

If you sat in one of my classes, you would probably hear me talk about “the forest” and “the trees.” I do this to help my students identify and distinguish the big idea (the forest) from the smaller details (the trees). Applying this metaphor to my teaching, the forest is empowering my students to use and enjoy mathematics and rigorous reasoning. The trees are the following practical principles that I employ in order to reach this goal.

Applications. When I redesigned and taught my own course on math in genetics and genomics, I always posed a biological question to the class before I taught the mathematics that answered that question. Binomial random variables and Poisson processes were more appealing to the class after they first understood how those ideas were needed to sequence the human genome. My public policy and pre-med students were motivated to study equilibrium values for difference equations after seeing how they can predict cystic fibrosis carrier rates. In a project on phylogenetic trees, one pair of students went far beyond the requirements by implementing tree construction algorithms in MATLAB after seeing how they were used to solve a murder case by tracking the evolution of HIV.

As a calculus instructor, I emphasized applications to chemistry, biology, and economics in addition to the traditional applications to physics. This diversity of applications reflected the diversity of my students’ majors and thereby motivated them as they saw how calculus contributes to the disciplines that interest them.

Applications also provide students with intuition by connecting a mathematical idea with something they already understand. As a calculus instructor, I gave my students applications-based projects that were designed to lead them to discover calculus concepts themselves. These projects relied heavily on applications to give students the intuition necessary to accomplish this difficult task. From giving these projects, I have seen how having the abstract notion of an ordinary differential equation grounded in the concrete example of the velocity of a baseball or the rate of a chemical reaction helps students to grasp the mathematics.

Through mentoring six undergraduates in five mathematical biology research projects, I have also seen that applications can inspire students to pursue mathematical research further. Multiple students that I have mentored have decided to go to graduate school in mathematical fields, and they have expressly attributed their decision to this research experience. Furthermore, since mathematical biology research projects don’t always require graduate level mathematics, undergraduates can often make real scientific contributions. I mentored an undergraduate on a project in 2010 that resulted in a publication, and results from a recent project with another undergraduate are currently being prepared for submission.

Active classroom. I believe that students learn best when lectures are punctuated by other activities. When I taught my math in genetics and genomics course, I kept this principle in mind. To complement my lectures, each student prepared and gave 10-minute presentations throughout the semester on topics that introduced and motivated the main ideas of the course. This aspect of the course was repeatedly praised in course evaluations and I believe the students benefited in a number of ways. First, the student giving the presentation had to learn the topic thoroughly before they could teach it. Second, on a practical level, the presentations helped maintain student attention through a 75-minute class period. And perhaps most importantly, as the students learned from each other they developed a sense of community and ownership of the material that caused them to be fully engrossed in the entire course.

As a calculus instructor, I looked for opportunities to get my students involved beyond just listening to my lectures. For example, to introduce the constant e I told my students we wanted to find a function that is its own derivative and showed that $\frac{d}{dx}a^x = ka^x$, where k depends on a . Then, I had my students use their calculators to approximate k for different values of a . As they raced to find the value of a that makes k equal to 1, they soon began to converge to a mysterious number slightly greater than 2.7. It was only at this point that I mentioned “ e ” and wrote the definition on the board. Judging from the reactions that suddenly filled the room, I believe the students experienced an aha moment as they connected this exercise with their high school calculus knowledge.

Growing. I am always trying to grow as a teacher. I was recently awarded the annual prize for teaching excellence by the Duke University Mathematics Department, but I already have ideas to improve my math in genetics and genomics course when I teach it again in Spring 2014. As part of completing a Certificate in College Teaching, I have taken courses on teaching practices and have learned from the feedback of colleagues after having six experienced teachers observe my classes.

When I taught calculus, I met every week with the other graduate students and faculty who were teaching that course. While we each had freedom in how we structured and taught our classes, these group meetings allowed us to discuss our plans and share ideas, handouts, homework problems, etc. I learned a great deal from my colleagues that semester and I am sure my students have benefited.

In addition to learning from fellow teachers, I try to learn from and adapt to my students. One practical way that I do this is by giving my own anonymous surveys to students partway through each semester. By asking about the pace of the class, ways to make the class more engaging, and just giving students an opportunity to offer comments, I have gotten valuable feedback that has improved my teaching.

I seek to adapt to my students because they are often very diverse in their interests, strengths, and learning styles. For example, my math in genetics and genomics class had freshmen, sophomores, juniors, and seniors with various majors, including math, biology, engineering, English, sociology, and psychology. Three of the six undergraduates I have mentored have been from various colleges around the country with various majors. I have also worked with advanced students as I have twice been the sole coordinator and teacher for weeklong intensive reviews of real analysis for incoming math PhD students. Working with students with such varied backgrounds has been a challenge, but it has also given me valuable experience.

Of all the principles of teaching, I believe that constantly seeking to improve is the most important. I look forward to spending the rest of my career trying to serve my students better.