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Teaching Statement

Human learning has always been driven by questions rather than answers; our classrooms should reflect this. My best teachers were great because they created a classroom where the dialogue was not so much about answering questions, as about asking questions and *trying to* answer them. My goal as a teacher is to do the same.

My adult life has been heavily shaped by four spectacular teachers: Everly Broadway, my MathCounts coach, Betsy Dawson, my Latin teacher, and Bud Stuart and Jim Tomberg, high school math teachers and Math Club coaches.

One thing that these teachers had in common was a tremendous passion for their subject, which kept all the students awake and alert, even in early morning classes. This was expressed in myriad small ways, the most memorable of which were frequent jokes with only peripheral mathematical content (morning calculusthenics, or interjections like "It's [26!] pronounced TWENTY-SIX!") and a willingness to ignore the usual curriculum in favor of interesting nonstandard topics. (Every so often, a teacher would purposefully organize such a diversion. I recall being particularly inspired by Mr. Tomberg's unit on countability and Cantor diagonalization. Usually, though, these grew out of questions asked by students. These teachers created classroom environments where we felt encouraged to ask questions, and we responded by doing so.)

Many of my happiest memories are of time spent at MathCounts practices and in Math Club. It was here that I learned modular arithmetic, combinatorics, probability, and geometry, as well as problem-solving skills that I still use regularly. When Mrs. Broadway retired, I returned to my middle school and coached the MathCounts team for five years, starting as a high school senior. Throughout my undergraduate career, I regularly went back to Math Club, taking on more of a teaching role. Watching a new generation of students discover these subjects was very rewarding, almost as exciting as learning them myself.

While a graduate student at Cornell, I was active in organizing the Ithaca High School Senior Seminar, a lunchtime program in which graduate students teach six-week modules to advanced high school students, then advise them in research projects. I taught modules on cryptography, continued fractions, and voting theory.

I have really enjoyed talking about these interesting mathematical topics with these students. Their questions have frequently led the units in unexpected and interesting directions, and they have been very successful.

The students in these programs are always self-motivated, and the topics are ripe with questions for them to ask. Consequently, learning is driven by the students' curiosity. For example, the continued fractions module spawned a two-week subunit on the structure of $\mathbb{R}$ in which the students discovered the epsilon-delta definition of limit, constructed the real numbers as equivalence

classes of Cauchy sequences, and used Cantor diagonalization to show that there are more real than rational numbers.

I try to make my college teaching as much like these extracurricular classes as I can. I agree with many of the ideas expressed by Paul Lockhart in his "Mathematician's Lament" [Lo], so I structure my lectures as much as possible around simple abstract questions (e.g., "What is the area of this shape?"), rather than lists of formulae to be memorized and examples of their application. One of the first, and most important, lessons I learned from Ms. Broadway was that many formulas can be reconstructed in real time if one understands the ideas behind their derivations; I try very hard to pass this understanding on to my students.

Another trait that my great teachers shared was a merciless patience and an unwavering faith in all their students. We were routinely asked to perform in front of the class, with no regard for our skill or lack thereof. (Bud would use dice to select victims from a large class - a free lesson in probability.) If we didn't know what to do, they would wait, sometimes for minutes on end, with minimal prompting, until we figured something out. I was very good at math and so didn't notice this except to giggle at unprepared classmates, but I was not good at Latin, and there the effect was profound. On the one hand, I studied harder for Ms. Dawson's classes than I ever had before in order to avoid being caught unprepared. On the other hand, when I was inevitably caught unprepared anyway, and wanted to declare defeat, she would not allow me to give up. Eventually, I would always come up with something. As often as not, it was mostly right. Furthermore, the process always left me with a good sense of which parts were right, and much more able to understand the corrections to my mistakes. These episodes gave me a considerable self-confidence boost, and incidentally taught me the value of perseverence.

I try to use similar techniques in my teaching. For example, I begin every class by having students explain the homework at the blackboard (a practice I borrowed from Mr. Stuart). Still, I am generally more comfortable using such methods in more intimate settings like office hours.

Office hours are by far my favorite part of teaching. Students come to office hours ready to learn and willing to ask questions. I am much more able to use Socratic techniques when working with students individually or in small groups. Answering a question with questions like "Can you replace it with two easier problems?" or "What might you try first?" has a tendency to produce a long silence followed by a correct answer, or at least a partial answer and a better question. Students frequently know how to handle a problem, but don't believe in themselves and simply need to be reassured that they are going about it correctly. With small groups, I usually let the students answer each other's questions; this gives them a chance to practice explaining their reasoning. The students often understand each other in ways that I don't, and lead each other down surprising and interesting lines of inquiry. When dealing with more difficult concepts, I think the challenge of finding multiple different

explanations is always worthwhile, and the reward of seeing a student suddenly *get* it is indescribable.

Most calculus students will not grow up to become scientists or engineers; indeed, many will never compute another derivative after the final exam. However, they will all face many situations - as consumers, as parents, as citizens - where they will be very well served by an ability to approach quantitative questions logically and explain their reasoning clearly. Thus, I believe that an essential part of my job as a math teacher is to cultivate my students' quantitative instincts and their explanatory skills. I try to emphasize these even more than the simple abilities to solve the exercises. This emphasis is reflected in my grading, where I expect the use of complete mathematical sentences and assign as much credit to a clear explanation as I do to a numerically correct answer, and in the design of my tests, where I use true/false questions to try to promote skepticism, and try to design other questions that measure the students' ability to reason in addition to their mastery of the algorithms.

References

[Lo] Paul Lockhart, *A Mathematician's Lament*, MAA online (2008). http://www.maa.org/devlin/LockhartsLament.pdf.