Teaching Statement

Jonathan P. Hanke

Teaching Philosophy

The most effective teachers I have known are those whose classrooms are places of exploration, marked as much by their openness and willingness to work through their students' perspectives as by the clarity and simplicity of their exposition.

My approach to teaching is twofold: to illustrate the main points through supporting examples, and to lead students to these points through an ongoing conversation about our evolving course goals.

In each lecture, I focus on conveying one or two main ideas. These are supported with motivating questions and examples designed to illustrate why one might naturally think this way and why it is interesting to us.

I try to keep my general style very casual and down-to-earth, so that students feel I am approachable and are comfortable asking questions. I am proactive about learning my students' names – and have several times asked students in larger classes if I can take their pictures to use as flash cards. I also make time for students with questions or general interest in some area of the course or mathematics. These have been some of the most personally rewarding experiences for me, and provide students with valuable encouragement and guidance in learning to explore things for themselves.

Teaching Experience

My teaching experiences of four semesters of Calculus (both I and II), one semester of Linear Algebra, and three semesters of Cryptography for non-majors have shown this teaching style to be highly effective at motivating students to engage course material through their natural curiosity to understand what is going on.

Calculus I at Princeton University – Most recently, I have been involved with improving and coordinating the Calculus I course at Princeton University. This is a university-wide course taken mostly by freshmen to satisfy their mathematics requirement. Aside from revising the syllabus and homeworks, I have made a comprehensive effort to improve the consistency of the course (across all 10 sections) and to provide more review resources for students than the usual "classroom/office hours" model provides. Together with the Director of Undergraduate Studies, I setup weekly lunch meetings for instructors to share ideas about the material for the upcoming week, and arranged for all of the lectures (from one section) to be videotaped and made available to students for viewing online. In addition to this, I created many more review opportunities for students in the form of weekly review sessions, a comprehensive set of review problems for the exams with online answers, and several days of 2–3 hour review sessions before exams both for course review and problem solving. While not requiring substantially more man-power to impliment, these changes greatly improve the ability of the course to accomodate students' varied study habits, which is particularly important given its predominantly freshman enrollment. These changes have been well-received by students, and will likely become a lasting model for the way this course is taught in future years.

Graduate Student Support – In terms of graduate education, through the VIGRE program at Rutgers I led a semester-long reading course with two graduate students interested in number theory. They read most of Gouvea's book "p-adic numbers", and then gave a 30 minute presentation on a related topic. One was an introduction to p-adic numbers, and the other was an application of p-adic techniques to the Hasse principle for quadratic forms over $\mathbb{Q}$. I have also tried to encourage and assist graduate students in learning new topics. Along these lines, I led an informal weekly support seminar for graduate students who were having their first experiences in algebraic geometry, which lasted for one semester. This involved discussing problems and ideas from the first two chapters of Hartshorne's book, with a focus on the classical phenomena that motivate the more sheaf-theoretic language of the subject. Additionally, I have been closely involved with several informal graduate student seminars focusing on various aspects of automorphic forms.

Topics in Cryptography at Rutgers University – One of my more interesting teaching experiences was when I was asked to teach the honors section of Math 103, which was a course for non-math majors addressing topics in cryptography.

This was an innovative and fairly new course with a "math for poets" style, which focused on an appreciation of the mathematical issues and general structure of cryptography with very little mathematical content. One of its main goals was to engage the public policy consequences of this rapidly changing subject, and for students to be informed enough to have an opinion about them. Since I wanted to focus more on the mathematics, I decided to redesign the course to illustrate many of the same issues through a working, example-based, knowledge of various classical and modern ciphers. This had the advantage of grounding the issues in the students' experience, as well as providing tangible skills students could measure their progress by. However, maintaining the original spirit of the course, I arranged for guest lecturers with professional cryptographic affiliations as well as discussions of current events and student presentations for extra credit. This helped illustrate the timely nature of the topic, and its relation to the world at large. The course was divided into two halves, each of which had an in-class and take-home test. The in-class test was designed to test a general appreciation of the issues involved, and the take-home tested cryptographic proficiency and involved cracking/decoding various ciphers.

The first half of the course focused on classical cryptography (letter relabelling and rearrangement) and various attacks which can be used to break many such schemes. The students were responsible for evaluating the security of these schemes, and for cracking them if they were insecure (by various statistical attacks). These ciphers included the shift cipher, cryptogram (without spaces), permutation cipher (of size < 9), Vigenère cipher, and the one-time pad. The second half of the course focused on public-key cryptography and developing the necessary proficiency with modular arithmetic needed to implement these. Mathematically, this included a discussion of primes, units, multiplicative inverses, the theorems of Fermat and Euler, and primitive roots. With this, we covered RSA, Diffie-Hellman secret sharing, and ElGamal. The students were responsible for creation of their own public/private keys, encryption and decryption, digital signatures, and key management issues. We also discuss related security issues such as: what is a "hard" problem, why ciphers are based on "hard" problems, and the man-in-the-middle attack.

All computations were essentially done by hand (student were allowed to use a small calculator, but no computers), which gave a tangible appreciation for the computational complexity of various cryptographic operations and ensured that students really knew what they were doing.

It was impossible to find an adequate text for the material, so there were many handouts. To help with this, I created a course web page with homeworks and many lecture summaries as well as various C programs to compute the relevant statistics and aid in the creation of the exams. While primarily designed to help students, these will be a valuable resource for the next instructor and will provide a sense of continuity and a solid starting point for any future changes.

This more rigorous style in a course for non-math majors comes with the possible pitfalls of discouraging those with weaker backgrounds and obscuring the issues with mind-numbing mathematics. However students seemed quite interested in this more hands-on approach, and the course has consistently received high evaluations, with comments like: “Jon allowed me to look at math like I have never seen it before”, “The teacher was outstanding”, and “If I were stranded on a desert island, I would want him with me”.