

# Teaching Statement

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## 1 Introduction

It is often said that the best way to learn is to teach. I have recognized that fact since tutoring my peers in calculus, all those years ago when I was first finding that math excited me. I have tried to teach with many different approaches, seeing what works and what does not; of course, most approaches tend to work well for some students and not as well for others. As I move forward, I hope to find a general approach that is adaptable to as many different circumstances as possible.

My student feedback scores at Illinois repeatedly placed me on the campus-wide List of Teachers Ranked as Excellent. I received the 2014 Brahana Teaching Assistant Award from the Mathematics Department at Illinois, the highest teaching award from the department available to graduate students.

## 2 The evolution of my philosophy

When I first started teaching in a formal sense, I was distributing worksheets to students in “Elements of Mathematical Reasoning,” a course reviewing algebra, some logic/probability, statistics, and financial mathematics. It got me accustomed to being in front of and among a class. I often had to find different approaches to explaining the same technique or idea. I got my first taste of how to deal with group work, especially the dynamics among the students therein.

Then I arrived at UIUC. My first semester I had a pair of Calculus 1 sections. I ran the sections as Q&A. I think this was time reasonably well spent, as the main course lectures were purportedly theory-heavy, and many of my students had trouble transitioning to the drill-style homework. I always “crowd-sourced” solutions to the problems: only very rarely did I make a step without first having it suggested by one of my students.

Soon I had a discussion section which was to be run with groups of students working on pre-scribed worksheets. I had learned to less frequently give answers “yes” or “no,” and more frequently give answers “show me how you got there” and “does this answer make sense?”.

Next I taught two semesters of Merit calculus, which targets populations traditionally underrepresented in STEM fields. The format is, on the surface, quite a lot like the group worksheet setup. It has several nice features though: first, the students have volunteered for the special discussion, so the students were more ready to participate in groups. Second, because the class meets twice as long as a usual discussion, the worksheets can have some additional length and depth. I really enjoy the flexibility that the longer worksheets allow. I frequently gave my students application problems, and also regularly gave deeper theoretical problems.

The following semester I was the lead instructor for Calculus & Mathematica, Calculus 2. C&M is based on having a flipped classroom and making use of electronic resources. This class gives students control over their own instruction, relying on Mathematica files as primary textbook

and lecturer. I selected and modified the electronic homework problems, created quizzes and exams, and oversaw undergraduate Classroom Assistants in grading and classroom assistance. In the classroom, my role was to add to the computer lessons, helping to fill in any gaps students might find themselves troubling over. When it became apparent that students needed more direct support, I started to give short recap lectures before each class and prodded more deliberately for questions.

Next I taught a more traditional Active Learning style discussion section, where group worksheets are the focus. I adopted more of a blended style: I opened each class period with a quick recap on the previous lecture(s), encouraged general questions (that I answered fairly directly), then moved on to the worksheets. On the worksheets I took a more Merit-style stance, challenging the groups to figure things out from what they already knew, trying to guide them in the right direction without much explicit intervention. (“OK, let’s see where that takes us... ah, so we were missing something; what might that have been?...”)

I then taught two more semesters of C&M, both Calculus 3. In Calculus 3, the classes meet for an extra hour a week compared to the C&M Calculus 2 that I taught before, so I had more time to spend in a lecture hall reviewing what students ought to have gotten out of their electronic work and perhaps providing additional material that I thought beneficial. I had gotten better at both forcing students to be proactive in their own learning and being more proactive myself in seeking out student misunderstanding. In these semesters I supplemented the electronic homework with written work and gave a weekly quiz. Upon student suggestions, I moved the discussion days ahead in our schedule so students would have more time after our discussions to complete the homework.

Next I taught a discussion section of Applied Linear Algebra. This is an interesting class to work for, with many different ways of looking at any given topic. I tried to always draw connections between the matrix algebra, geometric intuition, and previous knowledge. When students would have no questions, I developed worksheets emphasizing theoretical aspects, in particular giving examples to demonstrate and explain the necessity of various hypotheses in our theorems. I especially enjoyed the end of the semester, when the course got into applications like the Page Rank Algorithm for internet page rankings.

### 3 ...and its current state

I firmly believe that mathematics is best learned by understanding the ideas (“the pictures”) behind the symbols. (One of my favorite reviews from a faculty member: “you give very clear, well thought out presentations with good pictures.”) When asked in discussion how to go about a problem, I almost always give a brief explanation (brief, because the students have already seen it) of what the first step is really doing. Memorization of formulas and procedures should come at some point, if only to expedite solutions; but if memory fails, a student should be able to recreate the steps necessary to arrive at a solution. (A student in Calculus 3 once happily recalled the derivative of  $\arctan(x)$  in an exam by using implicit differentiation.)

Overall, I try when possible to let my students figure things out “on their own.” I help guide them through their own thoughts, pointing out inconsistencies or providing extra examples for them to ponder. Perhaps the best part of this approach for me is when a student will suggest an approach that never occurred to me. (In one technology class, when asked to find whether two projectiles collide with their positions in the plane given as functions of time one student made a 3D plot of (time,  $x$ -pos,  $y$ -pos) and found a viewpoint that made it obvious that these curves did not intersect.) For the student, I think the best part of this approach is instilling a sense of self-accomplishment, which helps motivate further self-study.

I am still on the fence about group work. I have increasingly come to appreciate its power to help students of all skill levels (quick students improve when they have to tutor their colleagues, and slower students get more support). However, there seem to be a few students who just don't get much out of it. My wife reports that she was such a student. Perhaps these students just haven't had the "right" kind of group work, or maybe there really are students whose learning style is at odds with group work. My current stance is to "strongly encourage" working in groups, but not to force the issue.

I try, at the beginning of a semester, to plot out where I want to be week by week, and where the exams will fit in. I am willing to adjust this as necessary, but it helps to have a rough idea of how much time I think I will be spending on each topic. Before a lecture, I draft an outline of what I want to discuss, and spend some time finding examples and pictures that naturally bring up the important points of the subject. Depending on the class format, I will scatter examples for the students to work on in small groups throughout the lecture. I always try to elicit student questions or answers during the presentation.

## 4 Looking ahead

I hope to further refine my skills in encouraging independent thought from my students and instilling an honest enjoyment of mathematics. I will continue to try different methods, hoping to increase my effectiveness with many different student learning styles.

I look forward to teaching more advanced courses, especially in the areas of mathematics that I have come to enjoy so much.

I look forward to mentoring undergraduate research. In each of the last two summers, I visited an REU at Illinois State University; it was great to interact with the students as they continued research, began writing results, and also prepared for their one-week Research Camp for high school students.