Teaching Statement

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Introduction

My teaching career began in 1997 with my first course assignment at the University of Arizona. At the time, I naively spent many hours strategizing on how to the become the best possible College Algebra instructor. Since then, multiple classroom experiences, conversations with mentors, journal articles, training sessions and a host of other variables have defined and continue to define me as a teacher.

This statement is comprised of four main sections which, taken collectively, illustrate some aspects of who I am (in my view, and perhaps in that of others), and what is important to me as a teacher. The first section concerns my personal philosophy of teaching, which I have chosen to illustrate with three themes, rather than to describe exhaustively. I then describe some of highlights of my teaching experience which are course-specific, and discuss some of the education courses that have awakened my interest in Mathematics Education and curriculum development. I close with a brief section on the many rewarding student comments and letters that continually spur my efforts and have lead to the honor of three teaching awards.

Views and Personal Philosophy

Motivating through enthusiasm and empowerment

Experience has taught me about two main sources of motivation: enthusiasm and empowerment. Enthusiasm in the classroom is highly contagious. It promotes engagement. It sets the tone for a positive and productive classroom experience that invites all and excludes none. It also establishes a context in which knowledge is created rather than delivered:

> She enthusiastically presented new material [...] which drove home not just the problem solving methods but the ultimate importance of the mathematics we were learning. (Differential Equations student, 2003.)

Enthusiasm is an attitude, but it can also be more explicit. Mathematics is beautiful! I often tell my students this as a prelude or a postlude to certain specific examples, proofs or theorems. The hesitant looks that I usually get are not surprising. They stem from the all-too-familiar misconception that mathematics amounts to tedious arithmetic or unilluminating, complex procedures linking “made-up” problems and their impractical solutions. For many, this perception is often coupled with feelings of inadequacy. How does one dislodge from students’ mind such deeply-rooted misconceptions and feelings? Enthusiasm must be channeled to promote empowerment.

In my courses, I train my students to engage in the thinking process the way mathematicians do. This often requires more effort on their part, as it entails an active role in the classroom (group work, board arguments, etc.) and an investigative spirit at home (not all homework topics are systematically covered in class). After the course ends, the mathematics may or may not be retained, but the experience of having *owned* the thinking processes leading to a solution will endure and even transfer to other non-mathematical contexts.

> [I] walked away [from the class] with a better understanding of math in general, stronger skills, and a feeling of accomplishment because this course is not easy, but worth it (Business Calculus student, 1999).

Doing mathematics is being able to reason from first principles and build arguments that justify certain truths. The particular principles and truths that characterize a topic are perhaps less fundamental than the thinking processes from which they are born. My ultimate goal in the classroom is to convey to students that fact that doing mathematics is a creative, fluid process to which everyone can contribute and from which anyone can learn something valuable. I believe that *success,* as defined by the standard academic parameters, is more likely to exist in a setting permeated with enthusiasm and empowerment, *where mathematics is cooperatively done and individually mastered, rather than uniformly delivered.*

Inquiry-based and cooperative learning

How does one achieve an atmosphere in which math is collectively done and individually mastered? Attaining this goal requires time invested into designing and planning key activities. But it also depends on providing an intangible environment that fosters mental engagement and where critical thinking can simply take place. Here is one of my favorite examples.

A few years back, on the first day of the term, one of my integral calculus students raised a question regarding the product rule for differentiation. The question was simple enough to be answered quickly and move on, but it was also important enough to warrant a valuable teaching moment. I chose to turn the question back to the students: What do you all think? After one or two timid, half-mumbled responses, I encouraged the first student to go to the board and write what he meant. The next twenty minutes were filled with activity. Several students raised questions about what was being said and used the board to explain their views on the problem. Others led on the discussion from their benches, until reasonable consensus was reached. This *impromptu* instance of cooperative learning illustrates what I consider a very successful classroom experience. A wealth of mathematics unfolded during just a few minutes. Various misconceptions were uncovered and clarified, some key notation was reviewed, and the importance of saying what you mean and meaning what you say, was clearly manifested.

