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Statement of Teaching Philosophy

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1. My teaching goals

I want my students to *own* the mathematics, and I accomplish this by focusing on fixing problem areas. I noticed as a calculus TA that many students rely on their calculators because they do not trust their arithmetic. Thus in my lecture courses, I stress the process a student uses to get an answer over whether the student has simplified 8!/6! to 56. In this way we focus on the process of mathematical reasoning, a much more versatile and necessary skill in everyday life than that of quickly adding several numbers together. We talk about determining what a story problem is asking and how to model it, and if the students struggle, I encourage them to make up problems that they do know how to answer and to compare their problems to the ones they've been assigned. This helps us pinpoint where the learning challenge is. As the students become more comfortable with the methods, going back and reducing fractions comes easier as well; I have had several cases in which calculator-clutching "numerophobes" turned into careful arithmeticians through this focus on developing the algorithm.

The previous goal describes what the students should get out of the course as a whole, but much of teaching is about helping students engage with the material from day-to-day. In the several dozen desks in front of my chalkboard sit a discriminating audience that doesn't always know how to appreciate mathematical culture. My duty is to catch their attention by persuading them to care about the mathematics at hand. My energy plays a key role in how much my students pay attention and learn. If I think a theorem is cool, I need to convey that to the class because that is why I want to be teaching that theorem. This is the "why" of the lecture.

Then there's the "how:" creativity and flexibility. Although I scrupulously plan most lectures, I enjoy following the lead of my students' questions. In order to handle whatever is thrown at me, I spend time thinking about where questions might arise as well as various ways to interpret the concepts. This extra preparation often blossoms into helpful activities or review sheets that I distribute from time to time for my students. In the linear algebra course I taught in Fall 2006, I adapted this idea into sample true/false questions at the beginning of class that covered problem material from the previous lecture. The true/false questions addressed the students' past struggles with similar problems on exams and the ideas about which they had seemed confused; they also focused students at the beginning of class and provided a neat transition into the new material to come.

I need to become part of my students' learning community by being *available* to go over homework questions, give extra examples, listen to a student's frustrations, or just to learn how they think. If a student remains intimidated by me, I haven't done my job of being an accessible, impartial, relatable teacher. Often it turns out a student's struggle is not with my class per se, but with learning how to take notes, to pay attention in class, or to manage his/her time. I once had a student who never made it to office hours because that was the only time during the day she could eat, so I offered to help her at the student union while she had a sandwich. I take effort to understand my students, their background, strengths, and learning styles. This is why I put a high priority on learning names, by passing back homework myself for the first few weeks. I also take surveys at the beginning of the year from my students so that I learn a bit about who they are as people. In the finite math classes, I used information from the surveys to design counting and statistics problems about the class that showed up in examples and on exams.

In any type of course, it is my duty as a mathematician to help students learn the language, methods, and theorems of the subject; it is also important that I relate the subject to its place in the broader scientific world: why it was developed in the first place, who uses it now in applications, and how a research mathematician might use it or improve upon it today. I don't achieve this broader goal consistently, but it is an ideal in my teaching that I hope to approach. For that reason I often invite my students to talks I am giving or to other seminars I think they might find interesting.

As a career goal, I would like the opportunity to help students learn about the cultural richness of mathematics. Writing-based courses studying the history and philosophy of math give students a more organic view of the theorems and algorithms they learn in traditional math classes. One can also introduce students to how integrating technology with mathematics can help us illustrate and understand how to apply it. I took a wonderful course called "Experimental Mathematics" at my undergraduate institution (Northwestern University) that used visual C++ programming to model and solve physical problems by watching what happens (seeing the flow of heat through a rod, or the movement of a mass on a spring). I would love to come up with a similar course, possibly encompassing more dynamics and topology as well as the classic mechanics.

