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

The consistent driving force for my path within academia has been a passion for teaching and student mentorship. 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 like to 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

On a day-to-day basis, my natural mode of instruction is what I like to call "conversational lecture" – a casual form of teaching that blends direct instruction, guided discovery, and inquiry-based learning as appropriate. In my classroom, students are on a journey to uncover the mathematics; and I am there to ask thoughtful 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 and perspective of the entire field.

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.

Equity in Education

Throughout American history, black, indigenous, and other people of color (BIPOC) have been systematically oppressed; and the consequences of this oppression have grown to renewed prominence within the public discourse as a result of the Black Lives Matter movement. Even more recently, the racial inequities present within society (and especially within the healthcare and education systems) have exacerbated the effect of the COVID-19 pandemic on these communities.

As a white male, I'm aware that I cannot and should not have the first voice in that conversation. However, I can be an ally in spaces where BIPOC are present and an advocate in spaces where they are not. As such, I have spent time working to better understand equity issues, the lived-experiences of BIPOC, and how I can help make necessary changes – especially within the educational system. I've used both passive and active strategies to better educate myself. In particular, I started following BIPOC thought-leaders and equity-focused institutions on Twitter. I've read literature, attended webinars, and engaged with other faculty and students in equity-focused discussions – all of which I hope to build upon in the future.

In addition to racial inequities, there are many other areas of concern within education. Education is an important factor in a student's future socioeconomic status; however those with lower income already have less access to academic support (e.g., private tutoring), a problem that is compounded by underfunded public schools and the increasing out-of-pocket costs of higher education. Despite explicit efforts to address the dispairity, there continues to be a gender gap within STEM; and as a gay man pursuing mathematics, I was almost exclusively the sole member of the LGBTQ+ community in my classes – which has made me acuately aware of how that part of my identity has made me role model for some of my students. These problems are difficult and will likely take generations to truly overcome, but I hope to be a part of that process.

In my current position at IMSA, I am fortunate to have the opportunity to encourage many young BIPOC, women, and LGBTQ+ individuals as they pursue these fields at a publicly-funded institution. To help address equity issues in my own classroom, I have become more intentional about who I call on during class in order to promote distinct and varied voices. I have also ramped up how often I solicit and act on student feedback.

It's perhaps not surprising; but I've found that creating an environment where students feel comfortable having an open and honest dialogues about their logistic, personal, and content-related challenges has helped me to better support any difficulties that may arise – ultimately leading to the overarching goal for all teachers: student success.

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 of non-dynamic instruction. It lets them get their hands dirty, explore, and visualize in a way that paper and pencil cannot always allow for. 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 in graduate school. 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 doesn't have to be a major component of the course; it can simply be a tool to facilitate the learning process. In the pre-calculus course that I taught at SC GSSM, I built GeoGebra applets for my students to help them visualize various transformations of trigonometric functions. Since then, I have continued to make greater use of Geogebra and similar online tools. Here are some more recent examples:

- Trigonometry (Ambiguous Case), made for Mathematical Investigations IV.
  `https://www.geogebra.org/m/zxrqrrxb`
  In the established curriculum, there is a guided discovery activity that requires students to use a compass to explore the ambiguous case that arises when solving a triangle. I

built a GeoGebra applet that allowed the students to explore the same activity, but in a more efficient way.

- Calculus (Building a Derivative Function), made for AB Calculus and BC Calculus.
  `https://www.geogebra.org/m/gzthstqy`
  As I've taught calculus more and more, I've realized the conceptual link between the graph of a function and the graph of its derivative can be challenging for students to understand. With that in mind, I developed a GeoGebra applet that allows students to explore this relationship on their own. It also became helpful as we proved the derivatives of new functions – allowing the students to formulate a guess about what the derivative of a particular function might be before proving it.

- Differential Equations (System of ODEs Phase Plane with Eigenvectors), made for Differential Equations.
  `https://www.geogebra.org/m/g88pncep`
  There are two things that originally made me interested in differential equations: 1) their direct application to understaning the world; and 2) the elegance of their qualitative analysis – especially when it comes to how analytic results can inform the graphical respresentation of their solutions. As such, getting my students to understand the "picture" of differential equations is important to me. I have a variety of GeoGebra applets that do this, but this is perhaps one of the more comprehensive ones.

Distance Learning

With the COVID-19 pandemic, many instructors (myself included) found themselves needing to quickly adapt their courses to an online platform. I was extremely lucky to have some experience teaching in that realm beforehand. The SC GSSM Accelerate program was my first exposure to synchronous online instruction. While there, I was fortunate to have colleagues that guided me – showing me how they leveraged the online setting and encouraging the ideas I came up with. Looking back, I learned broad lessons about online teaching in that year.

Firstly, it is extremely important that you **familiarize yourself with every aspect of the technology** – both from an instructor's perspective and a student's perspective. During class, being fluent in the video conferencing software, virtual whiteboard, and any other tool that might be used allows for efficient use of time. Outside of class, understading the technology allows you to set up better asynchronous learning experiences, provide clearer communication, and circumvent tech issues as they might arise for the students.

Secondly, my experience at SC GSSM taught me how important it is to **humanize online instruction**. While I've always used things like humor and storytelling in-person, being online removes many of the verbal and nonverbal cues I rely on to build community and understand where the students are in their learning process. With this additional barrier to the student-teacher relationship, I needed to learn to laugh at my own jokes and over-exaggerate my facial expressions – which I have found immensely helpful in future online lessons.

The summer after my first year at IMSA, I was tapped to pilot a hybrid summer bridge program for students who had failed or were close-to-failing our Mathematical Investigations III course. It 4.5 weeks of online instruction, and 1 week of in-person instruction. This experience really taught me **the importance of adaptability**. Many of the students had technology issues (e.g., low bandwidth at home or unreliable computers), some had non-academic commitments (e.g., summer jobs), and one was even in Japan for most of the course. I found myself re-working the coursework and assessments to better meet the students' availability and needs; and since it was a bridge program, I even leveraged their performances on the final exam to direct the topics. In the end, I think it was a good experience for everyone involved, and I was glad to see it continue the next summer – even though other time commitments kept me from staying on as the instructor.

As IMSA has continued to be remote during the Fall 2020 semester (and into the foreseeable future), I have continued to develop my online teaching skills. Since the administration has altered the day-to-day schedule by stetching one in-person instruction day into two online instruction days in order to accommodate Zoom fatigue and at-home commitments, I've found that creating **a balance of synchronous and asynchronous work** has become even more important. Synchonous class time helps the students to engage with the course material, allows them to work out ideas together in breakout rooms, and offers an opportunity to address deeper questions. However asynchronous time can be leveraged for additional practice, introducing a concept, or formative and summative assessment. Both are crucial; and like each instrument's part in an ochestration, they need to work together for maximum effect.

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.