Gregg Musiker's Teaching Statement

Teaching is a passion for me, and I have spent the last decade sharing the power and grace of mathematics with a diversity of students. I have taught my own classes, including algebraic combinatorics for undergraduates at MIT ($\sim$20 students), and precalculus at UCSD for a class of approximately 70 students. My dedication to teaching began when I was in college as I embraced opportunities to teach fellow students. I was a course assistant at Harvard, and in this role, I held a weekly discussion section, office hours, and graded homework for courses in calculus, linear algebra, and abstract algebra.

One of the fundamental truths about mathematics is that different people approach the same material in different ways. This is true for mathematical researchers as well as for students. Indeed, this is one of the most beautiful aspects of mathematics. Accordingly, in my teaching I always try to link ideas together and teach them in multiple ways. For example, in my precalculus course, I emphasized the relationship between algebraic equations and their graphs, and how the solutions to a system of equations are equivalent to the points of intersections in the coordinate plane. When I showed that one can graph a function by taking advantage of the symmetries and recognizing basic transformations, I first did the same examples by plotting a table of points. Thus, I illustrated techniques for graphing an assortment of functions in a systematic way, while at the same time grounding it as a topic which the students had previously encountered.

My teaching style is influenced by my high school mathematics teacher, Paul Machemer, who would never "deprive us of the joy of discovery". While it is sometimes necessary to answer a student's question by reminding them of the relevant theorem or method, I have found that students retain the answer more deeply if I guide them to recall the method themselves instead of providing step-by-step instructions.

Teaching is a balance between challenging the bright students while encouraging and not frustrating the ones having difficulty. I therefore like to give optional questions and examples that stimulate the students to think ahead. As an added bonus these examples frequently prepare students for upcoming topics, making them more palatable since the students have already been introduced to the concepts. In linear algebra for instance, I would frequently ask students, after presenting the definition of invertible matrices and row reduction, whether they could see a general formula for testing if a 2-by-2 and 3-by-3 matrix was invertible, thus previewing determinants. I also considered classifying all possible 2-by-2 matrices up to reduced row echelon form.

I believe in setting a high standard for students with encouragement and support to help them achieve it. Sometimes, this involves holding special office hours prior to an exam, or providing sample exam problems. Other times, I have held review sections to help students better conceptualize the highlights of the course. Evaluation should be fair with clear expectations given to the students in an accurate syllabus. However, the emphasis on different skills depends on the class. A gap in logic would be substantially marked down in a mathematical reasoning course with more leniency in a course such as linear algebra. Similarly, while an algebraic or arithmetic mistake would require a high deduction in precalculus or calculus, it would be a minimal error in an upper division class such as number theory or combinatorics. Grading is not only an evaluative tool, but also a pedagogical tool for helping students take notice of their mistakes and learn from them.

While teaching, I also always try to encourage students to ask questions, patiently pausing when I see confused looks or when I am aware that I just described a difficult theorem or example. I start on this the first day, letting the students know that my classroom is a welcoming atmosphere and that every time a student asks a question, there are usually a handful more with the same perplexity. I fondly remember a thrilling result of this environment when my precalculus students started connecting the dots between different topics, asking poignant questions which foreshadow future lectures, such as "Even though function $f(x) = \frac{x-1}{2x-3}$ is 1-to-1, isn't its inverse not defined everywhere?".

While I present material, I review important concepts in a larger framework so students can see the forest for the trees. For instance, when explaining conditions for invertible matrices, I keep a running list of all the equivalent conditions, adding to the list as the course progresses. When doing examples which illustrate a more general method, I clearly write down in general terms what each step entails so it is the method that is reinforced and not just the specific example.

In graduate school, in addition to my role as associate instructor for precalculus, I was a teaching assistant for a wide range of subjects. One such course was a graduate level course in applied algebra, one of the six courses laying the foundation for the graduate curriculum. In this course, I held my usual duties of grading homework assignments and exams, holding office hours, leading recitation and review sections, for a course in representation theory of the general linear and symmetric groups. It was a great experience to teach students fundamental topics, such as Schur-Weyl duality and to see the look of eureka on their faces as they drew trees of tableaux and solved other problems on the blackboard themselves as I overlooked.

As a postdoc, I taught a course at MIT in algebraic combinatorics aimed at advanced undergraduates, and it was with great energy that I designed a curriculum of topics and lecture notes highlighting the beauty and effectiveness of combinatorics and the related algebraic tools. I was pleased to learn that these course notes, along with the course syllabus and problem sets, will be published online at MIT's Open Courseware repository. The students seemed to appreciate the variety of topics and examples covered, and their engaging in-class questions showed me how much they had learned. I also had a number of intriguing discussions at office hours about further questions or topics extending class material.

I also greatly value undergraduate research, and had positive experiences myself in a summer Research Experience for Undergraduates at Mt. Holyoke College, and as part of the NSF funded REACH group run at Harvard and led by Jim Propp. I have already supervised the research of two undergraduate students at MIT, and have a number of ideas to get more students involved in such research. I have proposed an undergraduate research program to the NSF, one which would use the open source math software SAGE to get more students interested in combinatorial topics such as cluster algebras and chip-firing games, while creating computational packages for other researchers. This work may also lead to the discovery of new combinatorial patterns motivating further research. Through both teaching and research, I look forward to conveying the beauty and universality of mathematics to more and more students.