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Teaching Statement

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My teaching follows one simple mantra: Know your audience. Accept your audience. Adapt. Thus far, my audience has consisted of undergraduates in algebra, precalculus, calculus, and discrete mathematics courses. Below I detail some illustrative adaptations I have made to the distinct goals, personalities, and ability levels of these audiences and those at expository talks as well.

Discrete Mathematics for Computer Scientists:
This past spring I taught a highly intelligent, curious, and motivated 500 level discrete mathematics class of computer scientists. Most students genuinely loved applications to their field. Most thoroughly despised abstract math without clear use. I adjusted accordingly. At first I went too slowly and bored them to tears. I picked up the pace, and the frowns turned upside down. While “partial order” questions did not excite them, they were intrigued by rewordings with scheduling, flow charts, and parallel processing. While freshman Calculus students fear participation and want “the formula”, these students wanted to think. When asked a tricky problem during class for the optimal graph coloring yielding a most efficient schedule, every student wanted in on the action. On day one it was fine, but by week three we connected.

Calculus:
Many calculus students are future engineers, biologists, physicians, and others with more intellectually demanding futures than the average student. They have trouble thinking independently, but they learn material well. If a problem is complete aside from four lines of simple algebra, they “get it”; they say to skip that and just get onto the next hard problem.

Their main difficulty is understanding theory and notation. If Riemann sums are taught immediately with summation notation, they don’t know what each line says, let alone the logic of the argument. They are also unable to do a Riemann sum with n intervals (as opposed to a specific number of intervals) on their first try. First, we try to approximate an area bounded by a parabola. They say nothing. I ask them if it could be negative 3. They say no. I ask if it could be four billion. They say no. I point out they can indeed say something if they just try. I challenge them to do better. I wait. A student usually says the area is less than one because it is contained in a unit square. When I ask how to do better, the two answers I hear are to use a triangle and to use smaller rectangles. I work out both examples and explain that we will use the rectangles. We then approximate many more integrals this way for a whole day. Theory and summation notation are entirely delayed until the second day. At this point, it seems “same old same old”, and they see the symbols just mean the same concrete thing they did before.

New notation and theory must only be given once enough examples are stated concretely to be old hat to them. This applies equally to limits, the Mean and Intermediate Value Theorems, and so on. For instance, students do understand that since the graph of \( y = x^5 + 1 \) goes ever higher to the right and ever lower to the left, at some point it crosses the \( x \)-axis. They also see that we don’t know where. At this point and not before, they are ready for a statement of the theorem.

Remedial Algebra:
Teaching college algebra could not have been more different. Most students were returning students with full time jobs, paying for college themselves, with little interest in mathematics and a great deal of math anxiety, who saw the class as a hoop costing precious time and money. Some saw me as the enemy. One
word was paramount: empathy. My teaching perspective was, “We’ll tough this out together.” The word “easy” can never once be used. Professors, once precocious, can forget that these students are at their limits just trying to understand. If their emotions shut down, so do their minds. The professor must do each type of problem many times, never skip even the smallest step, and (almost) never make a computational error. Avoiding nearly all errors requires not only preparing for class, but actually working out every problem in detail before class begins.

Math Circle and Expository Talks:
I give numerous expository talks to talented and curious undergraduates. This year I have started participating and speaking in Math Circles for high and middle school students at Ohio State and George Mason Universities as well. These are best thought of as math “shows” with the chalkboard as the stage. A magic show demonstrates the “coolest” magic that one can. The math show does the same for math. Teaching happens as a byproduct; putting on a great show guarantees these math whiz kids put in the rest themselves both during and after.

The undergrads love to see a hint of higher math in a juicy special case. The speaker’s role is to open a new world. Cute elementary problems are nice, but more successful is the speaker who makes them say, “Wow.” That is what I said when I first saw the simple proof that infinity comes in different sizes, that there are more irrationals than rationals, and that elementary rules of exponents for infinite cardinalities yield a simple proof that real numbers exist that no computer program can approximate arbitrarily well. To make students as excited, I just retell the tale. Basic set theory is standard fair to me, but seeing their excitement lets me relive the day I first read of this myself. It lets me remember why I’m here.

The younger students struggle with theorems and proofs, but can be quicker than the professors with patterns and explanations. Their explanation might not meet modern standards of rigor, but then neither did many of Euler’s, so I think we can forgive them. The Math Circle is not a talk, but guided exploration. They love to think and participate. They love patterns, cute problems, learning about buzz words they have heard, and using the math they learn in school to solve far harder problems. The “Circle in a Box” publication at www.mathcircles.org is by far the most authoritative reference on how to run these circles, and my overall method is what I learned therein.

Universally Applicable Techniques:
Some tried and true methods apply no matter what the course. I would like to say I discovered thousands of these myself. The truth is I learned almost all of them from two sources: my teacher training course in graduate school and Steven Krantz’s book “How to Teach Mathematics”. Reading theories of learning did not have an overnight, significant effect on my teaching. Krantz’s book did. As a new teacher, I thought only explanations mattered, and such things as proper blackboard use and looking students in the eye were trivial. Krantz reminded me what I learned in teacher training. I now refresh my memory with its contents twice per year.