Statement of Teaching Goals

"Why do I need math anyway?"

In 1994, champagne flowed as British-born Andrew Wiles completed the finishing touches on a proof that finally confirmed the 350-year old "Fermat's Last Theorem", the long sought Holy Grail of mathematics. Two years later, three brave scientists wielded the new weapon of fractal geometry and explained in one fell swoop relationships between body mass, metabolic rate and longevity that physiologists had observed for centuries but remained at a loss to demonstrate on theoretical grounds. And one year after that, I used mathematics to uncover the duplicity of an award letter that, though it guaranteed a prize of at least $1, involved a process that would cost the average gullible respondent $23.50.

"Why do people need math?" is a question that I hear repeatedly and one to which I could provide more answers than most care to hear. As an instructor of mathematics, today's value climate forces me to keep in mind the goals which motivate my teaching. I share these goals with every introspective mathematics teacher who knows how to simultaneously look back at his or her own footsteps even while observing the countryside ahead. My objectives in teaching mathematics are twofold. Firstly, to teach mathematical concepts and develop an ability to manipulate these concepts so as to provide the foundational underpinning of a specific profession. Secondly, to teach my students to think reflectively using mathematics and to make the jump from having knowledge to understanding that knowledge. Any enterprise that involves precise quantitative and qualitative analysis falls within the scope of this endeavor.

Unfortunately, prejudices prevent taking a direct route to reaching one's goals. During my first two years of teaching, I quickly discovered that freshmen do not arrive at the university with clean slates when it comes to mathematics. Many fear math, categorically dislike math, or "know they're just not got at it." Often times shortsighted utilitarianism ("Is this going to be on the test?") dogs the well-intentioned instructor at every new step, questioning the scope and purpose of mathematics. On the other hand, it is hard for instructors not to deplore the average freshman's abilities since their crippling algebra mistakes (which should have been eradicated many years before college) testify to a fundamental miscomprehension. Mathematics is a deep subject: its branches build on each other. And without a solid foundation, any structure will fall.

I am by no means qualified to discuss the root causes but the problems are real. Some possible sources include woefully deficient school programs, bag-of-tricks-oriented learning, high school teachers armed with little post-undergraduate experience, or the effects of an ill-informed postmodern philosophy of mathematics. I am not able to confront these causes directly but my teaching must overcome them. Fear, poor mechanics and a lack of understanding confront me daily in the classroom so I must address these, either directly or indirectly, as I strive to effectively communicate with my students. Each distinct course, each different class and every individual student requires a slightly different approach but some principles apply across the board.

In America, as opposed to many other countries, we view teaching as a highly social function. Teachers interact more with students during lectures, in discussion sections and even outside of the classroom. Consequently, my first strategy when I teach a new class is to establish some form of rapport, either through greeting students personally or by some other initial exercise. Before the first class of a course, I memorize students' names and then during that class I ask them to tell me their first name and I respond by giving them their last name. This simple game invariably catches students' attention and shows them that I must care about them to have spent time learning their names.

Throughout the rest of the course, I strive to foster an atmosphere of mutual respect, strongly encouraging students to work with me individually whenever the opportunity arises. Even in the subtle details of interaction, I try to implement habits that aid students. For example, I know better than to ask, "Does anyone have any questions?" without pausing long enough to show that I truly welcome their queries. When I taught *Applications of Algebra*, a general education course that many

undergraduates take to fulfill their math requirement, I sensed that a number of students knew they needed help but felt too intimidated to visit me during office hours. Consequently, for the rest of the quarter I reserved a room in the library and changed my office hours to "study sessions". Suddenly, the number of students coming for help rose significantly.

Over time, I've adapted my lectures to incorporate audiovisuals and the Internet. When learning a skill, I believe students need to see the process of how I progress from one logical step to another and hence I still use the blackboard during most of my lectures to present concepts. However, when dealing with complex geometric objects such as those presented in *Multivariable Calculus* or *Chaos & Fractals*, I employ a computer projector and overheads to help students develop a more accurate geometric intuition. I also utilize overhead slides when I feel the material focuses more on the presentation of certain facts rather than the development of fundamental skills. Either way, I always try to create ways to keep students interested even if the material itself isn't inherently captivating. As for using the Internet, I've begun to create course webpages to which I attach study guides, answer sheets, challenge problems and Maple® programs that help with projects.

When I organize my lectures, I remain aware of the utilitarian aspect of modern education and I constantly point out applications of the material we cover in class to current scientific research or to other branches of inquiry. For example, when I teach engineers, I find out ahead of time what other classes many of my students take concurrently and during the course of my lectures present examples in physics, circuits or economics that may be relevant to those classes. Sometimes, I season my lectures with historical notes but I usually prefer to remain forward looking, emphasizing more how mathematics is a part of the future than a part of the past. Furthermore, as often as possible, I clearly point out why I cover something at a given time by explaining how we will apply it later on.

As I provide vistas into other areas of math and science, I consciously choose nontrivial examples in class. My personal journey of learning and my interaction with students have convinced me that students learn through examples. Thus, not only do I work through simple examples to illustrate the theory I teach, I also carefully select difficult examples that show how to use mathematics creatively. Then, on homework, quizzes and projects, besides questions that test their mechanical skills, I always pose non-rote problems that challenge their understanding. In fact *Chaos & Fractals*, students love and learn from the two guided research projects I assign. No matter what material I teach, I always encourage students to wrestle with questions that probe their understanding because those who refuse to give up invariably profit from the exercise.

The last major tactic I use requires a lot of time on my part but I persist with it as I believe it helps students more than they sometimes realize. I grade all quizzes, homework and tests and return them with comments by the next class. At times, to emphasize that they need to read my comments, I refrain from assigning a numerical grade and simply bring their attention to errors in their argument, flaws in their mechanics or areas they could investigate further on their own. Many professors have abandoned the practice of collecting and correcting homework but I still believe this habit is essential for students to acquire the skills we teach them.

Universities pride themselves on preparing students for a profession. Given the university's particular role in modern society, mathematics instructors must concentrate on communicating knowledge, presenting valuable concepts and honing students' skills. Superimposed on this goal, we strive to deepen our students' understanding, for it is this understanding that allows one to develop new knowledge from what is already known. So whether my students go on to explore the foundational principles of science, program the next popular telecommunications public key cryptosystem, obtain a position at a large engineering firm or find gainful employment in any other sector of society, I strive to provide them with an education that benefits them in every aspect of work and helps them avoid becoming the next "gullible respondent".