

It is often said that the role of a successful teacher is one of “lighting the fire” of curiosity in students rather than “filling the cup” of knowledge. I believe that both roles are essential for a college educator. Students should get what they pay for, and my immediate goal as a teacher is to help them absorb as much of the relevant course material as possible. Setting clear course expectations, being organized and well-prepared, and providing ample feedback to my students are of fundamental importance to me. To these ends, an up-to-date course website (usually via a learning management system), consistent office hours (regularly scheduled and by appointment), plenty of supplemental material and exercises, and online access to detailed solutions to homework and exam problems are just a few of the resources that I always provide during my courses. On the other hand, I believe that my role as a “fire starter” is to help students discover how to think mathematically, which I do by dispelling myths about mathematics, fostering students’ ownership and accountability in the learning process, and being flexible in my methodology. I am also committed to creating an inclusive environment which affirms diversity in my classroom.

### **Dispelling myths about mathematics**

One of the most pervasive myths about math is that it is all about rote memorization and application of formulas, which I think is a product of the bottom-up approach to pedagogy that is followed in most primary and secondary schools, and even in some post-secondary institutions. We take mathematical truths discovered painstakingly by trial-and-error over centuries, silo the information and organize it linearly, and then present it as something static and immutable. Though this approach has merits (the information has to be organized somehow!), it can obscure connections between seemingly unrelated topics, and, worse, hide that the process of doing math is a process of failing repeatedly. It is no wonder that so many students develop such a fear of math during their pre-college experiences!

One technique that I use to dispel this myth is to teach examples before theory, because I believe that we should teach math by using something small to hint at something big, building students’ understanding like a blurry painting which becomes more and more clear over time. When presenting a new topic, I like to motivate it with an example and allow the students to first attempt to tackle the problem with the approaches that they already know, so that they can discover on their own that something new or more general is needed. I make it a point not to tell them right away that I have set them up to “fail.” When the students begin to make the connection that something new is necessary, I can present the relevant theorem, knowing that they have a good example in the back of their minds to accompany the explanation. If I am lucky, I can even use that same example to give a hint of the proof of the theorem. This parallels what mathematical discovery is really like, and I also think that it prepares students to think critically and come up with creative solutions to problems they will encounter in any job after higher education, all while fostering a growth mindset.

Another technique that I like to employ to help students see the interconnectedness of seemingly unrelated mathematical topics is to present them with “math riddles” which hint at beautiful ideas directly or indirectly related to the course material. For example, prior to introducing the natural log function in calculus, I might ask students how to detect which one of 1000 bottles of grape juice is poisoned using only 10 thirsty rats to

remind them of logarithms. Or, I might ask them to determine whether  $e^\pi$  or  $\pi^e$  is larger without using a calculator. This illustrates the power of logarithmic differentiation and also opens up a discussion into what it means to have an irrational exponent in an expression.

### Student ownership and accountability

A focus on examples before theory also spurs students to ask questions and make connections so that they take more ownership in their learning. I took this philosophy to the extreme in Fall of 2016, when I ran a discussion section as a “math lab,” where the students worked in groups on worksheets prepared by Dr. Sepideh Stewart (for whom I was the teaching assistant) and me to augment their learning in the Calculus II lecture. The worksheets were designed to walk the students through multi-part problems, more challenging than typical homework problems, which built on material from the last lecture and hinted at new material in the next lecture. While they worked, I would visit each group in turn to engage with the ideas they came up with and give them hints when they were stuck. This project-based learning approach to the discussion was incredibly well-received, and it was rewarding to see what new connections and questions the students could come up with all on their own. For example, one student was curious to find a series made out of elementary functions for which the methods we learned in class could not determine easily whether it converged or diverged, and successfully found one online! See Figure 1. An important aspect of mathematics which can be hard to convey is that it is crucial to understand the limitations of the methods available to us. I love that this student asked this question because it gave a real opportunity to address this concept in class.

$$\sum_{n=1}^{\infty} \frac{1}{n^3 \sin^2 n}$$

FIGURE 1. A “simple” series which is not known to converge or diverge. A student found this example on <http://math.stackexchange.com>.

Encouraging students to open their textbooks is something else that I emphasize in an attempt to foster students’ self-reliance. I assign textbook readings as part of most homework assignments, and will sometimes give short quizzes on the reading material. When students ask me questions in office hours, I will often encourage them to find a similar example in the textbook and emulate the technique. Sometimes, I will encourage them to search for a hint online and help them parse it as necessary.

Another technique I have used to emphasize students’ accountability is to do “exam breakdowns” after an exam that didn’t go as well as expected. This entails having the students make a list of factors that led to them not performing the way that they wanted, and then organizing them into things that were in their control as students, my control as the teacher, and out of anyone’s control. Then we make a deal as a class to address the factors over which we have control. This exercise helps the students to see that I am on their side, while emphasizing the role they have of reinforcing their own understanding of course material inside and outside the classroom. In an age where a college education is becoming more of a parental expectation than a conscious decision to invest in one’s own future, I think such attitudes are especially important to develop in students. And it goes almost without saying that part of thinking mathematically is having an internal locus of control.

