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Teaching statement.

As of writing this teaching statement, I have graded homework and held weekly office hours for two semesters of undergraduate topology, and taught recitations for first-year calculus courses at the University of Rochester. I enjoy teaching and I have received very nice feedback from my students, and no negative feedback, but owing to a research fellowship which paid my tuition and expenses for two years without requiring me to teach, I have done less teaching in graduate school than I did as an undergraduate, when, in my last term at Portland State University (Spring 2003), I taught a topics course ("Introduction to Stable Homotopy Theory") for advanced senior undergraduates as part of an Honors thesis program at PSU. The lecture notes I prepared for the course are available from me, on request.

I am very comfortable teaching mathematics, and my students are usually very comfortable with me. I keep the atmosphere in the classroom relaxed and, while I encourage students to offer their solutions to problems, and I ask them questions during lectures, I make it very clear that they will not be graded down or looked down on for their mistakes. I like to emphasize that present-day mathematics is the result of a historical process in which natural and obvious mathematical questions were asked, answers (sometimes partial and sometimes complete) were developed, and obvious mistakes were generally made many times until they were discovered and corrected. As a result I think that what happens in the classroom while I teach is a process of asking the most natural, most obvious questions brought up by the subject at hand; for instance, when teaching about the derivative, I emphasize that the derivative lets us describe the movement of an object in space, and the formal properties of the derivative don't appear from nowhere, rather, they come directly out of our investigations into how objects move; and I emphasize not only the applications of the mathematics to the various majors and fields of study that the students in the class are engaged in, but also how the mathematics was developed naturally out of the needs of those fields of study. I make it a point that, if left to their own devices, the students in my classes would themselves have developed calculus, given enough time, in order to deal with naturally occurring problems in physics, engineering, economics, medicine, chemistry, and so on. This helps students to approach mathematics with a little more confidence, but perhaps more importantly, it answers the inevitable students' questions "What is this stuff actually good for? When am I going to ever use this in the real world?" before those questions are even asked, which seems to keep the students more interested in the mathematics we are doing.

I think that being relatively young also helps me in teaching (today, as I write this teaching statement, a student I had for an entire semester last year asked me if I am a senior—it had not occurred to her at all that I might not be an undergraduate); I think it makes my students more comfortable to be taught by somebody who is close to their own age and who grew up with the same pop culture that they grew up with. I don't feel any need to insist on my authority in the classroom by setting myself apart from the students in some way, and I find that my students learn best when I am casual and friendly with them, and I have never had a student challenge my authority as a result. As a result, I think my students have more confidence when approaching mathematics because they aren't as terrified of failure (although I don't have a problem giving a student a poor grade if they haven't earned a good one). At Portland State University, where I was an undergraduate, there is a very active graduate program in Mathematics Education, and while at PSU I learned from the teachers and students in that program that the greatest obstacle facing undergraduate students in mathematics courses is the student's own sudden drop in self-confidence when the student experiences failure; this idea has been supported by my experience teaching, and I remind my students often that mathematics is difficult and they should not expect to understand every idea the first (or the second, or sometimes the third) time they see it; what is important is that they do not give up, that they continue working on what they are making some progress on, and later they can come back to the ideas they are stuck on, with a fresh perspective.

I also like to point my students in the direction of research, when it's possible. In teaching calculus, once students have seen the Fundamental Theorem of Calculus, I like to point out to them that it is only valid for functions on $\mathbb{R}$, and I like to run them through an example of why it fails on the circle S^1 (the circle has no boundary, so even if it were possible to find an antiderivative for a continuous function $f : S^1 \rightarrow \mathbb{R}$, we would have no "endpoints" of S^1 to plug into that antiderivative to find $\int_{S^1} f$); when students have seen the generalized Stokes' Theorem, then I show students that the Fundamental Theorem of Calculus and (in higher dimensions) the generalized Stokes' Theorem can fail when we are doing calculus in a non-Euclidean setting, and I then tell them that it fails in a *controlled* and *predictable* way, which is measured by something called de Rham cohomology. I am not a gifted enough teacher to even attempt to explain to freshman calculus students what de Rham cohomology is, so I don't, but I do at least mention to them that it exists, and that it rears its head in very concrete situations. I like to give them the example of a mechanics problem involving a very dense object which blocks a magnetic field, such as the reaction core of a nuclear power plant, which (if the object is sufficiently dense) acts like a "hole cut in space" and means they had best use a physical model with a spherical geometry, and that in an emergency, the accuracy of an engineer's model and that engineer's ability to handle calculus on a non-Euclidean manifold may prevent a disaster (like in the example of the nuclear power plant!). For some students I think this whets their curiosity for higher mathematics, and I think it also has the effect of reminding students that they are in college to become experts in some field, with very real responsilibities attached, and while some students find this idea troublesome, others are energized by it. In any case, it keeps the students who aren't math majors invested in the course.

Other examples I like to mention to remind students of the importance of calculus and higher mathematics in many fields include knot theory and knot mechanics used to model DNA replication in cancer research–this helps to keep the biology students invested in learning calculus–and, for the students of the humanities, I like to mention the anthropologist Levi-Strauss' "canonical formula" which uses an anti-automorphism of the quaternion group to describe changes over time in the myths of a given culture (for the skeptical, Jack Morava has written an account of this, "On the canonical formula of C. Levi-Strauss," which is available on the mathematics preprint Arxiv), and in philosophy, Alain Badiou's project of reducing ontology to set theory, and the use of Riemannian geometry by Deleuze and Guattari to model the way desire operates in Freudian psychology, and the use of knot theory as well as the development of a symbolic algebra by the philosopher Jacques Lacan to describe the relationships between the "Symbolic," the "Imaginary," and the "Real." Obviously I do not go into detail about any of these subjects in a calculus classroom, as no single one of these examples will be of interest to all or even the majority of the students in a calculus class, and most of them demand a deeper knowledge of mathematics than what freshman and sophomore undergraduates will have, anyway; but I think that at least mentioning that these ideas are out there helps to keep some students interested in learning mathematics.

Each of these examples provokes curiosity in some section of students in a mathematics classroom, and I think that the reason this happens is that they remind the student of the life of mathematics outside of the classroom: mathematics was developed to describe structure and pattern in the world and it is the creativity, curiosity, and practical needs of human beings which fuel its ongoing development. Many college students have never seen this kind of vitality in mathematics, and they have never knowingly encountered substantial mathematics outside the classroom. As a teacher I think it is my responsibility to try to reveal some of that vitality of mathematics, some of the life of mathematics *outside* of the classroom, to my students while we are *in* the classroom. So far it seems to have worked well for me.