TEACHING STATEMENT

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1. Introduction

I strongly believe that mathematicians have a duty to disseminate mathematical ideas broadly, both to the undergraduates who pay us to teach them and to the public in general. This is challenging work: we must contend with the common feeling that math is scary as well as the belief that it is largely useless, especially (ironically) in service courses such as calculus and linear algebra. But these misconceptions are an opportunity—aside from the work of educating students in the actual content of our courses, we may educate them about the mathematical mindset.

I'd like to use this document to (§2) discuss my experiences in the classroom and my goals and techniques while teaching (especially in service courses), and (§3) to discuss the importance of educational outreach, and my experience therein. I'll conclude with (§4) a discussion of my plans regarding future teaching.

2. Interacting with Students

Thus far, I have taught sections for calculus linear algebra (during graduate school at Stanford), and last year, I taught an 80-person multivariable calculus course as a postdoc at Columbia. Currently, I am teaching a topics course on deformation theory — however, this teaching statement will focus primarily on my experience teaching service courses. All the quotes below are from my formal evaluations after teaching calculus or linear algebra.

Keeping in mind that the goal of a service course is just that—service—it's important to be aware of what students want to get out of a course, both consciously and unconsciously. Often the conscious goal is just to get a good grade or fulfill a requirement for a major. While this goal is not ideal, it is fine if not every student leaves the classroom with an abiding love for abstract mathematics.

That said, we as teachers can have a significant impact on the margin, even for students who are just in it for the grade. Often all it takes is an understanding of a student's actual passion (say, economics) to find aspects of the course that she is interested in beyond their impact on the final grade (say, principal component analysis with applications to understanding the factors underlying changes in asset prices). I make a conscious effort to discover the interests of my students, and to present example applications which (1) incorporate course material, and (2) are relevant to their coursework and passions. For example, when discussing symmetric matrices, I might draw the image of the unit ball under the linear transformation induced by a symmetric matrix A (an ellipsoid with axes labeled by the eigenvectors of A) and then illustrate the usefulness of this picture by discussing principal component analysis, wherein the preponderance of the variation in a data-set is explained by the largest eigenvalues of its covariance matrix. It is of course very important to explain such an example very slowly and in detail. In general I think that I am successful in connecting classwork to students' interests; comments from the Calculus course I taught last year bear this out:

> Not only does he make class very engaging, for instance with problems maximizing your wealth, but he is also very nice and sweet. If you ever have any problems he is always there to help.
>
> Great instructor!! Great examples and real life applications. great balance of students asking questions and engaging to professor lecturing. He also shared cool fun facts with us and made math enjoyable!!

Part and parcel with the necessity of encouraging students to find aspects of the subject matter that interest them is the goal of convincing them that their grades do not matter as much as they think: that D on the first midterm is not the end of the world. In some cases, grades do matter a great deal (for example, for students applying to competitive medical schools), but in general it's valuable to suggest that students' lives will differ very little after a change in their Calc III letter grade. After undergoing the rat race necessary to get into a selective college, students seem to appreciate these sorts of reassurances; for example, one commenter on my teaching evaluations said:

> His attitude was very optimistic and relaxed, so the class itself never felt stressful despite the fact that this was a difficult class. Always made himself available outside of class!

Students who are alienated by a challenging subject often find it hard to participate—it's important to make sure that every student participates to some extent, if only to evaluate their engagement with the subject. For example, I like to give the geometric intuition behind a concept with demonstrations, often involving volunteers from the class: students typically find this funny (so it reduces their tension) and it generally encourages participation. Students seem to appreciate this sort of technique:

> my favorite instructor this semester. definitely knows what he's talking about. very approachable. does fun and entertaining demonstrations of the binormal and tangential vectors with his arms.

Of course, teaching well requires serious preparation and attentiveness to students' feedback. I generally try to come up with examples highlighting new concepts individually, and then present a problem (with heavy student interaction) which uses all the concepts learned in the last lecture. I also try to find out which concepts to stress, by asking for questions before and during classes. I typically ask for an informal evaluation midway through the semester. I think these techniques met with some success:

> Daniel Litt is a very engaging lecturer. He goes by the topics pretty quickly, but students are always engaged and attentive. He is very passionate about the material he teaches, and is overall, one of the best instructors I have had.
>
> Best! Workload is more but definitely worth it.
>
> He was probably my best prof this semester, very passionate and very very committed.

3. Outreach

I've taught at the middle school level (through the MIT and Stanford Math Circles), the high school level (through the SPLASH program), and given many talks aimed at math majors in the Stanford and Columbia math departments (the SUMO and Columbia UMS lecture series). I've also taught a course for lay adults, again through the SPLASH program. The subjects of these courses have ranged from Gödel's incompleteness theorem to the mathematics developed in the pursuit of (false) historical theories of cosmology.

My feeling is that mathematical outreach is extremely important. I vividly remember one of my undergraduate professors telling me that her parents thought her job was to add very large numbers together; while there's no need to tell the average layperson what a quasi-coherent sheaf is, I think there's some value in spreading an accurate idea of what mathematics research looks like and what kind of joys can be found in its practice. I've found that many laypeople are astounded by the idea that one could find beauty in mathematics, and stressing this fact is very effective.

One of my goals, both when teaching service courses and when engaging in mathematical outreach, is to incorporate as many pictures and diagrams into my lectures. (See e.g. `https://www.daniellitt.com/s/musicofthespheres.pdf` for an example of one of my lectures aimed at high school students.) As a geometer, I think it's important to convey that mathematics can be about very concrete objects, and that intuition and aesthetics play a very important role.

Focused outreach aimed at women and under-represented minorities is extremely important (the SPLASH program, for example, makes this a conscious goal). While some of the distorted representation of minority groups and women in academic mathematics likely stems from broader social problems—for example, different levels of encouragement in elementary school—we as teachers have a duty to (1) make an attempt to remedy these issues at the university level, and (2) do what we can to reach out to promising younger students from all backgrounds. I take these duties extremely seriously, and I think fair representation of all under-represented groups should be a fundamental goal for mathematics as a discipline.

4. Future Teaching

Of course, I plan to continue teaching at the university level, and to seek out opportunities to teach younger students. I'd also like to engage in more one-on-one mentorships. While at Stanford I mentored two groups of undergraduates through the SURIM program, helping them research certain number-theoretic topics. At Columbia, I've run two REU programs (jointly with Daniel Halpern-Leistner and Dave Hansen, repectively; the program itself was organized and run by Chiu-Chu Melissa Liu), on an algebro-geometric topic and a representation-theoretic topic. I am also currently mentoring two undergraduate research projects, one on modular representation theory and the other on Galois theory. These activities are extremely rewarding—in the future I hope to continue to mentor projects in mathematics and in more interdisciplinary subjects.

As my teaching experience expands, I'd like to try various types of courses—for example, I've been interested in teaching a "Writing in Mathematics" course. I suspect this sort of writing could be useful even for students who do not want to be math majors: writing convincingly and precisely is a useful skill in many fields. I am currently teaching a topics course on deformation theory, which has been an absolute pleasure thus far, and of course I look forward to teaching more topics courses, largely as a method of deepening my own knowledge algebraic geometry and of nearby fields.