2. My philosophy of teaching lower-level (required/terminal) math courses:

My general approach is one of enthusiasm, with a goal to get the students to take ownership in what they are learning. For arts and letters students, that may mostly be overcoming math anxiety and being able to mathematically model story problems that relate to the coursework. Or that may be by getting students in groups to help each other, using a hands-on activity. In my summer and winter finite math classes (of less than 20 students each), I used a game to help students learn how to apply concepts of counting when order matters. I took my students to the campus "Main Building," a 4-story (plus a basement) structure with 4 sets of stairs that go between the levels. I tell my students to go all the way to the top floor and back, twice, without staying on the same staircase between consecutive floors, and without ever setting foot on a particular stair more than once. Then we talk about how many different ways there are to do this, and what strategies people used to play the game. When students turn back to their homework, they can remember how they worked through the game to determine algorithms for other counting problems. I think this "hands-on" idea transfers over equally well to calculus classes; for instance, one could use the game of Red Rover in teaching the intermediate value theorem.

Students also own mathematics when we require them to think about it in ways beyond just solving exercises each night. The college experience is a community experience, so learning in groups or teams, and sharing ideas through spoken and written word, is also very important. I like to have a healthy balance of group projects and individual assignments in class, so students can interact as they learn. I incorporated writing assignments where students discussed the process used to solve a problem and what they learned, much like in a lab report. I also helped students work on expressing their ideas and understanding through individual in-class presentations in my 11-student class, and by holding a debate on whether math was invented or discovered in a class of 65 students.

3. My philosophy in teaching upper-level classes

In upper-level courses, I put a lot more responsibility of the "why do I need to care about this?" on my students. If someone is taking a sophomore level class, it isn't because the college insists upon it for graduation; it's because somehow that class will benefit the student in his/her career path or educational program of choice. So I persuade them to care, and to use the material I cover in lecture, by constantly pushing them to think more about it. I tell my linear algebra/differential equations students that they should expect something in their homework assignment to be a "surprise," not exactly like what they saw in lecture. I expect them to read the sections and go over my lecture notes and think about the moral/big ideas of my lecture. Within the book and the notes, they'll find the clue to attack a problem, but doing the mathematics of the problem itself is still the responsibility of the students. Lecture is a time to talk about how to think about certain kinds of problems and theorems. I do examples, but I don't give them every possible example. If everything in the homework feels exactly like my lecture examples, how can a student know if he/she has learned to *do* mathematics or merely learned how to follow a recipe?

For this reason, even with 200-level engineering courses, I believe students should be expected to know, and know how to use, the theory, not just the most common algorithms that a computer will calculate for them if they ever need them again. I don't mean that I want students to necessarily memorize statements word for word, but I mean for them to understand that the theorems and definitions provide the framework for everything else. Having the theorems, formulas, and definitions at hand leads students to *use* them, and still leaves the question of *how* to apply the theory in their hands. They learn by doing, and by thinking about what they are doing. In upper level classes such as linear algebra, real analysis, abstract algebra, or point-set topology, the problems students do should be both of the theoretical (such as true-false, or applying a theorem to a particular case) and of the calculational nature (such as Gaussian elimination, delta-epsilon proofs, determining the subgroups of a group, or proving a map is continuous). This is reflected in the homework assignments, exams, and extra in-class questions I give students in the linear algebra and differential equations class I teach right now.

4. QUALIFICATIONS

- **Training:** I participated in the departmental teaching seminar for 2 years in which we discussed and practiced teaching methods, the demographics of our students, and how to incorporate collaborative learning into calculus classes. I was later asked to be on a panel of "successful" graduate student teachers, giving advice and answering questions from new mathematics TA's. I have attended talks at Notre Dame sponsored by the Kaneb Center for Teaching and Learning that focused on improving my teaching skills in a lecture course. I also took a seminar topics course in topology that focused on learning how to give talks on higher mathematics. This taught me "by fire" how to pace myself in lecture, effectively use the chalkboard, and anticipate questions, as well as how to fit a talk to the experience level of the audience, a skill which I think will help me in the future when I help with undergraduate research.
- **Evaluations:** Based on the strength of student evaluations and faculty recommendations, I was awarded the Kaneb Center for Teaching and Learning's *Outstanding Graduate Student Teacher Award*. My overall teaching scores are higher than the mean score of instructors in my department. I have prepared a summary of my teaching evaluations from the lecture courses I taught at Notre Dame, which is available on my website. I also have available the full statistical data on the evaluations from Fall 2004 and Spring 2005 which I can send upon request.

