

## Heather Hardway - Teaching Philosophy

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In an interdisciplinary field like mathematical biology, communication across disciplines is essential for success. I learned first hand the difficulties that can arise in such a research group, but I also learned that overcoming the communication barrier can be achieved by having an atmosphere where people feel free to ask questions and answers can be explained in multiple ways. I have approached teaching with the same philosophy: many opportunities should be given to answer students' questions and they should be given an answer they understand, which may take multiple attempts and/or utilize technology.

My first teaching experience as a graduate student was a non-traditional one. I was in charge of organizing a VIGRE research seminar in mathematical biology. I presented current research papers and individually met with undergraduates to develop research projects related to developmental biology and supervised their progress. The first project that was started involved a numerical partial differential equation solver. Students implemented a numerical scheme, but did not take care in their choices for parameters to insure stability of the method. After drawing erroneous conclusions from the faulty data, I eventually realized the mistake, and while much work had to be redone, I gained a greater appreciation and understanding for numeric methods, and made sure to emphasize these points in the future. In a later group, a project culminated in a paper (Hardway et al 2008). My expectations of our undergraduate researchers continue to be surpassed and I have found the experience extremely rewarding. I hope to continue finding projects for undergraduates and getting them involved in this fascinating field.

The first traditional course I taught was Vector Calculus. I was the sole instructor, responsible for designing the lectures, structure, exams, and homework for the course. I also took the initiative to demonstrate MATLAB functions relevant to the course (plotting surfaces, contours, vector fields, etc.). As students frequently have difficulty visualizing objects in 3D, I encouraged students to use technology as an aid on homework, but emphasizing how all could be verified analytically, and that they would be required to do so on exams.

In addition, I held regular office hours, which were readily used by many students. I took pride in the fact that so many students felt comfortable asking me questions, where other instructors rarely had students visit their office hours. I believe math has to be made accessible and it is necessary to relieve the fear many students have. One way to do that is to show students how to tackle problems by asking them leading questions, and showing them they already have problem-solving skills. For example, often the first step in solving a problem is recalling a definition, so this is an easy question to ask students to get them started. On an evaluation: *Hardway's greatest strength was her responsiveness to the students. She was very helpful at office hours... a good balance between*

*going slowly and making sure we understood the material and making sure it was not too slow.*

The last course I taught was also my favorite, Ordinary Differential Equations. I emphasized the existence and uniqueness theorems and qualitative analysis. While the proofs are not part of the course, the theorems are very powerful and can be used to gain much information about the behavior of solutions. Later, I introduced numerical methods and used the Lorenz system to illustrate complicated nonlinear phenomenon not seen in the local analysis. Also, I felt it was important to introduce examples where numerical methods fail, and how such inconsistencies can be seen analytically. Namely, I sought to show how useful numerical methods can be in depicting nonlinear phenomenon, but emphasized caution and the need for check-points when using them.

While physics examples frequently appear early in early calculus (notions of work, force, etc), ODE offers many natural applications to the biological sciences. The class gives a way to introduce students to mathematical research as well, by implementing a project in place of an exam. My first semester as a TA, I was required to grade final ODE projects, based on the spruce budworm model of Ludwig et al (1978). I was so impressed with the sophistication of the reports, covering topics such as dimensional analysis and bifurcation. When I taught the course myself, it was during a condensed three-week summer session, and I did not feel students had enough time to complete such a project. However, if I teach this course during the full length semester, I would implement a final project, creating a bridge between the course and undergraduate research in mathematical biology in the process.

In the future, I would enjoy teaching any course related to dynamical systems (ODE, PDE, discrete dynamics, etc.), but I also really love single variable calculus. Working with several highschool AP and IB calculus students, I learned how to explain concepts in many different ways and which ones had the most success. Each time a student finally understand a concept is extremely rewarding. Also, my students frequently commented that they “never felt dumb” and always felt free to ask questions. This experience transferred to the classroom as well. Students wrote on evaluations:

- *She was also good at explaining concepts in more than one way, which was helpful in learning and understanding the material.*
- *The atmosphere was great. I was not afraid to ask questions that might be “silly” to others, but not to me*
- *...was always extremely well-prepared and quite helpful. very approachable and really enjoyed the class and learned the material thoroughly*

I hope to always put students at ease and be able to describe concepts in multiple ways. At the same time, as an interdisciplinary researcher, I can expose students to interesting biological applications and involve undergraduates in research across fields.