What kind of *planned* activities and organization lead to individual engagement in and out of the classroom? What I call inquiry-based activities coupled with a flexible class format are key in this regard. The aim is that students may experience the benefits of cooperative work and peer discussions as well as the importance of self-reliance and independent investigation. Here are some practices that I have successfully implemented in the past, and that I believe capture the cooperative and individual dimension of doing mathematics.

- *Board-work for all.* I utilized this activity during the first 50 minutes of class in one of my integral calculus courses. The lesson of the day was polar coordinates. No discussion of this topic had previously taken place. My students had been asked to read the chapter and examples "with paper and pencil" in preparation for the class. As the bell rang, each of the usual eight teams was assigned one of eight sections of chalkboard I had previously marked. The entire class was then given a list of five problems (of increasing complexity) in the new topic of polar coordinates. I told them to work on the first problem in their groups and then select one or two group members to put the solution on the board. As solutions were going up, I circulated from group to group and discussed them. Before boards were erased for the next problem, a brief summary of what the problem had taught us was offered (by myself or a student.) The dynamics in the classroom were nearly ideal: everyone worked and had an opportunity to present; peer interaction occurred not only within teams but also across teams. Peer feedback was abundant and goal-oriented. In sum, a new topic was successfully introduced and *learned* to a large extent without a formal lecture!

- *Non-traditional in-class quizzes.* (Some variant of these was used in all my courses of the calculus sequence, at various points during the term.) These quizzes contain at least one problem on material that has just been presented in class, or is not to be covered in class on a formal basis. In the latter case, students may have been asked to investigate the topic of the problem outside of class, as homework. Once the quiz is handed out, students are given roughly five (out of 20) minutes to discuss the quiz with a partner. Sometimes the partner is assigned, sometimes they are free to discuss with whoever they want. At the end of the discussion time, the students must work individually on their quiz for the remainder of the time. Occasionally, it is useful to allow students to work with a partner throughout the entire 20 minutes, while writing their own individual solutions.

Establishing good feedback practices

In the mathematics classroom there are two kinds of important feedback: subject-specific–from the teacher to the students, and performance feedback–from the students to their teacher.

How do we ensure students make the most out of subject-specific feedback? Here is a practical example. Students often struggle with reading mathematics and with translating thoughts into mathematical notation. In particular, they tend to use notation inconsistently and ambiguously. On one occasion, while grading College Algebra homework, I noticed a large and varied collection of answers for a problem involving arithmetic sequences. Some solutions portrayed incoherent procedures that somehow lead to the correct answer; a few featured extremely creative correct solutions; others were simply unintelligible. Once again, I saw an opportunity for a valuable teaching moment. I hand-wrote a representative sample of the answers and made copies. The next day, our meeting started with a mock grading exercise for the students. If these were their best friends answers, could they grade them fairly? Were the answers right or wrong? Why? The activity effectively demonstrated to the class that sensible writing and proper notation are fundamental for communicating ideas, *even among peers*. Most importantly, it gave them concrete examples of good, bad, inconsistent and ambiguous notation. On the other hand, the task bluntly demonstrated to students that it is possible to give creative, one-of-a-kind arguments leading to a correct solution, and that creative reasoning must be carefully analyzed before flagged as wrong (or right).

How do we get timely feedback on our classroom performance? From a students perspective, midterm course evaluations are important means for providing feedback while a course is still in session. When used early in the term, such evaluations may also open healthy verbal feedback channels. For the last four or so years, I have given students a one-sheet midterm evaluation, modelled on one designed by a colleague. The students answer the following four questions:

- What has your teacher done that has positively contributed to your learning in this course?
- What could your teacher improve on?
- What have you done that has positively contributed to your learning in this course?
- What could you improve on?

I love this form! It gives the students the chance to be both critical and reflective regarding each persons role in the learning process. It also gives me the opportunity to make adjustments while the class can still benefit from them. While teaching vector calculus a few years back, I was surprised to learn that –in spite of our active class discussions– many students felt the course dynamics were still dominated by my lectures. Following their suggestion, the next day we began "spicing-up" lecture periods with small group discussion on new material. Everything changed! Students were much more engaged and productive, and extremely appreciative of my listening!