5. TEACHING EXPERIENCE

- **Finite Mathematics : Summer 2004.** Class of about 20 students. Taught in 1hr15min lectures 5 days a week for 7 weeks. I also designed and maintained a course website. I was responsible for the entire class: syllabus, grading homeworks, writing exams, designing activities. I took two mid-semester surveys during the course to gauge how the students were responding to the material. The biggest challenges were packing in enough material in such a short time span and designing exams at the right level of difficulty. I tried to balance in-class activities and class projects with the lecture (examples of activities are available through my website). As my evaluations reflect, the students were pleased with my performance; a student even sent me an email to thank me for the class and commend my teaching skills (he was studying to become a teacher himself; see his comments in my portfolio).
- **Finite Mathematics: Fall 2004.** Class of 65 liberal arts students, one of two sections. I maintained a website for both sections of the course. The material covered was the same as the course I had taught the summer before, but the format was slightly different: three

50-minute lectures each week. Exams were given out of class, written jointly with the course chair. I incorporated activities into my lecture on at least a weekly basis and occasionally gave quizzes as well. Highlights include group projects (see the portfolio on my website) and an in-class debate about whether mathematics was invented or discovered (mediated by a panel of math graduate students). Although the students took many courses with fewer students in the class, I had 8 students ask me to write letters for them for summer/study abroad programs because they felt I knew them better than their other professors did.

- **Principles of Finite Mathematics: Spring 2005.** A special admissions class for students with weak backgrounds in mathematics. Eleven students were enrolled. The course met four days a week for 50 minutes. I assigned homework three times a week and it was either collected or I gave a pop quiz on one (or two) problems they had done in their homework. This helped me keep track closely of what the students had learned and where they struggled. With this small group of students I had the opportunity to do many more activities (see the course's web site). I also had each student give an oral presentation on material that grew out of what we covered in the course. Some highlights of this included a student bringing in a roll of toilet paper to show us about circuits in graphs and a student applying conditional probability methods to understand the statistics of concert playlists.
- **Intro to Linear Algebra and Differential Equations: Fall 2006** A class for engineering students who have already taken multivariable calculus. My motto for this class is "variations on a linear system." My section (one of two) had 47 students. I had much less flexibility in how the course would be graded so I was not able to incorporate activities. However, I did give handouts from time to time with details of algorithms used in class or leading questions to help the students get the most out of lecture. The course also had a tutorial section run by a graduate student TA. I designed a course website to make available any handouts and practice exams from the course. I worked jointly with the course chair on writing exams, which involved free-response and multiple choice questions. Homework was collected weekly and graded for overall effort as most of the answers appear in the textbook. The challenge with the class was getting the students to understand how to use theorems, so I started giving them a few true/false questions at the beginning of my lectures to make them more comfortable with the theory.
- **Teaching Assistant: 2003-2004** In the fall semester 2003, I taught 3 tutorial sections of Calculus 2 for science and engineering students, in which I graded quizzes and aided the students in solving homework problems. Students actually switched out of another TA's section to be in mine when they determined from a review session that I was a better expositor of calculus. In spring 2004, I had 2 tutorial sections of the Linear Algebra/Differential Equations course for sophomore engineering students, in which I was responsible for answering homework questions in tutorials. A student commented in evaluations for that course that I was "the best math TA I have had at Notre Dame."

For more information or course materials, consult the teaching portion of my website,
http://nd.edu/˜aberline/teach.html