Teaching Philosophy

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Teaching addresses a core question: How can I help students to balance their own enjoyment and motivation against the rigorous and sometimes repetitive work needed to understand mathematics? Further, how can I help them retain the material beyond the next exam? My students enter the classroom with a range of interests and ability levels. For each of them, I seek to create positive experiences that affirm why mathematics matters.

Students starting pre-calculus or calculus are more likely to already have negative feelings about math. So, in addition to communicating content, I need to help them build positive associations with the subject. One effective way I do this is by distinguishing the actual mathematics from the formal tools we use to teach and communicate it. For example, students may shut down when they encounter set builder notation, integral signs, the Leibniz derivative notation, etc. Compare this with students who think that they dread writing, when in fact they really dread using Microsoft Word (a tool, not inherent to writing). As an educator, I search for opportunities to separate tools from topics, so that students grow their respect for and interest in mathematical principles, while together we investigate friendlier tools.

To excite passion about concepts, I explore applications that I hope will resonate with the group. In a multivariable calculus class, for example, 3D games provide an ideal backdrop for a discussion of euler angles and their susceptibility to gimbal lock (a loss of a degree of freedom in a three-dimensional mechanism when axes of two of the three gimbals become parallel). This can lead naturally into studying quaternions and their advantages in performing smooth 3D rotations. Seeing applications like these can lead students to dramatically change their attitudes, and help them to embrace the rigor of the discipline, with more curiosity.

My background in industry also informs my approach in the classroom, in particular my emphasis on group work and peer review. As a Senior Software Engineer and Scientific Programmer, I've mentored many junior software engineers. The most effective way I've seen to help an individual improve is through communicating to and with a group, with a clear shared goal in mind. For example, how can we as a team write code that is the purest logical expression of the idea/algorithm in the given language? How can each individual contribute the most to this shared goal? At Wall Street On Demand in Boulder, we initiated code reviews: a small subset of the engineers sat together and reviewed one another's code, line by line. This tedious-sounding practice was extremely effective at improving both code and engineer quality, and it also produced a positive ethos of teamwork.

Inspired by the results of the code reviews, I tried a similar idea in a graduate graph theory course at Arizona State University. A student would present a homework solution on the board and the rest of the class would give feedback. To foster a positive atmosphere, we took the "Yes and..." approach espoused by theatrical improvisation: all feedback must build on the good parts of the solution instead of just pointing out the bad. Students were initially shy, but by the end of the semester they could better articulate their own reasoning and communicate with others, and they also had a greater sense of pride and focus on finding the best possible collective solution.

When I teach a class at any level, I like to experiment with classroom mechanics such as the balance between working alone and in groups. Last year, I had students keep a *Practice Journal* in which they worked suggested exercises. I gave them a large list of exercises of each type and simply instructed them to keep working problems in their journals until they became easy. I said that I would be collecting journals for inspection every few weeks, to better understand their individual processes and progress. It turned out to be unfeasible to collect and review journals this often, and initially I thought that the journal idea was a total failure. But at the end of the course, a large fraction of the students remarked on the efficacy of this requirement. Allowing students ownership over the number of problems had inspired more rigor and repetition than I would have asked of them. As with the peer review, I continually look for ways that I can facilitate students' self-motivation, which is essential for them to deeply understand the concepts.

Beyond these mechanics, I bring to the classroom a great love of and enthusiasm for mathematics. Because my path within the discipline is unique to me, I seek to mentor the infinite possible paths that my individual students might take, from a standpoint of interest in and respect for their work. I aim to balance rigor, which is necessary for mastery of the discipline, with pleasure, which will motivate students to think beyond a single course. Though rigor is often uncomfortable, I want my students to see that the payoff is worth it, because the work opens up crucial windows into perceiving the structure of the world.