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.
– Antoine de Saint-Exupéry

I consider myself fortunate to have a real passion for teaching. Good teachers have been such an important part of my education, and I am now happy to have the roles reversed. During my first semester teaching as a graduate student, I found myself eager to engage my students and to provide them with the tools they needed for success. Since that time, I have found myself teaching a variety of different courses – from college algebra to differential equations; and I relish the unique set of challenges each presented.

Goals

In general, my teaching goals are...

...to create and mainatain 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 respect. I'm quick to give positive reinforcement, and I'm careful to use language that is inclusive and treats my students as equals.

Another part of creating this environment is active engagement and discussion during class time. It's been my experience that many students are not used to having to communicate big-picture ideas, and I think that is a shame. So I do what I can in my role to change that. It's common to hear me say something like: "Yeah, keep talking... What do you mean by that?" (especially a month or so into the semester). I think an active discussion helps students draw connections and share realizations.

...to provide clear but flexible course structure.

With the exception of the first year, I have been an independent instructor throughout my university teaching experience; 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. 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 is the chapter on determinants. 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 level, 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 semester. Moroever, 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. It means providing the support they need to achieve the expectations and being readily accessible to them – espcially at pivotal times during the course (e.g., before an exam).

...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 freshmen how to respond to emails and answered upperclassmen questions about applying for 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 find I must be constantly evaluating and adjusting my daily instruction, my course organization, and my idea of what it means to be a teacher. As such, I frequently 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 semester.

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:

- 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). Through this tactic, I hope to build the students' problem-solving skills and promote full comprehension of the abstract mathematical concepts by grounding them in concrete experiences. I believe that such a teaching style fosters conversations that 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 comprehension. 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 the mathematics. 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 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.

Use of Technology

Technology has become an integral part of the mathematics classroom; and when used appropriately, I find that 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.

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 a written and presentation portions 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 my business calculus courses, we use GeoGebra in class to help understand the graphical representation of a derivative as the slope of a tangent line. Afterwards, I post the applet online for the students to play around with. We also use *Mathematica* to visualize local extrema and saddle points of two-variable functions at the end of the course. With a handful of prototypical examples, they are better equipped to picture what is happening on their homework and draw correct conclusions regarding the applications.

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 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 the required mathematics education courses, Ph.D. students have the opportunity to participate in teaching internships – during which the graduate student is the independent instructor of an upper-level mathematics course. These internships are unique in many ways. In

particular, each graduate student is paired with a faculty member for the duration of the internship. That faculty member then sits in on every class period of the internship and provides feedback after every lesson. They are also there to help

My teaching internship courses (with their accompanying 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 internship experiences. As I further pursue my goal of being an excellent teacher, the guidance I received from my faculty mentors is indispensable.