

Teaching Statement – Christopher A. Francisco

My role as a mathematics teacher is to help my students both to learn mathematical concepts and to improve their ability to think independently. Mathematics is a wonderful subject through which to empower students to realize how much they can do by applying knowledge they have accumulated to an unfamiliar situation. Though students may be uncomfortable doing anything but calculating at first, I think students are capable of thinking more deeply about mathematics than we often ask them to do. My first-semester calculus class culminates with my students talking me through the proof of the evaluation portion of the Fundamental Theorem of Calculus, using a guide I provide. I always have multiple students who took calculus in high school tell me after class that it had bothered them that they did not know why we evaluate definite integrals like we do, and since it was “easy” enough for them to do themselves, someone should have shown it to them before. It is fun to hear that at the end of a semester.

When I teach, I maintain a running dialogue with my students. I almost never talk for two minutes without asking for student input. Even when I introduce a concept that most students have not seen, I find it useful to hear their intuition. When I taught integration to a group of students who had not previously taken calculus, the students tried to estimate the area of a curved region I drew by creatively drawing polygons inside; the leap to the standard rectangle techniques was easy to make. In a more advanced course like linear algebra, I asked for students to volunteer ideas for approaching a proof, occasionally giving them hints. Sometimes, they came up with proofs better than what I intended to present, and the students remembered these arguments better than those I simply explained myself. I promote an atmosphere that encourages students to volunteer without fear of making mistakes, and my students have said in evaluations that they feel comfortable in my class. Additionally, I write complete English sentences on the board as much as possible when I teach. This makes the class feel like a conversation and exploration and less like a course in how to manipulate mathematical symbols.

One of the biggest challenges facing mathematics instructors, particularly in introductory classes, is to help students understand what math is and why we ask them to learn it. Students often come to college thinking that mathematics is largely a computational activity, and they struggle with open-ended questions that require them to think conceptually. As with any subject, students understand math better if they see a way to relate it to their own experiences.

To address these some of these concerns, Cornell is experimenting with new techniques to use in calculus classes. I participated in an NSF-funded project called “Improving Calculus: Developing Concepts Through Good Questions,” with principal investigators Maria Terrell and Robert Connelly. With other graduate students and faculty, I wrote and revised a wide range of questions for first-semester calculus classes that focused on improving students’ understanding of concepts they are learning; students vote for one of the multiple choice answers, discuss the choices with their classmates, and then vote again. Many questions try to illustrate mathematical ideas in settings familiar to the students. One difficulty that my students often face is that while they have a vague idea about what a theorem says, they do not really know what the hypotheses are and why they matter. In the case of the Intermediate Value Theorem, some simply memorized that they needed to check for continuity. I addressed this by talking about a basketball game many watched that week in which the team that was behind at halftime won, but the game was never tied. (One can score one to three points at a time in basketball.) The students noticed this possibility quickly, and they were able to explain later in writing why this example did not violate the Intermediate Value Theorem (and even discussed whether the same thing could happen in soccer); this is typical of a question from this initiative. The “Good

Questions” project has also produced a number of theoretical questions to see how well students understand definitions; for instance, last spring, we asked students whether how a function f is defined at a affects whether $\lim_{x \rightarrow a}$ exists. I have found the theoretical questions particularly useful when reviewing concepts students should have internalized earlier in the course. When I taught linear algebra, I used similar techniques. The students were skeptical about how useful changing coordinates was when they first learned about it. We talked about how it was easier for me to tell them that I lived a block east of their dorms than to describe how to walk the mile from our classroom on the winding roads in Ithaca. The students understood this easily, and some of the reasons for using different coordinate systems became clearer.

I attribute some of my success in teaching to getting to know my students early each semester. I have my students send me an introductory e-mail so that I know their background. In particular, I ask students to describe both their academic and nonacademic interests. Using this information, I develop examples and homework questions tailored to each class. One semester, I had many students interested in business. I frequently gave examples using ideas I knew they would study in first economics classes, such as why a business would set marginal revenue equal to marginal cost. Another semester, half of my class participated in athletics. When some students struggled to understand relative error, we discussed shooting percentages of basketball players. They knew Michael Jordan had played better when he made 20 of 22 shots than when he made 2 of 4 even though he missed the same number of shots each time. Putting mathematics into a context that was familiar to the students helped them understand what they could not see with the examples in the textbook of computing areas. Discussing subjects students like makes them more likely to see why mathematics is important.

