Statement of Teaching Philosophy and Practices

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I have taught mathematics at a variety of institutions: a state university in the Pacific Northwest, a vocational school in the Midwest, a university in Scotland, and a private liberal arts college in the Northeast. I have also taught many different levels of mathematics, with topics ranging from fraction addition to Riemann surfaces. My experience has helped me develop a philosophy on teaching, as well as specific tactics I employ in my teaching.

Teaching philosophy

Teaching is an important component of being a mathematician, and is necessary for future of our discipline. Furthermore, exposure to mathematical reasoning is a critical part of a student's well-rounded education. It is an honor and a privilege to share my love and enthusiasm for mathematics with others.

Learning can and should be fun. Of course, the purpose of a mathematics class is to learn, and learning yields some less-than-fun moments, as frustration and struggle are an unavoidable part of the learning process. Nevertheless, students learn more effectively when they have a positive attitude and enjoy the material. As a teacher, it is my responsibility to foster both, which I do with a relaxed and enthusiastic, yet professional, demeanor in the classroom.

Teaching goals

(1) **To foster holistic learning, not mere memorization.** In order to understand the details, students need to see the big picture and see how all the various topics fit together. During my first year as a graduate student, while I was teaching an introductory statistics class, a student asked me if she was expected to memorize one of the large probability tables in the back of the book. I realized many students view mathematics as a series of unconnected facts to memorize, set apart from the rest of the text by red rectangles. Under this unfortunate view of mathematics, memorizing a Z-table is not so unreasonable.

(2) **Portray mathematics as an ongoing story about discovery, not merely timeless facts.** Students often view mathematics as a subject set in stone, unchanging and eternal. Alas, this perspective robs the subject of its excitement. I remind my students that mathematics—or at least our understanding of it—is the result of human endeavor, and that struggle is an unavoidable, and often essential, aspect of the subject.

(3) **To encourage increased student responsibility and ownership of learning.** Of the most important lessons that students should learn in college is how to take responsibility for their welfare and learning. I agree with Steven Zucker [2], who said "The instructor's is *to guide the students' learning*. It is not to cover the material, for that is the textbook's job. It is not to teach everything to the student: *teaching in college becomes a cooperative effort shared by the instructor and the student.*" (Emphasis in original.) Students are more motivated when they are in control of their studies. Furthermore, putting students in control of their own learning better prepares them for life after college.

Teaching practices

• **Encouraging conceptual, holistic learning**. It is a challenge and a responsibility for teachers of mathematics to encourage conceptual understanding. To meet this challenge, I try to encourage what Ken Bain calls a *natural critical learning environment* [1]. Rather than viewing my role as giving the students information, I encourage them to be active participants in the creation of knowledge. This means, for example, giving worksheet problems deriving some of the main principles of the course. It also I try to keep in mind the larger picture while planning lessons and writing lectures, rather than simply covering the material in one lecture or another. I also drop hints about the big picture while teaching the material, and choosing examples that naturally raise the larger ideas and issues.

• **Discussing (relatively) recent developments in mathematics**. For example, when covering series in a calculus class, I not only briefly discuss the Riemann Hypothesis, but also how Apréy's constant ($\sum_{k=1}^{\infty} 1/k^3$) was only proved irrational in 1978. Likewise, while teaching about graph theory, I've mentioned Appel and Haken's proof four-color theorem.

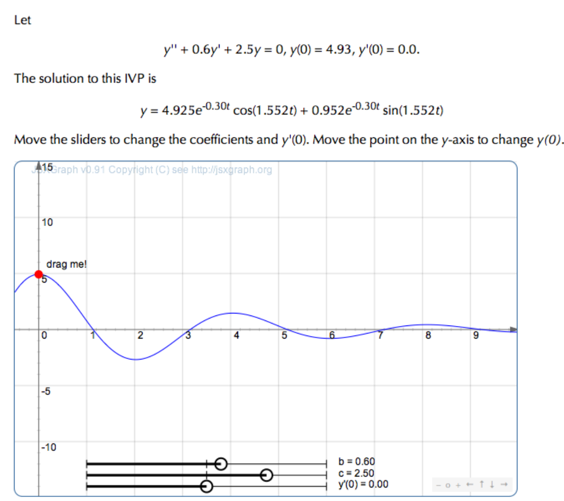
• **Making explicit at the beginning of the term the expectations for the class**. Student responsibility cannot be obtained overnight, and postsecondary educators must make the expectations clear. It is best to make this expectation explicit on the first day of every term, and reinforce it throughout.

Examples of worksheet problems designed to encourage student construction of knowledge:

• Using the quotient rule and the information above, compute the following:

$\frac{d}{dx}\tan x = \frac{d}{dx}\frac{\sin x}{\cos x}$

• Let $f(x) = b^x$ where $b > 0, b \neq 1$ is a constant. Then we can rewrite the rule as follows: $f(x) = b^x = e^{(\ln b)x}$. Use this and the chain rule to find $f'(x)$.



A demonstration I created for my differential equations class. This and other demonstrations are available online at `http://chrisphan.com/a/demos.html`.

• **Incorporating low- and no-stakes assessments to reduce student stress**. When beginning a math class, students may feel ill prepared or have had bad experiences in mathematics. During their first year, they may be apprehensive about the transition to college. These stresses can bring about a negative attitude and a feeling of inevitable failure, which can interfere with learning. *Teachers of mathematics can and should take steps to reduce this stress.*

While we should have high expectations for our students, we should also avoid creating *unnecessary* stress. For example, I use low- or no-stakes methods of student assessment before exams, and emphasize to the students that they are "practice for the exams." I generally do not make homework as a large part of my students' grades, although I do encourage them to do it, explaining that it will help their exam performance. I believe in-class worksheets, which are not to be graded, are a good method of low-stakes assessment, as well as a good way to encourage active learning.

• **Incorporating computer demonstrations into my teaching**. While I strongly believe in *also* graphing functions by hand, a computer demonstration can illustrate principles in an exciting way.

For example, when teaching calculus, I use a demonstration showing the graph of a function, a line tangent to that point, and the graph of the derivative. My demonstration allows me to move the tangent line to different places on the graph, which helps the students understand the relationship between the graph of a function and its derivative.

Likewise, while teaching differential equations this term, I created a demonstration showing the graph of the solution to the initial value problem

$$y''(t) + by'(t) + cy(t) = 0,\ y(0) = u,\ y'(0) = v.$$

The demonstration allowed me to change the values of b, u, v, allowing me to showcase the various possible behaviors of y (e.g. dampened oscillation).

• **Educating students about the strengths and limitations of graphing calculator**. No doubt, it is unfortunate when students reach for their TI-89s when asked to compute $\frac{1}{7} \times 7$, but this problem can be addressed with patience and assessments in which calculators are disallowed. On the other hand, calculators can help students explore the behavior of functions in a rapid way. We must educate students about the limitation of these tools.

References

[1] Ken Bain, *What the Best College Teachers Do*, Harvard University Press, 2004.

[2] Steven Zucker, *Telling the Truth*, Notices of the American Mathematical Society **50** (March 2003), no. 3, 325.