TEACHING STATEMENT

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Like many mathematicians, I see mathematics not only as a subject to study, but as a lens I use to look at the world. In my classes, I aim to teach students how to view the world through this lens, to apply logical reasoning and abstraction in a wide variety of situations. A common attitude toward mathematics–held by students and non-students alike–is that mathematics is a dry, sterile collection of accumulated statements, which students are supposed to memorize and reiterate on command. So I must also convince students that precisely the opposite is true: that mathematics is useful, flexible, and–most of all–beautiful.

Increasing students' knowledge. First, I must introduce students to and familiarize them with basic mathematical concepts. When I do this in my classes, I look for ways to avoid dry "textbook-style" exposition. For instance, I try to emphasize what motivated people to study these concepts in the first place–while sometimes this involves highlighting how they help solve real-world problems, it can also simply mean framing these concepts as answers to natural questions that anyone can ask. Simply put, students are much better equipped to learn something once they understand why they are learning it.

I also try to continually remind students of the narrative of the class, and the underlying themes that explain the content of the course. This often helps students contextualize the material they learn, and understand the relationships between concepts they have seen at different times during the course. Whenever I can, I like to use adjectives to describe mathematical concepts as well: describing a theorem or technique as "beautiful" or "weird" or "intuitive" helps in the construction of this narrative, and helps convince students that mathematics is an art as well as a science. On homework and tests, I look for ways to test the students' ability to synthesize different concepts from the course; it is far easier for students who have constructed this narrative to integrate the concepts they have learned into a more unified whole.

Creating a learning environment. To help facilitate students' learning, I aim to create an environment where students feel comfortable communicating with me both in and out of class, by asking questions about the material or asking for help with a concept or problem. But in practice, there are several barriers students must overcome before they feel truly comfortable asking questions, regardless of their level of understanding. When they ask a question in any setting, they must feel that they are not wasting the class's or my time, and that they are not being judged adversely by their peers or me.

To encourage participation and overcome these barriers, I tell students repeatedly, "It's ok to be wrong," and "If you have a question or are struggling with something, then you are not the only one." When students do speak up during class, I try to answer their questions with statements that apply to everyone–for instance, if a student makes an algebra error on a calculus problem, I point out situations in which similar errors are easy to make, and explain how to avoid them. Once a student sees that his classmates' questions lead to answers that help everyone in the class, that student becomes much more willing to ask a question as well. When questions are patiently and openly treated as a natural part of a class, students soon gain confidence and become more active in lectures, office hours, and discussion sections. Students consistently praise this particular aspect of my teaching in evaluations.

Employing different teaching methods. This is an aspect of my teaching that has changed a great deal with experience; as a new teacher, I believed that good teaching was largely about polishing and honing elegant lectures and delivering them clearly and concisely to my classes. Certainly this is quite important, but the lesson that students learn in many different ways is one that I am continuing to learn with every new semester of my teaching career. So when I lecture, I try to explain each problem from as many different viewpoints as I can. An elegant proof that convinces a senior analysis student will often simply bewilder a freshman in a calculus class, while a less-rigorous argument based on an example or a picture may satisfy the freshman but not the senior. The language of mathematics is spoken at many different levels, and effective teaching can sometimes be less about the actual ideas expressed in that language than in choosing the correct dialect of that language in which to express those ideas.

Also, my teaching style has been changing, as I have started to use more group work and other alternatives to lecturing in class. In my more advanced proof-based classes, I jump at every chance I get to encourage students to make conjectures based on computations and observations they make. The abstract and formal nature of higher mathematics can be daunting to students of all levels, and I am constantly trying to show students how to understand mathematical theorems and statements in more down-to-earth ways.

In calculus and similar classes, group work is often about helping the students teach each other the material. As a mathematician, as someone who is used to arguing with and convincing other mathematicians, I am constantly reminding myself to let this process happen on its own. For instance, during group work in a recent calculus class, one student was helping another solve a problem, and I found myself resisting the urge to jump into the conversation and add to her (quite excellent) explanation. I am learning that while good teaching is often about knowing what to say, it can also be about knowing when not to say anything.

Staying flexible. When I began teaching, I dreaded the possibility that a student might point out a mistake I had made, or ask me a question that I did not know the answer to. But I have found that such moments almost always stimulate students–they relish the chance to demonstrate their insight and participate in class in this way. So I try to look for opportunities for improvisation when class does not go exactly as planned.

Recently in my cryptology class, I was preparing for a lecture on a particular attack on the RSA cryptosystem. I decided that, instead of working out an example myself and showing it to my students, I would set them up in groups and have them attempt to decrypt each other's RSA-encrypted messages using Maple. I thought that this idea was fairly risky, and I confessed to the students that it might not "work out." Indeed, it didn't–some groups were unable to carry out the decryption. Nevertheless, I believe the students learned much more from this exercise than they would have from a polished example. When the students' computational attempts failed, they took it upon themselves to think about what had gone wrong. Eventually one student discovered that his group had introduced errors in transmission of their messages when they showed them to their would-be attackers, which foiled their decryption attempts. This was an instructive lesson about practical cryptanalysis, although it was not exactly the one I had intended to illustrate! Above all, the students' enthusiasm throughout the class convinced me that the exercise had been a success.

Challenging students. The classes I learned the most from as a student were the ones where the most was expected of me. The best teachers challenge their students and try to raise the students' expectations of themselves. My classes at Berkeley, Georgia, and St. Mary's College have generally been recognized by students as difficult, but fair. Making a class difficult but not unreasonable necessitates a delicate balancing act. To help me gauge the level of the class, I look for signs from the students, through formal feedback, questions I am asked in class and office hours, and in-class exercises. I want students to feel that my class is difficult, but I also try my hardest to make sure that students feel that they will be rewarded for their study and work. At the end of

every semester, I want to be sure that my students have a deep understanding of the material they learned, and I want those students to feel proud, not that they got a good grade, but that their grade reflects that they earned that understanding.

Teaching students how to think. Many people believe that college classes should consist entirely of filling students' heads with knowledge that will be useful in their post-college jobs. But for me, the highest joy of teaching mathematics is showing students how to think critically about mathematics for themselves, to give them the tools to reason through a trigonometry problem, algebra proof, or any other mathematical situation they might encounter.

During classes and on homework and tests, I emphasize conceptual understanding, synthesis of the material, and lucid explanations. I tell the students constantly that they are not expected to memorize lengthy formulas or regurgitate facts or proofs. Whenever I can, I give students all the time they need for tests, and try not to be too picky or punitive about grading. Students eventually realize that they are being asked, more than anything, to *think* about the material and to truly understand it. As my teaching evolves, my ultimate goal will always be to design my classes to motivate and teach students how to think.

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