> [My instructor] was extremely responsive to the class. She even took suggestions midsemester about changes that might be made and followed through with them (Calculus III student, 2001).

Experience

During my graduate years at Arizona and my post-doctoral time at Michigan, I have had the privilege of teaching a variety of courses, both as the sole instructor and as part of a team. Recently, I have discovered the challenges and rewards of directing multi-section, entry-level courses. I have also had the opportunity to participate in several teaching-related activities: mentoring, running graduate-level research tutorials, organizing qualifying-exam preparation sessions, workshops for high-school and middle school students, etc. All of these experiences have helped shape and improve the teacher I am today. However, those listed below have been the cause of paradigm changes in my views about teaching and course dynamics.

- **Harvard Consortium Calculus Sequence**

  Both at Michigan and Arizona, precaculus, differential, and integral calculus are taught using the Harvard-consortium texts by Hughes-Hallett, et. al. These texts are heavily based on the reform approach to calculus, which emphasizes independent reading and non-rote, applied exercises while de-emphasizing traditional lectures formats. I have taught each one of these courses at least twice as the sole instructor and, in so doing, I have learned quite a bit about myself, my students, and the varied views on how mathematics should be taught.

  In my opinion, the Harvard-consortium approach has a lot to offer. Having learned calculus with a traditional, heavily proof-based approach, my student days trained me well for solving hard problems that were already stated in precise mathematical notation within a pre-defined mathematical context. However, the concept of the mathematical toolbox, which prepares one to use mathematics to model and understand physical phenomena, was missing. The Harvard Consortium texts emphasize the mathematical toolbox approach to calculus, perhaps at the expense of a more in-depth, proof-based development of certain concepts. I align myself with the style and ideas of Calculus Reform. The toolbox metaphor has helped re-defined who I am as a teacher, and is an integral part of the student-centered format that I employ in all my course, regardless of the textbook.

  During my three years at Michigan, I was also appointed as the course director for each of the calculus courses just discussed. As such, I coordinated, managed and trained a team of instructors of variable size (7 to 20 instructors, depending on the course and the term) responsible for teaching a total of 200–900 students. Being at the head of these multi-section courses, I developed a strong sense of the ethics and diplomacy needed to address the needs of mass numbers of students and sometimes their parents. I also learned of the benefits and challenges of writing uniform exams and of being in a position of leadership among colleagues. The experience has been simply fantastic.

- **Mathematics for Business Decisions**

  About three years ago, I taught Mathematics for Business Decisions, a brand new, highly innovative math course designed for business majors at the University of Arizona. The course (taught in state-of-the-art classrooms featuring electronic white boards, wireless PC technology, a cluster of media projectors, etc.) is based on an electronic textbook written using interactive PowerPoint presentations, Excel, Word, streaming video and so on. The course content is essentially applied probability. The material is not delivered in the traditional sequential format, however. Topics are presented and discussed only as they become necessary tools for solving two major projects which, in effect, define the syllabus for the course. The first one involves a loan work-out/foreclosure decision. The second regards stock option pricing. Students work entirely in teams throughout the term, and are expected to formally report their progress on the projects frequently. Each team's final presentation utilizes PowerPoint slides, printed materials, and includes a written document on their analysis and findings. The technological arena surrounding the daily lessons for this course and its project-centered syllabus has made it a unique teaching and learning experience!

- **Mathematics for Elementary Central American Teachers**

  This was a summer course at the University of Arizona, taught entirely in Spanish. I ran it together with a faculty member from the Math Education group and a graduate student. We all took turns presenting the course material, leading classroom discussions and designing activities. The audience consisted of about 20 elementary school teachers from various Central American countries. It was challenging to teach a course promoting meaning-giving techniques to a group of teachers who relied heavily on memorization skills. This course taught me that great ideas about teaching mathematics are sometimes only deliverable in tiny doses, and that the best way is often context-dependant.

