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TEACHING EXPERIENCE AND PHILOSOPHY

My primary goal as a classroom instructor and research supervisor is to convey to students a deep understanding and appreciation of applied mathematics, including both its theoretical foundations and the mathematical modeling of scientific phenomena. In 2003, I received an American Mathematical Society Project NExT Fellowship in recognition of these efforts.

At the departmental level, an ideal mathematics program at a research institution fosters not only research excellence but also significant one-on-one interactions (in both quality and quantity) between its faculty, postdoctoral scholars, graduate students, and undergraduate students. Such interactions are also integrally important at schools that do not grant a mathematics doctorate, although only a subset of the career stages I mentioned might be involved. An undergraduate education in mathematics and science can *begin* fruitfully in classroom settings, but other learning experiences such as individual research projects and seminars geared explicitly towards students are crucial. At the graduate level, it is accordingly essential to involve Doctoral and Masters students not only in their personal research but also in other facets of the department's academic environment such as colloquia and undergraduate education.

In the remainder of this teaching statement, I summarize my student research supervision, teaching experience and course development, teaching philosophy, and educational service activities.

RESEARCH SUPERVISION

As a postdoctoral scholar at Caltech and a VIGRE visiting assistant professor at Georgia Tech, I have advised and co-advised more than twenty undergraduate students since 2003. Several of my research advisees have since garnered awards for their research and enrolled in doctoral programs at top institutions. Some of these research projects have even resulted in publications in refereed journals.

Because of my interdisciplinary background and diverse research interests, I have often worked with other colleagues (in mathematics, physics, and biology departments) in advising student research projects covering a wide variety of topics. Such close interactions with faculty with varied backgrounds have proven very beneficial both for my students and for me.

The following projects provide a few concrete examples of my work with undergraduates:

- I advised Georgia Tech electrical engineering major Vivien Chua (now a doctoral student in applied mathematics at Stanford University) on a project concerning spatial resonance overlap in Bose-Einstein condensates. This work led to a publication in *International*

Journal of Bifurcation and Chaos.

- With biologist Christopher Klausmeier and mathematician Leonid Bunimovich, I advised two Georgia Tech students (electrical engineering major Leo Dachevski, now a doctoral student in quantitative finance at Georgia Tech, and discrete mathematics major Julie Bjornstad, now a masters student in urban planning at University of North Carolina, Chapel Hill) on the interaction dynamics of plankton under periodic fluctuations of resource levels.

- With mathematician Peter Mucha, I advised three Georgia Tech students on projects in network theory: applied mathematics major Thomas Callaghan (a Goldwater Fellow who is now a doctoral student in applied mathematics at Stanford University) developed a ranking system for collegiate football by examining the dynamics of random walkers on the network of games played; discrete mathematics major Casey Warmbrand (now a doctoral student in mathematics at University of Arizona) studied the community structure of committees and subcommittees in the United States House of Representatives; and discrete mathematics major AJ Friend (also a Goldwater Fellow), continued where Casey left off on the Congressional committee network project. The work on the ranking system led to a research article in *American Mathematical Monthly* and an expository article in *Notices of the American Mathematical Society*. Thus far, the work on Congressional networks has resulted in a publication in *Proceedings of the National Academy of Sciences*, a second paper currently under review, and a winning entry in the nonlinear science gallery at the 2006 American Physical Society March Meeting. AJ and Caltech undergraduate Yan Zhang, a double major in mathematics and computer science, are presently studying both the committee networks and legislation cosponsorship networks in Congress.

- I advised Georgia Tech electrical engineering and mathematics double-major Steven Lansel (who was named a Goldwater Fellowship finalist and is now a doctoral student in electrical engineering at Stanford University) on a project concerning the development of a graphical user interface (GUI) to simulate classical billiard systems in Matlab. Once the interface was completed, the second part of this project, advised jointly with Leonid Bunimovich, was the study of the dynamics of billiards shaped like (generalized) mushrooms. In addition to the GUI, this project led to a research publication in *Chaos* and an expository publication in *Notices of the American Mathematical Society*.

- I advised Caltech physics major Eric Kelsic on a project entailing the study of communities in collegiate social networks, as determined by friendships listed in the Facebook. My collaborators and I are presently building on Eric's research (using both the Facebook and Congress data) and have recruited a student to undertake this work in Fall 2006.

To further expose my students to current scientific research and give them opportunities for one-on-one interactions with mathematicians and other scientists, I have encouraged them to attend and present their work at academic conferences. In January 2004, for example, four of my students presented posters at a nonlinear dynamics conference (Dynamics Days) held in Chapel Hill, NC. Three of my other students presented posters at Ohio State's 2004 Young Mathematicians Conference, which I also attended.

While in graduate school at Cornell, I spent three summers (2000-2002) mentoring students as part of the Mathematical Theoretical Biological Institute (MTBI), an undergraduate REU run by Carlos Castillo-Chavez that offers research opportunities to women and underrepresented minorities. Like my research mentorship, my role in MTBI included lots of "hands-on" interactions with students. I not only helped out on homework assignments (as would a canonical teacher's assistant) but also advised two research projects and helped teach the students how to disseminate their results in lecture, poster, and paper formats. Additionally, I co-organized minisymposium sessions at the 2002—2005 SIAM Annual Meetings to showcase the achievements of past MTBI students. For the first of these sessions, I also helped organize an MTBI field trip to the SIAM meeting so that the current REU students could see their peers speak and be exposed to a diverse selection of applied mathematics research.

