TEACHING STATEMENT

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Teaching is one of the most enjoyable aspects of my career; there are few things more satisfying than to watch a student finally understand a concept. Realistically, the bulk of most academic scholars' impact on society will be felt through their teaching rather than their research or service. Accordingly, I view teaching as my opportunity to have a tangible positive impact on the world, an opportunity that should never be wasted. It is with this attitude I enthusiastically approach my teaching duties.

1. Philosophy

Many students unfortunately believe that mathematics is just a set of steps for solving a certain set of exercises that happen to appear in their textbook. It is instead a language for logical thought, and set of incredibly powerful tools built with this language that took centuries to get right. The primary purpose of teaching mathematics is to teach students critical thinking skills; necessary secondary objectives are to teach them the tools in this toolbox, and how to use these tools. This philosophy underlies my approach to teaching mathematics.

It is also true, however, that in our society college now serves as a gentle way to introduce many young people to adulthood: rules and responsibilities are clearly defined, encouragement given, and mistakes are easily forgotten. Accordingly, I try to teach my students as much as I can, and not just about mathematics. I can teach them to have integrity, to help one another, to be tenacious, etc. Occasionally, I even try to improve their writing skills by asking my students to explain some mathematical phenomenon; in my experience, the best way to learn something something is to try to teach it.

Students learn the most when expectations are set high and as much support and encouragement as possible are provided. Expectations that are too high cause students to give up, while expectations that are too low are a missed opportunity. The beginning of a course must start slowly, to build confidence and enthusiasm in the students. Later, the students should be challenged, but not bewildered, with expectations increasing throughout the course.

Rather than the instructor being the hurdle to success, I try to setup the material as the hurdle, with me as a guide, working as hard as them and with their success at heart. The alternatives can be toxic to the atmosphere of a course. A student's final grade should be determined solely by how

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well they understand the material; I tell my students that I can give them all A's or all F's, if those grades were earned, and that I only curve when an assessment is unfair (poorly stated problems, unreasonably difficult, or too long). Thus, I try to setup a system in which expectations are high, as much support and encouragement as possible is given, and the final grade is determined solely by the learning of each student.

2. Experience

Between the University of North Carolina at Chapel Hill and the University of Toronto Scarborough, I have taught 18 semesters of mathematics courses.

As a graduate student, I completed a teacher training seminar and subsequently taught College Algebra, the entire calculus sequence, business calculus, and a special topics course for non-science majors. Throughout, I had substantial flexibility to design and conduct courses, write assignments and assessments, assign grades, and, for the topics course, even to choose the topics to cover. I was one of the few graduate students allowed to teach Multivariable Calculus.

As a postdoctoral fellow, I taught introductory calculus, business calculus, a third-year course on mathematical biology, and a challenging two-course sequence on proof techniques and elementary real analysis taught to math and computer science students. As this sequence of courses was new, I was able to suggest changes for future instructors, including a change in textbook, increasing the number of tests, and rearranging the topics. Some of my suggestions were used to redesign the courses so that the first was a sped-up calculus course, with the second teaching proof techniques and some elementary real analysis. In my mathematical biology course, my students found real-world data related to their choice of a published mathematical model, estimated the parameters of the model using Matlab, and then tried to improve the model in some way. Such open-ended assignments give students a taste of industrial mathematics.

I have taught small sections of ≈ 15 students, large sections of > 140 students, coordinated with others teaching the same course with > 500 collective students, directed and supervised the work of teaching assistants, and have had my lectures broadcast on the internet. I have experimented with various technologies, including "clickers", e-books, Webassign, and Blackboard, and adapted the ones I thought were helpful to my students. Outside the classroom, I have helped prepare undergraduates to compete in COMAP's Mathematical Contest in Modeling, co-organized and participated in graduate seminars, helped grade the Canadian Open Mathematics Challenge, and held discussions with middle school mathematics students. I look forward to teaching a variety of courses and interacting with students in new capacities.

3. Practices

My own teaching practices are a result of frequent self-evaluation, as I believe that good teachers become so through continuous improvement. For example, in my first experience teaching, I realized that I was moving too quickly. I started frequently asking questions of my students and waiting for their responses in order to gauge their understanding of the material. This assessment strategy worked well and so became the core of my lecture style. It allows me to appropriately adjust the pace of the class, and forces my students to think through topics as I teach them. It also communicates to my students that questions are welcome.

I also try to improve my instruction using data. Since it can be difficult to judge the length and difficulty of exams, I use data to inform my assessment practices by recording statistics for each problem on each exam that I give. This data allows me to spot deficiencies in my instruction or in the exams that I have given, and to estimate the difficulty of new exams. When grading, I also record qualitative data on mistakes that occur repeatedly and use these observations to improve my instruction. I often address these mistakes and misunderstandings when I hand back assignments, thus making assessments instruments in student learning rather than just summative in nature. Similarly, I will occasionally find an opportunity to teach my students while they are taking an exam. For instance, I might ask them to show that a new definition is equivalent to one that they know, or to check a property of a special function.

