Teaching Statement

Daniel Forger

Teaching Goals

Interdisciplinary academics must be effective teachers. As an interdisciplinary researcher, I must always wear my teaching cap as I constantly bridge different fields and communicate with scientists with varied academic backgrounds. In the classroom setting, I strive to create an atmosphere where students are comfortable and motivated to learn regardless of their academic backgrounds. Becoming a better teacher is a career long commitment for me.

Many of the courses that I have taught and developed have been interdisciplinary. The primary challenge in teaching these courses is that the students have been trained in diverse academic fields. I seek clarity, particularly in light of student's backgrounds. To accomplish this end, I carefully define biological terms, thoroughly explain basic mathematical concepts, assign group work that enables students to learn from each other, and require final projects that allow students to tailor the tools and techniques learned in the course to their unique academic backgrounds. Many of the courses I have developed incorporate computer labs where students gain mathematical intuition about the systems they study. These labs make mathematical equations more accessible to students who have been trained in the biological sciences, and give practical training to those trained in theory. I also meet each student individually to discuss their final projects, and to offer advice on how they can better equip themselves to understand the material they study.

In my courses, I strive to teach both the tools of mathematics and how these tools can be applied. Rather than only teaching facts, I frequently present wrong theories, and encourage students to question them. Instead of merely presenting a published mathematical model, I encourage students to think through the thought process used to develop the model. Together we explore the biological and historical context in which the model was conceived. This includes discussions of why ideas, which now are tacitly assumed to be correct, were so controversial when they were first presented. These teaching techniques will help motivate students, and improve their critical thinking skills.

Teaching Record

In response to the question "Overall, the instructor was an excellent teacher" from the University's official teaching evaluation of my courses, I have always received > 4 on the 5 point scale, since receiving tenure. Here are my average scores on this metric:

Math 463 Mathematical Modeling in Biology (4 times) average 4.38
Math 471 Introduction to Numerical Methods (1 time) 4.5
Math 563 Advanced Math Biology: Modeling Vision (1 time) 4.36
Math 563 Advanced Math Biology: Math, Music and the Brain (1 time) 4.25
Math 564 Topics in Math Biology: Analyzing Biological Rhythms (2 times) 4.51
Math 564 Topics in Math Biology: Scientific Computing in Medicine (1 time) 4.75
Math 571 Numerical Scientific Computing (1 time) 4.25

Here are a few recent written comments on my evaluations:

"Dr. Forger is one of the university's best professors"

"One of the best classes and professors in my life."

"Prof. Forger has been extraordinarily nice and very willing to help. It is obvious that he is very passionate and interested in the subject matter. It was also clear that he was very excited to be teaching the information to us."

"Despite my weak math background and difficulty in the course, it was still by far my favorite course at U of M so far."

"Dr. Forger honestly made math fun for me again - something I haven't had since about 7th grade."

I devote much effort to teaching and expect an equal amount of hard work from my students. In every course I have taught at Michigan, the students have rated the class in the top 50% in terms of workload, and some students have indicated that the workload is particularly high. In some classes, including last semester, I have decided to grade the problem sets myself, even if a grader could be provided. I have done this to get a better sense of the abilities of each student and to provide more informed feedback. When any of my courses involves a final project, as many do, I meet with every student individually at least twice during the semester (and I hope for much more), both to choose a topic and to check on their progress.

In the Winter 2011, I taught math 571, a graduate numerical methods class. The central difficulty with this course was the interdisciplinary nature of the students. The first time I taught the course, I taught it at too abstract and advanced a level for many of the students. Accordingly, the second time I taught the course I undertook strategic measures to ensure that the material was more accessible to make sure that all students understood the fundamental principles and ideas. While one student, who had seen material before, wanted a more abstract course, the rest of the students responded very positively. Comments included: "The course was well designed and covered a good breadth of topics," and "Professor Forger's enthusiasm for the subject definitely helped combat some of the dryness of numerical linear algebra."

I am particularly proud of developing new mathematical courses for the department, for example one on modeling biological rhythms and one on numerical methods for problems in the biological sciences, both listed as Math 564, a course number I registered. Math 564 has been offered three times, has had great student feedback, and has had relatively high enrollments for a graduate mathematics course (16, 18 and 13). At the urging of faculty in the Bioinformatics program, I developed the course on numerical methods for problems in the biological sciences in order to fill a gap in our curriculum and to cover additional material such as stochastic simulations of chemical reaction networks or the Immersed Boundary Methods for problems in biological fluids, which are not found in our other numerical methods classes.

The course on biological rhythms I developed has led to the development of a new textbook in press at MIT press. While preparing for this course, I realized that, while there are many interesting and related texts, no good textbook existed for the field. In the long run, this new text will hopefully be a key tool in training students in my field, but in the short-term this was challenging. I used the textbook I was creating as the sole reference for the course

during the winter of 2012. Such a process inevitably exposed several ways that the text needed to be improved, but the sharp eyes of my students made the work, in the end, all the more clear.

Perhaps the most innovative course I developed was a course I recently taught on math, music and the brain this past year. It was developed in collaboration with the school of music. The course description is listed below:

"How can our appreciation and performance of music be enhanced by understanding mathematics and basic principles of how the brainworks? By studying music, can we learn about new mathematics and principles of signal processing in the brain? Can principles of music theory be deduced by analysis of the works by master composers? The connections between mathematics and music have been known for thousands of years. Yet, recent advances in technology, computational neuroscience and "big data" have provided new answers to these questions. In this course, we study mathematical models for how the brain processes sound, and mathematical techniques for analyzing music performance. Although examples will be presented from ancient to contemporary music, we will focus on analyzing Bach's Trio Sonatas throughout the semester. Group work and original research will be encouraged. The class will meet alternately between a computer lab and a performance venue where live performances will regularly be included in class lectures."

A key part of this course was that I performed for my students the Bach Trio Sonatas on the pipe organ, and was able to digitize my performances based on technology I was able to put together. Students worked in teams and received a digitized version of my performance of each movement, which they would mathematically analyze. We would then meet in the performance space, where they would present the results of their analysis, I would perform the piece and a discussion would follow.

Outside of the standard semester long lecture course, I strive to do a lot of service oriented teaching, for instance, in our department, teaching ethics courses or independent study courses. I have taught modules in many courses around campus including at the Medical School, the Engineering School, and in the Neuroscience program. I have also organized the MBI-CAMBAM-NIMBIOS (the three North American Mathematical Biology Institutes) summer school for graduate students, and a similar summer school at the Institute for Natural Sciences at Shanghai Jiao Tong University.

I make my research accessible to the broader public by appearing on radio and tv programs, and have worked with reporters from many newspapers who have featured my work. Moreover, I have given lectures to the Michigan's Math and Science Scholars program for high school students and the mathematics department's math club. One activity I particularly enjoy is the Wolverine Express, a bus that takes Michigan faculty and staff to struggling, inner-city high schools across the state to stress the importance of mathematics, to inspire students to move in the direction of their goals, and especially to encourage students to apply to college.