Teaching Statement

My teaching philosophy is simple: Mathematical intuition and logic are fundamental to developing the problem solving skills of students of all disciplines. Not all students are destined to become scientists. All students will need to be able to critically think on their feet when presented with complex problems. More than seven years of teaching experience have shown me, among other things, that it is important to engage students using real life applications. Working closely with students has helped me to get another perspective on my own research and teaching skills. I have a strong interest in developing optimal strategies for teaching mathematics to students of all backgrounds and fields of study. As my career develops, it becomes more apparent that teaching and research go hand in hand. I would like to continue to challenge students with open ended questions and pose current, real life problems to help establish foundational knowledge as well as honing research skills. It is important to me to not only stay current in the world of research, but to also develop parallel programs for students so they can learn contemporary problem solving.

Due to my exceptional performance in core mathematics classes, in my third year as an undergraduate I was appointed to my first collegiate teaching experience as an assistant in the Basic Skills program at RPI. I participated in this program as an assistant for Calculus 2 and Differential Equations. I had the responsibility of teaching a recitation separate from that of the graduate teaching assistant to improve undergraduates' knowledge and retention of the fundamental skills of calculus and differential equations. This was an excellent way of enhancing student learning by providing providing them with a TA closer to their own age that they could feel more comfortable approaching about problems in the course. Because of my achievements in this program, I was selected as a student representative to discuss the merits of this program at the National Consortium for Specialized Secondary Schools of Mathematics, Science and Technology in San Antonio, Texas in May of 2005. These early experiences really sparked my passion for teaching and gave me a strong foundation for developing communication skills necessary to be an effective mentor and researcher.

My research and teaching accomplishments helped RPI's Math Department to obtain an NSF grant for the Computational Science Training for Undergraduates in the Mathematical Sciences (CSUMS) program. I then became the Research and Teaching Assistant for this program. This program set out to develop students' computational and analytical research skills in order to better prepare them for careers and graduate study in the sciences. During the first part of the semester, I gave Matlab and LaTex lectures, graded the homework and provided office hours and tutoring for all of the students. As the semester moved forward, the course became more research intensive. Students broke into groups based on their chosen research topics, ranging from the Maillard reaction to modeling materials with a negative index of refraction. I served as an advisor for all of these groups - it was my job to be familiar with all of the students and their research topics. It gave me great joy to be able to spend individual time with the students working on their specific problems and getting to hear their unique difficulties and ideas. Being able to discuss problems in an intimate environment with bright young minds helped to develop my skills as a research scientist as well as to hone the skills of the students. I then partook in choosing the students who received funding during the summer, as well as continued advising and teaching during the summer months and running the weekly research seminars. I was involved in this program for 3 semesters, and I trained a new CSUMS Teaching/Research Assistant when my own research funding began.

Also while a graduate student at RPI, I developed and ran problem training sessions for the Mathematical Contest in Modeling. The format of these problem sessions have proved to be an indispensable teaching tool, and I continue to develop and run this contest as a postdoctoral fellow at the Courant Institute of Mathematical Sciences. During a practice problem session, students are posed with real world problems, such as how to design an efficient and cost-effective traffic circle, for which they then must develop and test solutions. I start the session out with a mini-lecture about some of the mathematical principles that can be used to attack the problem, and then give the students the following outline of problem solving:

- Formulate physically realistic assumptions that constrain the problem. Is there a maximum/minimum speed that must be maintained upon entering the traffic circle? For a given radius, is there a maximum/minimum number of entrances/exits? Can car crashes be ignored?
- Research the problem's history. How are various traffic circles around the world laid out?
- Decide mathematical methods to be used. We might want to utilize queuing theory and the idea of a Poisson process to realistically simulate traffic flow.
- Identify key variables and parameters. We can say that the density of cars at a location x at time t is $\rho(x, t)$.
- Outline an algorithm. First, run simulations of cars arrive according to a Poisson Process at various amounts of entrances and arrangements of traffic signals. Assign a score to each arrangement based on the amount of time it takes for cars to enter and leave the circle. Determine a best score and best arrangement.
- Analyze your methods. Was it really realistic to assume that crashes can be ignored? How sensitive is the model to changes in traffic light timing or placement of signs?

After several weeks of these practice sessions, the students are prepared to complete a scientific research paper addressing a new real-world problem in the four-day contest period. This method of open problem solving promotes critical and creative thinking and adaptive learning rather than rote, inefficient memorization. My role as an advisor for this contest has revealed the merits of open student discussion, peer review, group research and inquiry/problem based learning. I utilize these techniques in the classroom as well.

While teaching a class like the Mathematical Contest in Modeling sessions would certainly be a dream come true, it is also important to realize that not all classes can or should be taught with such freedom. Many require more structure, especially for less experienced students - we want to reach ALL the students, not just the highest achieving ones. I want to inspire the love of math in students of all ages and academic backgrounds.

Teaching Calculus II at NYU has been a great exercise in appealing to students of all mathematical backgrounds as well as in creating innovative methods of student engagement. I do not have complete control over the course curriculum, but I am able to give my own assignments and design my own lectures. I find that lecturing for an entire 110 minute period is optimal for neither the students nor myself. I created worksheets to accompany lectures that the students work on in groups of two or three. These worksheets will often emphasize some practical applications of the topic we have covered, revealed through a step by step problem process. During the section on Improper Integrals, students were required to find the distance a particular plant could disperse its seeds through the use of a probability density function. When introduced to differential equations, the worksheet guided the students through a derivation of a model for arterial pressure. I also emphasize interesting mathematical properties that reveal the beauty of pure mathematics. One of my favorite problems is using inscribed polygons to approximate the circumference of a circle, which encompasses the topics of limits, integrals and series as well as teaches a bit of history on the estimation of digits of pi. I would love to be able to develop core Calculus curriculums for a variety of disciplines, each curriculum emphasizing the skills most important to that particular field.

One of my current projects outside of my required teaching is reviewing and creating problems for the Illustrative Math Project. This project provides a forum for professional mathematicians to contribute and edit problems that teach core primary math material in new, creative ways. My plan is to eventually develop a collegiate-level extension of the Illustrative Math Project that can be used in tandem as well as a resource for colleges everywhere. This semester I have been participating in NYU and Columbia's joint NYC Teaching seminar, which is a great medium for exchanging secondary mathematical education resources and ideas with colleagues that we are not able to interact with daily. I am learning to use more computer software and visualizations, such as those produced by Mathematica in my lectures. I enjoy using Matlab regularly as a research tool. There are an overwhelming number of excellent open source educational resources available online. The Wolfram Demonstrations project and their new computable document format (CDF) have both proved to be indispensable teaching tools in my current Calculus II classroom. I am greatly looking forward to designing my own Math Modeling course in the Spring 2013 semester at NYU. I have designed, given talks about and would love to implement a Calculus for the Natural and Physical Sciences.

The processes of teaching and being taught are essential not only for the development of student knowledge, but also for one's own development as a research scientist. My intention is to teach critical thinking skills regardless of a student's background or intended occupation. All students need to learn to think clearly and logically when posed difficult questions. I look forward to a lifetime of teaching and learning.