To learn mathematics well requires that students learn each topic on several levels. There is the *idea*, which is fairly simple and almost never clearly written down in textbooks; the *implementation* of the idea, which is often quite complicated and mysterious to students; the *use* of the implementation in practice; and the *details* that are necessary to fully understand the concept, including any exceptions, extensions, or necessary technical assumptions. For instance, when teaching limits there are, respectively, the concept of limits that can be illustrated with a picture; the epsilon-delta definition of the limit; the properties of the limit and how to use these to compute examples, or the understanding of how to write an ε-δ proof; and then, for example, all of the variations on the definition of limit (e.g., $\lim_{x\to\infty}$). Each of these levels should be taught, learned and tested, with the idea as the most important level.

I strive to help my students succeed even outside my classroom. On each course's website, I post full, detailed solutions for all graded assignments and tests, so that students can receive assistance at any hour of the day. This also forces me to only make assignments of reasonable length and difficulty, and models the quality of work I expect from my students. I also encourage students to work together on homework, as long as they each understand and have independently written up their solutions. Any concern about cheating is mitigated by appropriately weighting homework, having a clearly defined test[1] for cheating, and using exams that are sufficiently different from the homework. Recognizing that as an undergraduate I was hesitant to use office hours, I remind students of my office hours throughout the semester. Once they arrive at my door, I try to be friendly and eager to answer their questions. Office hours help my students learn the material, but they also improve relations with my students, and help me improve as a teacher by understanding and addressing the issues that brought them to my door. Often, a new explanation that I thought of during my office hours turns out to be the most understandable for my students during my lecture.

Some students view mathematics as a static and not particularly useful area of study. To counter these views, wherever possible I attempt to connect topics to real life, the sciences, or other areas of mathematics. For example, in a calculus course I might emphasize the profound importance of differential equations in the sciences (e.g., weather forecasting), and show how power series can be used to obtain most trigonometric identities. In my mathematical biology course, I used our theorems on the long-term behavior of solutions to linear difference equations to discuss Markov chains and Google's PageRank algorithm. To show that mathematics is still developing, I like to expose students to problems which are simple to state, but only recently solved or still unsolved. For example, when discussing sequences in a calculus course, I often mention the Collatz Conjecture, the "$3n + 1$ problem". In a special topics course, the Traveling Salesperson Problem may be used to describe the P vs. NP problem and its importance. The Four Color Theorem and Ramsey Theory may also be described in an accessible–if vague–way; for my students, the idea that they could discover new mathematics at a party seems incredible.

Teaching is an enjoyable and rewarding experience that gives me a concrete sense of accomplishment. I look forward to teaching a larger variety of courses and working with students in other capacities, including research, mentoring, and advising.

4. Evidence of Effectiveness

My course evaluations suggest that students generally find my courses challenging, yet are pleased with my instruction and what they learn in my courses. Students have called me "very engaging and personable," "patient and always willing to meet," "very organized," "clear about everything," and a "Great Instructor!!" One student said that they "gained a lot from each and every day in class. I can't think of how this class could have been any better." Another said, "He cares a lot about his students. Also, he helped me find my love for mathematics once again! I wished my other instructors were like him!"

My faculty observations have been consistently positive and have commented on my interactions with the class. For example, "Brian did a very

[1] A student should be able to explain their own homework to me.

impressive job, especially in clarity of explanation and engagement with the class." Another faculty member wrote "Very good class: clear presentation, good board work, active communication with students."

5. Future Development

There are undeniable ways in which I may grow as an instructor. For example, I have not yet found an effective way to manage students' preconceptions regarding their grades, something I believe is a result of grade inflation at the K-12 level and significantly higher expectations in college. Nor have I attracted the struggling students to my office hours. I must work on building relationships with my students, perhaps by meeting individually with each student after the first exam of the semester.

As a faculty member, I would like to experiment with curricula. For example, I would like to pair Calculus and Introductory Physics courses; many interesting problems can be done using both tools and there has historically been significant overlap. In particular, many of the tools of multivariable calculus are motivated by and have direct applications to physics. I particularly want to incorporate applications into a linear algebra course, as it is an incredibly useful tool that is sometimes unappreciated by students. In more advanced courses, I would like to include brief discussions of the problems that have motivated the field and the ways in which these problems have been made tractable. Eventually, I would like to teach an undergraduate topics course which combines very basic commutative algebra and algebraic geometry, with significant use of computational tools like Macaulay2. A seminar course, in which students present various aspects of a topic over a semester, should be experienced by every advanced undergraduate and graduate student. These help with presentation skills, give students a taste of more modern mathematics, and encourage collaboration and discussion.

In the past, I have had frequent and invaluable discussions with other instructors regarding teaching. I look forward to having similar conversations with my future colleagues to help me acclimate to a new institution, new students, and new courses.