## Flexible methodology

I am wary of saying that there is a single best methodology to follow when running a class. Everyone learns differently, and a class which favors more discussion and group work may respond poorly to the traditional approach of a professor lecturing for an hour while students sit quietly, taking notes and working examples on their own. On the other hand, some quieter classes prefer the latter approach, feeling that too much discussion in a classroom is a distraction to covering more material. Thus, I think it is important as a teacher to be flexible in one's preferred method of engaging students, being fluent both in the art of lecturing clearly and stimulating discussion when appropriate. I had one stand-out experience with the latter extreme in Summer of 2016, when I taught a class called Paradoxes and Infinities to gifted high school students as part of John's Hopkins University's Center for Talented Youth Program, during which I was encouraged to adopt a variety of inquiry-based methods, group discussions, and exploratory, hands-on activities, to which the students responded quite positively.

In the future, I know that many of my students will need to rely on technology to solve problems, so it is especially important to me to foster technological literacy. In fact, technology has opened up a treasure trove of possibilities for engaging meaningfully with students and has become a core aspect of my methodology, in large part *because* of the flexibility that it affords. In the last few classes I have taught, I have written lecture notes on my tablet and projected them at the front of the room. This makes it easier to use a variety of colors to make notes and drawings more clear. At the end of the class I can export my notes to a pdf and put them online so that students have easy access to them. I also use the TI-83, MATHEMATICA, WolframAlpha, Sage, and other online tools to give students visual demonstrations of course topics such as Taylor series that would not have been possible several decades ago. One of my favorite exercises to do to motivate power series is to use MATHEMATICA to plug small powers of 10 (e.g.  $10^{-6}$ ) into the function  $f(x) = \frac{x}{1-x-x^2}$ , show the students a visual similar to Table 1, and ask them why the Fibonacci numbers appear in the decimal output.

$x$	$\frac{x}{1-x-x^2}$	Decimal expansion
$\frac{1}{10}$	$\frac{10}{89}$	0.1123595505617977528089887640449438202247191011235955056179775281190...
$\frac{1}{100}$	$\frac{100}{9899}$	0.0101020305081321345590463683200323264976260228305889483786241034448...
$\frac{1}{1000}$	$\frac{1000}{998999}$	0.0010010020030050080130210340550891442333776109885995881877759637397...
$\frac{1}{10000}$	$\frac{10,000}{99989999}$	0.0001000100020003000500080013002100340055008901440233037706100987160...
$\frac{1}{100000}$	$\frac{100,000}{9999899999}$	0.0000100001000020000300005000080001300021000340005500089001440023300...

TABLE 1. A "riddle" for calculus students: Why do the Fibonacci numbers appear in the decimal expansion of these numbers?

In addition to engaging students in the classroom, I also believe that it is important to engage students one-on-one and in small groups whenever possible. This can certainly be done inside the classroom when class sizes are sufficiently small, and also by encouraging students to attend office hours, but I believe it is

important as an educator to seek additional opportunities for this sort of interaction. This is especially helpful for students who are unsure about what they want to do after graduating from college. By conversing with these students and learning more about their interests in this setting, I can help them to find opportunities to get ahead, perhaps via a summer internship, research program, or study abroad opportunity. At the University of Oklahoma, I mentored with a directed reading program which consisted of weekly meetings with undergraduates to discuss graduate-level mathematical topics including algebraic topology and geometric group theory, my area of research. I assigned weekly readings and exercises to my student, and we met in my office to discuss his questions, many of which I struggled to answer. I became better and better at distilling complex ideas to my student over time, and I think I helped solidify his decision to attend graduate school for mathematics. In the process, I developed a passion for communicating clearly about what mathematics research really is, and since then I have striven to craft explanations of mathematical research not only for mathematics majors, but to any student who might wonder what the day-to-day life of a mathematician is like. For students who are interested in graduate school, I thus feel well-prepared to mentor them by leading a reading course, suggesting a research project, or getting them connected with someone in their area of interest.

### **Creating an inclusive learning environment**

it is a core part of my mission as an educator to contribute to the construction of a diverse and inclusive environment within and beyond my home institution. After graduating from Bethel College, a Mennonite liberal arts college in rural Kansas, I volunteered with a Mennonite Central Committee program called Serving and Learning and Together (SALT), whose primary goal was to foster intercultural communication through development work. Each year, SALT coordinates with local organizations in foreign countries across the globe to place a group of young people from the United States and Canada in year-long volunteer roles. At the same time, they coordinate with organizations in the US and Canada to bring young people from these countries to play a similar role here. I worked with a nonprofit organization called the Lari Memorial Peace Museum in Kimende, Kenya, whose mission is to encourage inter-tribal communication and peace building in the climate of distrust stemming from numerous historical conflicts between tribes. We hoped to achieve this mission by refurbishing and distributing computers to primary and secondary schools across the region and offering classes in computer literacy, with the goal of educating students about issues of diversity, equity, and inclusion by encouraging them to communicate with their peers of different tribes in our online forum. This experience helped inspire me to be committed to working with students from diverse socioeconomic and cultural backgrounds, and also to encourage my own students to embrace their roles as global citizens.

