STATEMENT OF TEACHING PHILOSOPHY

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I use three guiding principles when evaluating my actions as an instructor. From smaller choices, such as the inclusion of a particular example, to large-scale design of the course, I believe that my decisions should support students developing their critical thinking skills with mathematics, improve their exposure to formal mathematical reasoning and intuition, and challenge every student to deepen their understanding of mathematics.

One of the best tools available for incorporating all of these principles into my courses is the frequent use of written assessments. In calculus classes, I use short writing assignments, asking students to specifically justify steps in computations or explain in a note to a classmate how to approach a particular type of problem, requiring students to check and improve their understanding of concepts through verbalization and discussion. Combined with standard computational exercises these assignments make the reasoning the focus of the problem. By providing sample solutions to these problems, I can model how a mathematician might approach and explain problems, fulfilling my second principle. Writing assignments also challenge students who have mastered the basics without introducing more advanced mathematics that may not fit the course as a whole.

In the classes that I have taught, I crafted the materials by focusing on my goals for the course. While many of the specific mathematical topics and skills were fixed, I set goals for the students in terms of exposure to formal mathematical arguments and their development. To that end, I used two types of homework assignments. Each class period, I assigned a few computational problems covering the material from that lesson to help the students engage with the essential skills. The second assignment each week consisted of more complex questions that required more formal responses and challenged the students to experiment with ideas, form conjectures, and go beyond the specific techniques discussed in class. In my course on mathematical modeling, the students were required to go even further, submitting five essays throughout the term exploring and applying topics in data analysis.

My classes also frequently incorporate computational tools. For complex topics, I create interactive software applications using Sage that allow the students to experiment with the specific parameters that are relevant to the problem, such as the degree of a Taylor polynomial approximation. These tools help build students' geometric intuition and removes some of the computational barriers so that students can explore the underlying ideas without being overwhelmed by the details. Many of the students in my mathematical modeling class had no programming background, so I developed tutorials and simple programs to help them analyze the data we encountered. By the end of the course, they were writing their own programs and designing their own projects. In several cases, these projects became senior theses in the quantitative social science department.

The greater depth and longer time frame of research projects, like senior theses, benefit students by providing them with new challenges and exposing them to modern mathematical culture and reasoning. As a postdoc, I have supervised several undergraduate and graduate research student projects in our lab. Additionally, in 2018 and 2019, I also helped organize and run the Voting Rights Data Institute, a summer program which brings students to Cambridge for 6-8 weeks to work on a wide variety of mathematical and data-driven projects centered around redistricting research. Several of the projects that began in this program led to publications with the students as coauthors. Guiding students through the process of writing their first papers also integrates all of my principles as it requires students to engage with the broader literature and synthesize their mathematical work with the intended application domains.

Since many of the mathematics classes offered at colleges and universities are service courses, I believe it is important to design courses that are beneficial students who are planning on majoring in other fields. In line with my first principle, I believe that mathematics is a wonderful setting to develop critical thinking skills. Mathematics provides an environment that is different from everyday experience in which explicit reasoning can be brought to the forefront. This is also related to my second principle, although many of our students will not go on to study more mathematics, I believe that society as a whole benefits from having professionals of all types that appreciate mathematics and mathematical reasoning. As such, I try to constantly model mathematical processes in my writing, lecturing, and discussions with students.

In addition to abstract reasoning skills, general quantitative skills are increasingly relevant in a world driven by data. As my research is rooted in the mathematics of data analysis I frequently incorporate real–world applications and examples into my classes. I use these experiences to motivate seemingly abstract mathematical ideas and provide opportunities for students to see how mathematics connects to their interests. Some of my most successful activities in calculus classes include using Taylor Polynomials to analyze ECG data, using voting data from the U.S. Senate to motivate vector properties, and doing multivariate calculus on real–time cellphone accelerometer data. Every lecture in my class on mathematical modeling used real-world data from the social sciences which the students used to motivate their selection of models, test modeling approaches, and expand their abilities to write quantitatively outside of the standard problem set framework.

My commitment to these principles extends beyond my official teaching in the classroom. In the Dartmouth math department I continued to develop my teaching skills outside of my classes by facilitating the research ethics workshops for first year Ph.D. students in 2015, 2016, and 2017 and helping to develop and teach a series of workshops on mathematical typesetting in LaTeX, with another graduate student and our physical sciences librarian. While in my formal courses I tend to teach with a combination of lecture and computer demonstrations, these workshops and seminars are driven by student interaction, small group discussion, and hands-on examples.

During graduate school, I also volunteered for three years as the coach of a math team at a local middle school and continued volunteering during my postdoctoral career. Many of these students have already taken all of the math classes that are offered in their school and I am able to expose them to new mathematical challenges. I develop activities and lead problem-solving sessions, encouraging them to work together on challenging problems. For similar reasons, I have developed and taught hour-long workshops on mathematical topics, including cryptography, forensic accounting, and barcodes, for the Johns Hopkins University Center for Talented Youth.

Even in these workshops and coaching experiences, I try to incorporate examples from my research, by having middle school students try to gerrymander a grid or having workshop participants construct their own ego networks. One benefit of my mathematical interests is that they offer many avenues for students to contribute and engage with the subject matter. This is particularly true of my work in political redistricting and social network analysis, both of which have substantial data and computational components that make appealing starting points for student research. This excitement benefits students by helping them see the relevance of mathematical ideas to real world problems.

I am constantly working to develop my skills as an instructor and I view each interaction with students, whether in formal class meetings, office hours, or informal discussion, as an opportunity to put my guiding principles into practice for the benefit of my students.

Appendix: Student Comments

Selected comments from Math 1: Calculus with Algebra students:

- "Very accessible."
- "Clear, relevant lectures"
- "I thought he was a great instructor who explained the material well"
- "'Really helpful and there for his students"
- "Great teacher. I could tell he really wanted us to succeed"

Selected comments from Math 8: Calculus of Functions of One and Several Variables students:

- "I really enjoyed this calculus class because the professor simplified the concepts and made me engage with the material"
- "Really showed he cared about the students and took extra time to ensure students understood the material. Extremely patient when asked to re-explain things."
- "He's a really good communicator and knows his subject. Also, he knows how to keep the class focused and interested in the material."
- "Great and enthusiastic in teaching the materials, made class engaging and interesting, always provided real world examples."
- "Made a huge difference in my understanding of concepts and their context in mathematics as a whole."

Selected comments from Math 36: Mathematical Modeling in the Social Sciences:

- "The essays and also the quizzes were very helpful for synthesizing material from each unit and better understanding how the techniques we learned could be of practical value lectures were very well organized and engaging, great use of MatLab examples for real time demonstrations."
- "Essays truly challenged me to think in a way I hadn't before in any Dartmouth class. I think they were super valuable and I feel like I learned to bend my brain in new ways."
- "Well put-together lectures, great, thorough, feedback on essays."
- "Professor DeFord did a wonderful job of being available for his students. He notified us far in advance of office hours, was almost always available over e-mail, and responded extremely quickly. He happily went above and beyond to help his students. He also did a good job of grading our work and handing it back in a timely manner."
- "Class was very interesting and engaging. Assignments were able to reinforce my understanding of the material."