that my teaching style fosters conversations which result in a growth of my students' mathematical maturity.

As part of my daily pedagogical method, I have some simple strategies to remove common misunderstandings and obstructions to learning. I find that many students get lost in new notation or don't grasp that everything they write down has meaning, and it puts a huge roadblock in the way of their progress. In each lecture, I try my best to highlight notation as a tool for understanding. By drawing particular attention to it, I endeavor to lessen this issue and teach my students how to appropriately communicate mathematics in writing. I'm also very conscience to provide pauses in the flow of material, during which I talk about some of the history behind what we are doing or tell a humorous story from my own past (often about a mistake I made along the way). I find this endears the students to me, making me more approachable. It also allows the students who write slowly to catch up. Finally, I pay particular attention to my use of color while writing on the board. It's a simple thing, but I find that my students are more able to sort through the material if I am careful to differentiate ideas with color. For example, I might write a formal theorem in black; and then a natural language expression for that in blue underneath it.

Technology in the Classroom

Technology has become an integral part of the mathematics classroom; and when used appropriately, it can push student understanding beyond the capabilities non-dynamic instruction. It lets them get their hands dirty, explore, and visualize in a way that paper and pencil cannot. With my background in applied mathematics, I have found myself well-suited to identify course objectives and lessons that would be enhanced by using technology and then create the educational materials to capitalize on those opportunities.

Most notably, I made heavy use of Python while teaching an introductory ordinary differential equations course. When I set out to teach the course, my biggest goal was to impart the larger world of applied mathematics to my students; I wanted them to develop some appreciation of how differential equations can be used to build mathematical models and understand the world around us. I wanted to them to know the standard solution techniques, but also understand those solutions in a broader context. Towards that end, I developed a series of Python projects to teach them the programming language as a tool for scientific computing, and then how to use Python to solve and analyze differential equations. At the end of the semester, the culmination of this was an open-ended final project with written and presentation components to demonstrate their ability to communicate ideas. While it was sometimes a struggle and there are things that I would change, the majority of my students ended up enjoying the projects and recognized Python as a skill worth having for their future academic pursuits and careers.

That being said, technology can play a role at all course levels. In the pre-calculus course that I am currently teaching, I built GeoGebra applets for my students to help them visualize various transformations of trigonometric functions. In my business calculus courses, we used GeoGebra to understand the graphical representation of a derivative as the limit of the slopes of a sequence of secant lines. In both cases, I posted the applets online for my students to explore on their own outside of class.

Formal Training

Part of the reason I decided to attend graduate school at CMU was the program's concentration in the teaching of college mathematics. As part of that focus, Ph.D. students are given formal training in strategies for higher education mathematics classrooms, exposure to mathematics education as an active field of research, and opportunities to exercise the full extent of their teaching abilities under the mentorship of a faculty member. Moreover graduate teaching assistants at CMU serve as the independent instructor for all their assigned courses

– with the exception of MTH 101 and MTH 105, which are coordinated for consistency in developmental mathematics instruction and university competency requirements.

While at CMU, I took two graduate courses in mathematics education:

- **MTH 761: Methods for Teaching College Mathematics.**
  Methods in teaching undergraduate mathematics including technology use, cooperative learning, inquiry, and guided discovery. Students will create activities and discuss issues surrounding undergraduate instruction.
- **MTH 762: A Survey of Research in Collegiate Mathematics Education.**
  Introduction to understanding and interpreting mathematics education research, trends, and evaluation at the undergraduate level.

As their accompanying academic bulletin descriptions suggest, MTH 761 is a methods course designed to provide detailed guidance on good teaching practices; whereas MTH 762 provides a working knowledge of mathematics education research in order to help graduate students better their own teaching via the current body of literature. I found both of these courses substantially rewarding, and I frequently find myself examining my own instruction through the lens of what they taught me.

After completing these two courses, Ph.D. students have the opportunity to participate in teaching internships – during which he or she is the independent instructor of an upper-level mathematics course. The graduate student is paired with a faculty member, and that faculty member sits in on every class period of the semester to provide feedback after every lesson. They are also there to help appropriately structure assessments.

My teaching internship courses (with their academic bulletin description) were:

- **MTH 223: Linear Algebra & Matrix Theory.**
  Systems of linear equations, matrices, determinants, vectors, vector spaces, eigenvalues, linear transformations, applications and numerical methods.
  Mentor: Dr. Meera Mainkar
- **MTH 334: Differential Equations.**
  Definition and solution of first, second, and higher order differential equations.
  Mentor: Dr. Leela Rakesh

I feel very fortunate to have had these unique internship experiences, and the guidance I received from my faculty mentors has proven indispensable as I pursue my teaching career.