TEACHING EXPERIENCE/INTERESTS AND COURSE DEVELOPMENT

To help bridge a gap in Georgia Tech's undergraduate curriculum, I developed and taught an undergraduate course in mathematical modeling that encompassed both traditional topics such as perturbation theory and solitary waves and "modern" ones, such as complex networks and synchronization, that have become very important research subjects in applied mathematics.

I enjoy teaching a wealth of subjects in applied mathematics covering both applications and their mathematical foundations. Among the topics I like to teach (at both the undergraduate and graduate levels) are dynamical systems, ordinary and partial differential equations, perturbation theory, asymptotic analysis, and complex analysis. More specialized courses I would like to develop and teach include ones covering complex networks, Hamiltonian dynamics, and nonlinear waves. Among more elementary subjects, I especially enjoy teaching introductory classes in differential equations, as I can pepper such courses with both famous examples (like the brachistochrone) and classroom demonstrations (using, for example, a tabletop double pendulum) to help motivate the course material.

At the undergraduate level, I have taught introductory ordinary differential equations (Spring 2005), mathematical modeling (Spring 2004), complex analysis (Fall 2003), and vector calculus (Fall 2002). I also taught (in Fall 2004) a modeling and dynamics course for Georgia Tech's Masters program in bioinformatics. At Cornell University, I served as a teaching assistant for an introductory graduate course in mathematical physics (covering the mathematical foundations of quantum mechanics) and an advanced undergraduate course in dynamical systems. As an undergraduate at Caltech, I taught an introductory class in probability theory and spent five terms as a teaching assistant for courses in the calculus and linear algebra sequence.

Classroom TEACHING PHILOSOPHY

In my courses, I attempt to convey to students a deep understanding and appreciation of applied mathematics, including both its theoretical foundations and the mathematical modeling of scientific phenomena. To achieve this goal, it is essential that my students learn the course curriculum's underlying mathematical concepts—not just how to manipulate the formulas and equations used to represent them—and how to apply them to situations that build on rather than simply repeat the ones they have seen before in the lectures and textbook.

My teaching approach depends on the level of the course involved. In advanced courses (with more mature students), I believe that students learn the requisite class material more effectively with projects rather than with examinations. While I find this more difficult to implement in elementary courses (in which tests are often necessary to help motivate the students to study), I assign extra credit material as a tool to give students opportunities to work on small projects that extend the material beyond the homework and exam problems.

When I teach graduate and advanced undergraduate courses, I find it advantageous to assign both a class project and a final "untimed" (take-home) exam, which essentially functions as a final homework assignment that ties together the material covered throughout the term and allows my students to explore the course curriculum in greater detail than they could with a traditional timed exam. The project in my Fall 2003 complex analysis class, for example, required my students to write a term paper consisting of a lecture on an advanced topic I did not have time to cover in class. This served two purposes: First, I disseminated these papers to the entire class to give them a flavor of the breadth of topics in complex analysis. Second, this assignment forced each student to review relevant background material (covered explicitly in the course) in order to successfully complete his/her project.

While I use in-class midterm and final exams as motivational tools when I teach freshman and sophomore courses in the core mathematics curriculum, I encourage students to delve deeper into the course material and relevant side material by offering extra credit assignments (which can be oriented towards theoretical concepts, applications, history, etc.). In my vector calculus course, for example, my extra credit assignments included writing a two-page biography on some mathematical scientist whose research was discussed in the course, examining relevant problems using computer software, and attending a seminar I gave based on the work of undergraduates I had advised the previous summer. I also encouraged my vector calculus students to attend a campus workshop on the use of computer algebra programs to study calculus and let them know about colloquia that I felt would be (relatively) accessible to undergraduates.

Educational and Service Activities

I have also contributed to my institutions' teaching environments through the initiation and organization of various seminar series.

During Georgia Tech's 2004-05 academic year, for example, I co-organized the mathematics department's weekly dynamical systems seminar. In September 2004, I organized a public lecture and book signing by Steve Strogatz, sponsored jointly by the math and physics departments, which was attended not only by Georgia Tech professors, graduate students, and undergraduates, but also by local Atlanta residents. During the 2003-04 school year, I organized the math department's "Research Horizons" seminar, whose purpose is to introduce graduate students to the breadth of research conducted by Georgia Tech's mathematics faculty. In the Spring 2004 semester, I organized these talks jointly with one of the department's graduate students to help prepare him to take over organizing these seminars the following fall.

I was also active in seminar organization as a graduate student at Cornell. In Fall 2000, I instituted an interdisciplinary graduate student seminar series in the mathematical sciences (described in the December 2002 issue of the *Notices of the American Mathematical Society*), which I subsequently organized for three semesters. (This seminar is still running and has become an important part of the applied mathematics doctoral program at Cornell.) During the Fall 1999 semester, I organized an already-established seminar series (which is similar to Georgia Tech's Research Horizons talks).