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Teaching Philosophy

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My interest in the many real-world applications of discrete mathematics has influenced my research as well as my teaching. Through content and skills, I show students how mathematics is used in the world and how it is applicable in their lives. I train my students to be life-long learners, stretching them to apply information in new settings, pushing them beyond memorization. While I maintain a high standard of learning in my classroom, I provide scaffolding to help each student succeed. Despite the rich variety of backgrounds that students bring to my classroom, I strive to challenge each one on their level by drawing on my experiences as an instructor of record for the past 9 years. However, I also try new approaches as I continue to grow as an educator, for example implementing a mastery-based system for exams.

1. Applications of mathematics

This semester I am teaching a senior-level Introduction to Graph Theory course where real-world applications abound: connectivity of airline networks, planarity of utility networks, matching algorithms for pairing medical students with hospitals. My students showed great interest when I shared some of my dissertation research on graph-theoretic models for genome rearrangement. Last year, several students came to my research seminar as their interest was piqued asking many questions afterwards. One returned the next semester to work with me on a research project.

Exam problems put in the context of a real-world setting push students to use each skill beyond the standard textbook problems and test understanding beyond the ability to follow an algorithm. They must analyze the situation and determine which skills would be most useful. As a outcome, students recognize uses for the material beyond the semester-long class.

2. Mastery-based grading

To help students develop proof-writing skills and deepen their understanding of the material, I am implementing a mastery-based system for exams in an Introduction to Graph Theory course this fall. Students must exhibit a mastery-level of understanding on a selection of core topics in order to receive credit, however students have multiple attempts to demonstrate mastery. I divided the course material into 14 categories, such as longest path arguments, implications of Prüfer codes, and corollaries of Hall's matching theorem. Exam 1 contains a problem from each of categories 1-5, Exam 2 is taken from categories 1-10, while Exam 3 and the final exam will contain one problem from each of the 14 categories. Once a student masters a problem in a category, they do not need to attempt further problems from that category. However, an incorrect answer does not achieve mastery if the student will improve their understanding by reviewing the topic again. (For example, a slight arithmetic error would not preclude mastery.) They can then attempt to master a similar problem on the next exam with no penalty. The final course grade depends on the number of problems mastered.

I chose this system for a variety of reasons. As mathematics is built on sound proofs, my students should not learn to settle for an argument that earns 7 of out 10 points. They must work toward a deeper level of understanding to master a problem. When doing research or preparing a manuscript, there is not generally a narrow window of time for us to find the solution and write it correctly. A proof may see many iterations before we work out all the details and I want my students to have a similar opportunity. Students receive feedback on an exam and can learn from their mistakes to solve a similar problem on a later exam. With the cumulative nature the material, this system also encourages earlier mastery of the material.

In an anonymous mid-course survey, my students were enthusiastic about this new grading scheme. While this is the first time I have implemented mastery-based exams, I have experienced this system as a student. Before the semester began, I sought council from several senior faculty as well as the Center for Teaching and Learning (CTL) on campus, leaving room for adjustment throughout the semester as needed. In response to the mid-course survey, I added a couple of short quizzes to give an extra attempt at mastery on a few problems.

3. Feedback from students

I gather feedback from my students to understand where they are struggling and how I can help them succeed. In a large Integral Calculus class, I used a classroom response system (clickers) to gather student answers to summary questions so I could assess comprehension and adjust my lecture accordingly. In office hours and review sessions, students often come with similar questions. Once a few students begin to understand based on my responses, I redirect further questions to them, adding clarification (and correction) as needed. During this exchange, I take note of how the students have internalized the material and which explanations are the clearest for them.

I also solicit feedback through a homework cover sheet. One question asks for an application of the homework material or something they found of particular interest. Some students detail applications from their own major. Following a lesson about the uses deBruijn graphs in genome assembly, one computer science student was excited to discover that distributed hash tables also use deBruijn graphs. Other students ask about extensions of the material, such as taking into account the capacity of alternative routes when a bridge is under construction (as related to the edge connectivity of a road network). I use this opportunity to direct them to appropriate resources. Another question asks which problems gave the most difficulty and why. As students reflect on the assignment, some share a need for a derivatives review, or note that their intuition with graph connectivity was not in the right place, while others acknowledge that they didn't leave enough time to complete the homework. When I see many students struggling with a particular topic, I either carefully cover additional examples in class or add an expanded commentary to my homework solutions.

4. Challenging each student

I have great success engaging my students, creating a classroom environment where students feel free to ask questions and group work is typical. After introducing a concept, I often pose 2-4 problems of increasing difficulty, asking students to work in pairs, putting their new knowledge to the test. For some, this is an opportunity ask questions in a low-pressure setting, identifying parts they don't yet understand. Others find themselves either reinforcing their understanding in conversations with a peer or confronting a more challenging problem that requires a new idea. While not every student has time to attempt all problems, each student is challenged. During the exercise, I monitor student progress, collecting information about common misconceptions and asking guiding questions to those struggling to get started. With 90 students, I am unable to significantly interact with each group, so I slowly provide partial solutions on the board, sometimes adding notes to warn of potential pitfalls, to ensure that students are converging upon accurate solutions. Afterward, the students are even more engaged, asking questions about the solution and the implications of the new material, leaving with a more solid footing to approach graded problems.

5. Mentoring students

As a postdoc, I have had the pleasure of co-leading an REU at Georgia Tech for 6 students from institutions in the Atlanta area (including two women's colleges and two historically black universities). I worked carefully with two of these students on a research project involving local moves on meanders. With notable progress on the problem, my students presented two posters about this result and one student gave two undergraduate seminar talks. In addition to research, I professionally mentored the REU students. We organized weekly professional development meetings covering topics such as applying to graduate school, non-academic employment opportunities, and what to expect at a mathematics conference– they joined us at the SIAM Discrete Math conference in town. This fall, I am excited to take part in the new Association for Women in Mathematics (AWM) chapter at Georgia Tech, mentoring a sophomore math major.

During the school year, I led a research project with a computer science major on the combinatorial properties of a simplified model for perfect RNA folding. Following her new-found interest in mathematics that began in my Applied Combinatorics course, I mentored her with REU and graduate school applications. She has been accepted in the mathematics masters program at Georgia Tech.

I have also enjoyed working with many graduate students as a postdoctoral mentor at two summer workshops for graduate students and early career mathematicians. At one of these, I selected a series of open problems surrounding the local dimension of a partially ordered set. With much interest in my problems, I coordinated a diverse group of students, ensuring that each participant found a problem to work on while I answered questions about background material, techniques, and motivation. With publishable results at the end of each workshop, I mentored students through the writing and revision process through to a final submission.

There are many facets of academic positions that I learned from my mentors. I have also taken steps to educate myself about opportunities for mathematicians in industry in order to mentor students interested in these career paths. In addition to facilitating research, I will help graduate students prepare for whichever path they may choose.

6. Summary

Since earning a bachelor's degree in adolescence education, I have accumulated 9 years of teaching experience at 3 different universities as the Instructor of Record for 11 distinct courses (and 23 sections) ranging from service courses (College Algebra) to major courses (Introduction to Graph Theory), ranging in size from 20 to 100 students. I have managed undergraduate and graduate graders and teaching assistants, in addition to serving as the mentor for graduate teaching assistants. Each new semester, I draw from my past experiences and explore new methodology to challenge each student, highlight applications, and build a solid foundation for my students' future career paths.