Jeremy L. Martin
Teaching Philosophy and Experiences

The key word for me in teaching is *challenge*: I expect a lot from my students and I work hard to give them the tools they need to learn. I practice the same philosophy with many different students: liberal-arts majors convinced that mathematics is impenetrable, computer scientists wrestling with the demands of mathematical rigor, talented high school students taking advanced courses, and undergraduate mathematics majors doing their first research I make sure always to remain accessible to my students, and to teach in such a way that they have an opportunity to succeed.

1. Excursions in Mathematics

I've lost count of the people sitting next to me on airplanes who, upon discovering that I am a mathematician, confess, "Oh, I was never any good at math," or, "I used to like math until I took calculus." What an opportunity! More often than not, a few words of encouragement and some scribbling on napkins elicit "Hey, that's pretty neat!" or "Is that all there is to it?"

In the fall of 2003, I was one of two instructors for Math 1001, "Excursions in Mathematics", a course aimed at liberal-arts majors who needed to satisfy a mathematics requirement but were either unwilling or unqualified to take a calculus class. The syllabus centered around the mathematics of voting and fair division, some elementary graph theory, and enumeration: topics with lots of evident applications, and that require little technical background to understand. Indeed, many of my students were shaky at algebra and even arithmetic—solving a linear equation on the blackboard was about the most I could get away with, and presenting a rigorous proof of anything at all was out of the question. Teaching the course was like sitting on an airplane with sixty people.

In order to emphasize the concrete aspects of mathematics and its power to model reality, I drew as many pictures and as few equations as possible. I enlisted the students' help in finding topics for lectures (for instance, polling them on their favorite pizza toppings, then comparing the results using different voting methods). I don't mind if my students laugh at me when I scribble on a cauliflower with a dry-erase marker (to show how the Fibonacci numbers occur in spiral growth). If they're laughing, they can't be bored. Perhaps not every single student responded well, but I had some unquestionable success stories, such as the student who planned a trick-or-treating itinerary for her three-year-old son, using all the Traveling Salesman Problem algorithms we had studied in the class. Here is someone who is not going to be intimidated by mathematicians on airplanes.

2. Graph Theory

This semester (Fall 2004), I am teaching Math 5707, an upper-division course in graph theory. Most of my students are graduate students in computer science, with a few mathematics majors as well. I think the interaction between the two groups is good for everyone involved. Because graph theory has so many applications, I want even the purest mathematicians among my students to understand the point of view that a theorem is only as useful as the algorithm that can be obtained from it. (For instance, Hall's Marriage Theorem, which provides a necessary and sufficient criterion for a bipartite graph to have a perfect matching, has a straightforward and elegant proof, but checking Hall's criterion is computationally infeasible.) On the other hand, I want the computer scientists to be willing to think abstractly—to understand the underlying mathematics without worrying about computational or algorithmic issues. (To continue the example, Hall's Theorem can be used to prove the König-Egerváry Theorem, which in turn suggests the form of an efficient algorithm to compute maximum matchings.)

In order to help my students learn effectively, I post detailed lecture notes, complete with lots of figures, on the course website at `http://www.math.umn.edu/~martin/math5707/`. Graph theory being what it is, I often need to use an elaborate diagram to explain a theorem or algorithm, and I don't want my students to spend all their time during lectures frantically copying down all forty-seven edges of some complicated example. With the notes available online, my students are able to focus on mathematics in class; they can always check the details later if necessary.

3. Work with Young Mathematicians

In the summer of 1997, I worked at Canada/USA Mathcamp, a five-week program for talented high school students. I was told that my duties would include hanging out with the kids, helping with homework, providing something of a voice of experience, occasionally giving a lecture if I so desired. In reality, I was one of a "Junta" of five—including one full-time faculty member and the other three graduate student counselors—who ended up running the camp. In addition to my teaching and mentoring responsibilities, I found myself distributing dorm room keys, renting school buses for weekend field trips, finding housing for visiting faculty, and getting very little sleep.

The students made it all worthwhile. The Mathcamp kids are quick learners, enthusiastic problem-solvers, relentlessly curious about everything from Nim to point-set topology to Cantor's diagonal argument, building models of four-dimensional polytopes in the hallways, reciting digits of π over lunch (to the astonishment of a non-Mathcamper who blurted out, "You know the whole thing!") Over the next year, the "Junta" put many hours into planning Mathcamp 1998, succeeding in eliminating much of the organizational chaos that had plagued us in 1997. The demands of graduate school kept me away for a few years, but I returned as a visiting faculty member in 2003 and 2004, to an atmosphere just as intense and exhilarating as before.

Here at the University of Minnesota, I've had the opportunity to work with high school students under the auspices of the Institute of Technology Center for Educational Programs (ITCEP). Last year, Peter Berman, Jennifer Wagner, and I collaborated in teaching two three-hour seminars on mathematical puzzles and games. We discussed topics including Nim, computer chess programs, and the Rubik's Cube, guided the students through the process of experimentation and conjecture, and showed them how to use abstract ideas such as groups and graphs to solve concrete problems. I'm currently planning a seminar on the Tutte polynomial of a graph (one of my favorite things in all of combinatorics), and a summertime short course on computational algebraic geometry. These topics sound ambitious, but Mathcamp has taught me again and again that high school students are eminently capable of grasping the necessary ideas.

I've greatly enjoyed my work at Mathcamp and ITCEP, and I want to deepen my involvement with younger mathematicians by supervising research projects for undergraduates. (Combinatorics, the main area of my own study, is well suited for such projects: the field is rife with mathematically substantial problems that require little machinery to study.) My own first research experience came as an undergraduate, one of a group of six in an NSF-sponsored summer program at Mount Holyoke College led by Prof. Harriet Pollatsek. Harriet chose an appropriate problem, mathematically substantial but accessible without requiring much technical background. Throughout, she provided enough guidance to keep us on track, but mostly stepped back and gave us the space to learn for ourselves—just the right balance. Here at UMN, I've watched Prof. Victor Reiner take the same approach with his summer research students. These are the examples I want to emulate, and they fit my philosophy: I want to challenge my students to succeed, and to give them every chance that I can to do so.