Statement of Teaching Philosophy

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I have been thinking lately about the difference between macroscopic and microscopic views of teaching mathematics. Like physicists, we can focus either on the large-scale behavior—the rotations of galaxies, the concept of limits—or on tiny scales, examining quarks and particular examples. The tension and interplay between the two scales can be instructive. I have taught a wide variety of courses in mathematics, at several universities and at all levels from "math for poets" to advanced graduate courses. Over the six years and 500-plus students I've seen since earning my Ph.D., I have seen striking differences in backgrounds, attitudes, and abilities. I've also seen that students at all levels benefit most from an emphasis on examples, presented in context, together with the creation of a mathematically challenging atmosphere.

Examples are vital in teaching mathematics, especially in Calculus and pre-Calculus courses. Although mature mathematical theories can sometimes seem like flights of abstract fancy, they grew out of trying to understand examples, and well-chosen examples are still the best way to understand them. Choice of examples can be a subtle problem: the feedback I've received from my students has helped me find the appropriate balance of basic, or "classic," examples versus more sophisticated problems. Too much emphasis on the former can leave the students with the impression that mathematics consists of recipes to work the same problems over and over, while diving right into the hardest applications won't allow them the time necessary to develop their intuition.

Let me illustrate with—what else?—an example. My most gratifying success in undergraduate teaching in the last few years has been MAT183, *Elements of Modern Mathematics,* at Syracuse University. This course, which is designed for students in the School of Management, consists of units on Probability, the mathematics of Finance, and applications of Linear Algebra to Economics. It is taught in a large-lecture format, with about 160 students per section. The format of the course certainly presented challenges for me, since my usual tactic of encouraging vocal participation isn't well-suited to large lectures. By focusing on real-world examples, though, I was able to convey to the students that the material really was relevant to their lives and their careers, and that they should *want* to learn it. Even more importantly, my own enthusiasm let them know that it was okay to be interested in the material. In the end, the course was a complete success: my students performed well above the mean on the uniform final exam, and I got excellent feedback from the students about their experience in the course.

Perhaps surprisingly, examples are equally important in advanced undergraduate and even graduate courses. Of course, graduate material requires a higher level of abstraction and theory than most undergraduate material, but by grounding my teaching in explicit constructions and examples, I have been able to keep the material motivated and relevant, even to students who do not plan to go on to study further in the area. I remind students that mathematics does not spring full-grown from the minds of theoreticians, but grows in response to specific examples. In my own research, I am driven by concrete examples; even if they don't make it into the final journal article, they were the source of my insight and intuition.

Amassing a body of good examples with the students, then, is one of my main goals in teaching. In addition to observing the balance mentioned above between basic examples and sophisticated ones, I believe that what differentiates a good example from a routine one is context. Providing background and hints of what is to come—a small helping of macroscopy—help motivate the students as well as giving focus to the material. Once equipped with a wide variety of concrete examples, together with some idea of the context they fit into, students can easily begin to see the patterns among them, and abstract their essential forms to arrive at theorems and theories. In non-major courses, we often don't even state these theorems explicitly, but recognize them as gestalts that allow us to work similar problems in the future.

When the focus is on examples in context and motivation, it is easy to create a mathematically comprehensive, challenging, comfortable atmosphere for communication in the classroom. There are of course many ways to do this. This issue is on a larger scale than the choices of examples, and I have used several techniques. For example, when class size permits, I have found that having students work in small groups can be marvelously effective. Students learn quickly to experiment without fear, and to take responsibility to think for themselves. Since different students learn best in different ways, I make heavy use of pictures, verbal description, computer-generated images and animations, manipulatives, and complete sentences written on the chalkboard. I always encourage students to be vocal, to jump in with questions and answers, and to answer each others' questions.

The atmosphere I create in the classroom extends outside it as well. For example, I maintain a course web page for every course I teach, with lecture summaries (where appropriate), links to further resources, worksheets, exam solutions, and all the course paperwork. This allows the students to review the concepts and answer their own questions about the course from the comfort of their dorm room or apartment. In a similar vein, I have instituted "virtual office hours," held via Instant Messaging on the computer. Students who are too shy or too busy to attend office hours can ask questions electronically, and get back an answer within seconds. This works surprisingly well, even in notation-heavy courses like Calculus. Similarly, graphing calculators are excellent tools for the students to experiment and visualize at home, as well as for me to demonstrate.

At the smallest scales, then, I focus on choosing good examples that lay the material bare, and presenting them in context. Zooming out one step, I use a number of methods to make the students' mathematical experience challenging and interactive. At the largest scales, however, a mathematics professor has a higher calling, one shared to some degree with all university instructors. Part of teaching undergraduate mathematics is teaching the ability to think mathematically, that is, clearly and deductively. To identify assumptions, examine logical steps, and avoid potential fallacies are skills that are not strictly mathematical, but all students should learn them in university. My class is often the best place to learn them, and concrete applications are often the best avenue.