As a graduate teaching assistant at the University of Oklahoma, I have striven to foster diversity, equity, and inclusivity in the classroom. One of the best ways to make students of diverse backgrounds feel comfortable is to get to know them on an individual basis. I always provide a survey at the beginning of my classes to get to know my students better. Beyond the basic questions like "What is your name and major?" I like to ask them about their career goals, hobbies, passions, and what I can do to help them succeed in the course. When interacting with students before and after class and in office hours, I find that small talk and asking questions can go a long way to encourage them to participate during the lecture. In conversations with students, I actively use principles of *mirroring* to better engage them. Having lived in a foreign country myself for almost a year, I feel that I can relate well to international students. I make extra effort to pronounce their names

correctly, send them emails to check on their progress, and refer them to foreign student organizations to help with the loneliness that I know many of them feel.

During the summer that I worked with Johns Hopkins University's Center for Talented Youth program teaching a course called Paradoxes and Infinities to gifted 7<sup>th</sup> through 10<sup>th</sup> graders, many of the students came from a mostly Hispanic school district in Arizona. Many of the students were English language learners, so it was a real challenge to build the course in a way that included them in the learning process. Thankfully, the small size of the classroom and the fact that I had a teaching assistant allowed us to give a lot of individual attention to each student and explain each problem to them individually in a way that they could understand. It would be a dream of mine to work for an institution with the resources to cater to the needs of these types of students by hiring a staff of diversity officers to work individually with me and students from these types of backgrounds to give them a better learning environment. Even simple programs like semi-annual inclusion and diversity trainings can go a long way towards achieving the goal of bringing awareness to issues of diversity. I am committed to lead the charge in this direction at my home institution by networking with organizations and colleagues devoted to promoting diversity and applying for diversity grants.

I am by no means an expert on diversity and inclusivity. I recognize that I have much to learn about promoting diversity, inclusion, and equity at my home institution. I want to express my willingness to engage these issues on a day-to-day basis with colleagues, administrators, students, and community members. It is my duty as an educator and human being to use my position of privilege to create a learning environment which enables individuals of all different backgrounds to thrive.

### **Teaching experiences**

I have learned a great deal about teaching over the course of the past six years. Please see Table 2 for a list of the courses I have taught at OU from 2013 – 2018 and some highlights from those experiences.

Course name	Semester taught	Class size	Description of course/new pedagogical idea used/lessons learned	Strengths according to student evaluations
Calculus II	Summer 2017	18	Fast-paced, six-week course. Presented students with "math riddles" directly or indirectly related to the material. I was especially intentional about post-exam breakdowns. When the first exam didn't go as well as we had hoped, we addressed what went wrong as a class.	"Ben is one of the best professors I have had to date. He is a good teacher and always made class interesting. I was surprised at how enthusiastic and willing Ben was to help students. He genuinely cares about his students and even added office hours to accommodate those of us who worked during regular office hours. Ben embodies all the traits of a great educator. He is compassionate, informed, and challenges students in ways that increase their understanding of the [course material]."
Calculus I	Summer 2018 (also taught Spring 2016 and Summer 2014)	31	Fast-paced, four-week course. Showed up to the classroom an hour early most days to give students some extra one-on-one attention in addition to regularly-scheduled office hours. I believe this contributed to better participation in class.	"To me this was one of my favorite classes at OU so far. It was well organized and the access to the note outside of class was a great resource. Everything was explained well because at the start of this course I was truly poor in math, I can say at the end of it I may make some mistakes here in there in mathematics but this course truly helped me excel tremendously with the help of Professor Ben."
Accelerated calculus I	Summer 2015	22	During this semester, I fundamentally changed my approach to teaching by giving students ample time to work through examples in class and coming around to help them, rather than lecturing for most of the class. Learned that I had a tendency to make exams too long and too hard.	"[T]aught using a cutting-edge tablet that really helps relate to the new age of students. Also all notes got posted online so you could actually pay attention in class."
Pre-calculus and trigonometry	Fall 2013	35	Focused more on examples. Made a great effort to connect the material to problems from physics, computer science, and engineering.	"I really liked this class. I am so glad I had Ben as a teacher. He was so great in every aspect and was very approachable. He also structured the class great too. I loved how laid back the class seemed."
Math for critical thinking	Summer 2013	10	I first focused on examples to introduce new ideas, rather than jumping into an abstract definition. I learned the importance of making additional material available to struggling students.	"Material and explanation of the material as well as access to additional help if required."
College algebra	Spring 2013	27	First teaching experience! My evaluations were not the best. I learned how important it is to gauge student reactions to material and adjust teaching style accordingly.	"Mr. Stucky was very personable and actually made learning math sort of fun to a certain degree."

TABLE 2. Some highlights from my teaching experiences