I have also been interested in issues in teaching outside my role as a teaching assistant. I participated in the Cornell mathematics department’s College Teaching class for two years, and I was one of five graduate students in 2002 who helped train new math teaching assistants. When Cornell recently revised its graduate curriculum, I met with professors who teach introductory graduate algebra and produced a suggested list of prerequisites. Then, in August, I gave several review lectures to help refresh the incoming students’ memories. As a second-year graduate student, I gave invited talks on introductory game theory at area small colleges in the Preparing Future Faculty program, showing students some fun ideas in math that they might not see in their classes. Finally, I also give a number of expository talks about my area of research, both in the graduate student colloquium and in the commutative algebra seminar.

Throughout my teaching career, my students have given me positive evaluations. My ratings have been consistently high in all of my classes. Most recently, in the spring of 2003, I was a finalist for the Cornell University College of Arts and Science’s Clark Distinguished Teaching Award. I also received the Cornell mathematics department’s award for the most outstanding graduate student teaching assistant in 2002. In my first year of formal teaching as a senior at the University of Illinois, I made the “Incomplete List of Teachers Ranked As Excellent by Their Students,” and my ratings were in the top 10% of all teaching assistants on campus.

I am most proud of the number of students who have told me that they became interested in mathematics for the first time while taking my class. I strive to convey my enthusiasm for mathematics to my students and inspire their interest in the subject. Several of my former students in introductory classes have gone on to major in math, and others have told me that they appreciate now that mathematics is not just a dry, computational subject best left to computers. I look forward to continuing teaching courses at all levels of mathematics and helping students understand both the utility and beauty of the subject.

Student Comments - Christopher A. Francisco

This is a selection of comments students have written on my teaching evaluations in classes in which I was the sole instructor. I will be happy to provide photocopies of the evaluations and my numerical ratings upon request.

- “This class sparked my interest in math, not something I expected out of it. Chris is a great guy and a very good teacher.”
- “This was a wonderful course which really solidified my understanding of calculus and inspired me to study math at higher levels. Our teacher, Chris, was the best math teacher I have ever had and an entertaining and clear teacher. A wonderful class.”
- “I found that Chris addressed his students’ independent needs well. He communicated well to students who had never seen calc. before and those who had.”
- “I’m really not a math person, but Chris made the class bearable and even interesting. I struggled with some of the material, but he was always patient and willing to help.”
- “I think this course has been better than my expectations because of the instructor... Math has always been my least favorite subject, but it has become one of my favorite classes this semester.”
- “If you can’t learn calculus from Chris, then you won’t be able to learn it from anyone; he does an awesome job.”
- “Lecture was great. Very informative and helpful. Chris always made an extra effort to help and answer questions. He was very cooperative and a wonderful instructor.”
- “I thought that the lectures were extremely valuable in this class. The instructor explained the concepts very well.”
- “Great job teaching material. Made a boring topic, to me, seem interesting and fun.”
- “Chris always was very eager and clear in communicating information and explanations... I would be glad to have Chris again for another course.”
- “Lectures were very helpful. Material was presented very clearly. The way HW problems discussed - very effective (helpful, guiding, but not giving it away, making us think).”
- “Chris is extremely helpful. Office hours are very effective... Notes are very clear and organized and help with homework.”
- “Enjoyed taking course. Instructor made himself thoroughly available and helpful if ever there was a problem or anything I did not understand. Class environment was laid-back and fun.”
- “I like how the instructor cares about the students. He is always concerned if we understand the material. I also like how we can apply calculus to life.”
- “Very good job with the lecture; although I’m not receiving an A in the class, you made calc. into a class where I could understand the material although I was afraid to take the course since I failed last time I attempted to. I would definitely recommend you as a TA because I feel as if I understand calc. now...”