- **Principles of Analysis–IBL format**

  IBL stands for "inquiry-based learning." This course (which I taught at Michigan in the Winter 2006 semester) uses an openly-defined inquiry-based format to introduce juniors and seniors majoring in engineering, mathematics and education, to the fundamentals of analysis. When planning the syllabus for the course, I was given examples of what "inquiry-based" had meant for past instructors, but given free reign to implement my own techniques. In my class, inquiry took place in-class, outside of class–in team homework, and in exams. Examples of daily in-class activities included writing proof arguments working as a pair with someone else, board presentations of these pair-proofs, written and verbal peer-critiques of pair-proofs, board presentations of inquiry-based homework, and meaning-decoding exercises (e.g., coming up with one or two english-only phrases describing a theorem and its usefulness in context). Homework had a standard component which was based on material discussed in class and meant to be done individually. It also entailed an inquiry-based component, based on material that needed to be researched independently by the students outside of the classroom. These latter topics were not covered in class, and not always addressed in the course textbook (e.g., cardinality and infinities, rearrangements of series). Exams also had a standard and an inquiry-based component. This class was very challenging for the students (who represented a vast variety of levels and abilities) and non-trivial for me to design and evaluate. However, feedback from students indicated that many of them had learned a lot and had found themselves capable of succeeding at independent work–something they truly valued.

Math Education Research, Coursework, and Curriculum Materials.

During my graduate years, I took a few **education-related courses** focusing on various aspects of either high-school or undergraduate level mathematics:

- *Teaching and Learning Mathematics with Technology.*
  Department of Teaching and Teacher Education, University of Arizona.
- *Curriculum Issues and Practices in Mathematics.*
  Department of Teaching and Teacher Education, University of Arizona.
- *Teaching Undergraduate Level Mathematics.*
  Department of Mathematics, University of Arizona.
- *Research in Undergraduate Mathematics Education.*
  Department of Mathematics, University of Arizona and Arizona State University.

Each of these courses has been instrumental in broadening my academic horizons to include a bit of math education research and develop a number of technology based **curriculum materials** for both high-school geometry and calculus (URLs available upon request):

- *A web-based exploratory unit on non-Euclidean geometries for high-school students.*
- *A dynamic software tool for calculus instruction at the college-entry level.* (Poster presented at PME-NA Twenty-second Annual Conference - Tucson, AZ, 2000)
- *Influence of Dynamic Software Visualization Tools on the Development of Undergraduates Concept Image of Derivative Function.* (Short oral at SIGMAA-RUME Fifth Annual Conference - Chicago, IL, 2000)

More recently, I participated on a grant founded by the Center for Research in Learning and Teaching at the University of Michigan. The project (joint work with Dale Winter) entailed designing multiculturally infused activities that could replace 6 to 8 standard full-day lessons in the precalculus course at Michigan. The new materials were implemented by a cohort of GTAs, and faculty in the Winter 2006 semester. The study showed that students can engage in significant social and multicultural learning experiences without diminishing their mastery of the technical subject matter of the course. The complete results of our investigation were presented by my colleague at the 26th Annual Lilly Conference on College Teaching in Oxford, OH, this past November. We expect they will be published shortly under the title:

- *Students Mathematical Achievement and General Knowledge in a Multicultural Mathematics Course.* Preprint.

Recognitions and Awards

The greatest testimony to a teacher's success comes directly from his/her students. During my time at the Universtiy of Michigan and the University of Arizona, I have been honored with over 300 outstanding student evaluations and with three teaching awards. The first two of these, were sponsored by the Mathematics Department at the University of Arizona (one for my teaching of Multivariable Calculus in 2000, the other for my teaching in the Differential Equations course in 2002.) The third award (which I received in 2003) is granted yearly by the College of Science at the University of Arizona to a handful of outstanding teaching assistants associated with different science departments.

It is a privilege to be able to do what you love; it is indeed humbling to be recognized so generously for it.