Teaching Statement

Asher M. Kach

Although I have been teaching mathematics classes for over eleven years, this fall semester is my first time teaching a large (first semester calculus) lecture. I am finding the difference between a classroom of twenty and a classroom of one hundred eighty to be not so great as I imagined. Regardless of the number of students, the fundamental tenets of teaching and learning mathematics remain. Here, I discuss two of the most important:

- *Mathematics is not a spectator sport.*
- *Mathematics is a conceptual subject.*

These two tenets shape my philosophy of teaching and learning, and influence my actions as both a teacher and a student, inside and outside of the classrom. Both of these basic tenets is worth elaboration, particularly my attitudes and approaches to each.

The most fundamental aspect of mathematics that shapes my teaching and learning is that it cannot be done as a spectator. Like everyone else, I have attended lectures and seminars in which I dutifully took notes, but failed to actively consider the symbols that I was transferring from the blackboard to my paper. At the end, my understanding of the subject was as weak as should be expected under the circumstances.

Our students are no different. The phenomenon of copying symbols from the blackboard straight to the paper without further thought or reflection happens too often in today's classrooms. Many of my teaching practices aim to confront this spectator approach to mathematics. Though the manner in which I do so depends on the classroom format, with effort it is seems always possible to engage students as active learners.

Within my large calculus lecture this semester, I ask several *clicker questions* every class period. These questions are (usually) multiple choice questions which the students have a couple of minutes to discuss and answer. Although the popularity of these clicker questions is mixed, there is no doubt that the students engage with the mathematics. It is not unusual for the questions to generate heated student discussion about the correctness of an answer.

In my smaller multivariable calculus class this semester it is easier to actively engage the students. Often, I have a worksheet which the students complete together in groups during class. The questions engage the students with the material, from routine exercises to difficult conceptual and computational questions. Though the worksheets use precious classtime, I find that students learn more from completing the worksheets than from hearing me speak at the blackboard.

Regardless of whether the class is a large lecture or small section, course policies and various teaching methods can invite student engagement. Within my classes, regular homework (assigned every class but often not graded) and weekly quizzes (always graded) ensure students are doing mathematics regularly. When doing routine examples at the board, I often invite the students to work ahead of me, completing the example at a pace that facilitates this. Of course, this not only engages the students with the mathematics, but also allows for immediate feedback on the correctness of their solutions.

An equally important aspect of mathematics that shapes my teaching and learning is that mathematics is a conceptual subject. Unfortunately, too often the emphasis is placed on skills knowledge rather than conceptual knowledge. This results in a frightening number of students who can, for example, successfully differentiate complicated functions given algebraically (e.g., $f(x) = \frac{x^3 \sin(e^{2x})}{(x^2+1)^2}$) but who cannot sketch a graph of $g'(x)$ from the graph of a function $g(x)$ or from a table of values of a differentiable function $g(x)$.

There are many ways I emphasize the conceptual aspects of material. As much as possible, I discuss functions defined qualitatively, numerically, graphically, and algebraically. When students see the same idea situated across multiple representations, the idea is more likely to become an integrated concept rather than a rule to blindly apply. When discussing theorems in a calculus course, I am happy to sketch proofs (as appropriate) if the proofs are enlightening. At the same time, I am equally happy to skip mysterious proofs or offer specific examples as evidence (emphasizing that an example does not equate with a proof). Finally, and perhaps most importantly, the question "Why?" is no stranger to my classroom. By regularly asking this question, I force my students to reflect on why we are doing what we are doing. Not only does this engage the students with the mathematics, the question emphasizes the conceptual aspects of mathematics rather than the computational aspects.

My assessments reflect and emphasize this belief in mathematics being a conceptual subject. Although all of my exams have routine computational questions, I believe in having less routine conceptual questions as well. For example, I would rather ask a first semester calculus student to compute, with $f(x) = x^2$ or $f(x) = \sqrt{x}$ or similar, the limit $\lim_{h\to 0} \frac{f(x+h)-f(x-h)}{2h}$ (which the course here does not cover) than the limit $\lim_{h\to 0} \frac{f(x+h)-f(x)}{h}$. The conceptual knowledge and algebraic techniques necessary to evaluate the limits are identical. The former, however, allows one to ask *why* the answer is the slope of the tangent line, $f'(x)$ (assuming $f'(x)$ exists), a connection that is more important than the computation in today's technological era.

The most important lesson regarding teaching that I have learned regarding teaching, in my thirty years as a student and eleven as a teacher, is that the students we teach are no different than ourselves. Some may be less motivated, less interested, or less adept mathematically, but fundamentally they learn best in the same conditions as we do. As educators, it is our job to try to understand student motivations, interests, and skills and to adapt the content and pedagogy to them. My hope for the future is to continue to become both a better teacher and a better learner, transferring my knowledge and experience between these two domains.