Statement of Teaching Philosophy

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My approach to teaching hinges on the recognition that students learn most successfully when they see connections between the course material and the knowledge they already possess. I want my students to view science not as a set of isolated facts to be memorized but as a complex of concepts and tools that connects with and has relevance to their own lives. My own most rewarding educational experiences both as a student and as a teacher have come through the “aha!” moments when such connections are first made. But these moments are infrequent if left to occur haphazardly, and students rarely come into a science class with the self-awareness or incentive to pursue them. In my teaching, therefore, I build activities into the course that specifically encourage students to explore the broader implications of what they learn and to help them incorporate new information into a larger cognitive framework. In my courses, students have the opportunities to cooperate with, teach, and learn from their peers; to explore course topics outside the classroom; to respond to what they have heard in a lecture; to draw connections between course material and their own experience; and to reflect on the personal path by which they arrived at a solution or gained understanding of a concept. These “connective activities” do not replace more traditional homework or laboratory assignments, which play a key role in developing problem-solving skills that are important both for majors and non-majors. Rather, they complement mathematically rigorous tasks by solidifying students’ grasp of the physical context for each problem and allowing them to engage course material at higher cognitive levels than they otherwise would.

In my past teaching experience, I have found that putting science into a larger context can also help non-science majors develop an understanding of the role of science in society and an appreciation of the scientific method as a remarkably successful prescription for discovery, understanding, and consensus-building. In the introductory non-major courses I taught in graduate school, for example, my students read popular science articles and discussed them in class. This exercise familiarized them with recent scientific advancements, helping them to consider the potential impact of the new findings on their lives and on society as a whole, and encouraging discussion and debate about controversial scientific issues. I also assigned term projects in which students worked in teams to research course-related topics of their choice and to present their findings to the class. This allowed each of them to experience science in a collaborative setting and to become “experts” in a particular area of interest. I encouraged the students to use these projects to explore the intersections between astronomy and other domains such as technology, history, politics, art, music, literature, and popular culture. I found that these activities led to greater student enthusiasm and engagement in discussion section than did the simple question-and-answer review format.

With these experiences as a basis, I am currently developing an idea for a semester-long group project that would teach students first-hand about the scientific process. Each student would design and carry out a very simple experiment outside the classroom on a topic not necessarily related to the course material. Examples might be an opinion poll of friends and classmates or a contest to see which method of folding paper airplanes results in the longest flights. Each student would formulate a well-defined question to be answered by his or her experiment, then take a first round of measurements and report the results and preliminary interpretations to a group of 2–3 fellow students. Using feedback from the group, each student would then repeat the experiment with an eye toward reducing biases and systematic errors, as well as refining the explanatory hypothesis. A final report would describe the entire process, analyze the experiment's successes and limitations, predict future results based on the refined interpretation, and propose ways in which subsequent studies might test these predictions or further reduce the uncertainties in the experiment. Because of the subject matter, such a project would not replace a traditional physics or astronomy lab course. Rather, with its simple and familiar topic, the project would allow students to focus on the nature of the experimental procedure that forms the basis for the scientific process. In grading such a project, I would focus mainly on the extent to which the student explored the topic, gave serious thought to the factors affecting their results, and addressed the issues raised by his or her group members. In a course for majors, I would require students to include some statistical analysis, but my goal for the project would be to encourage creative scientific thought within a systematic framework rather than to insist upon a definitive result.

Reciprocal peer teaching is another connective activity that I plan to incorporate into normal course activities in the future. Through this method, students learn to synthesize diverse contributions, to explain their own reasoning to others, and to collaborate in pursuit of a consensus solution, all important aspects of the scientific enterprise. Such group work also plays an important role in providing the supportive peer interactions that are critical to the retention of female and minority students in the physical sciences. I will implement reciprocal peer teaching in my courses through a version of The Astronomy Learning Center (TALC), a program now underway at UC Berkeley for undergraduate non-major and introductory major courses. In TALC, groups of students work at blackboards to solve homework problems with occasional guidance from an instructor; students are encouraged to help and to learn from each other rather than depending on the instructor for answers. This collaborative learning process improves students' understanding through guided practice, boosts their confidence as they teach each other, and builds community among the participants. In addition, since TALC occurs outside regular class hours (in lieu of some instructor office hours), it allows discussion section time to be used to supplement lecture material rather than simply to help with homework.

In courses for majors or graduate students, connective activities can help students not only to improve their understanding of the course material in a broad context but also to practice professional scientific activities. To help students in an advanced class learn how to write scientific proposals, talks, and papers, I would give short writing assignments assisted by examples and culminating in a final presentation. To show how the physical principles we discuss in class are being used, tested, and extended in current research, I would bring in visitors for guest lectures, set reading assignments from research journals, or arrange tours of local research laboratories. To familiarize students with the various settings in which scientific research occurs, I would organize "job shadow" days or invite speakers from academic and nonacademic institutions to discuss their work, career paths, and advice for young scientists. To emphasize the collaborative and process-oriented nature of the scientific enterprise, I would implement both short- and long-term group projects in which students would work closely with one another toward a common goal; grading would be based less on achievement of a particular solution than on the paths taken to pursue it and the success of the group in fostering understanding and expertise in all of its members. To give students experience in communicating science to nonscientists, I would assign group outreach projects such as leading a star party, organizing a physics demonstration night, giving a talk to a public audience, or writing an article on a scientific development for casual readers. Finally, in my advanced classes I would like to help my students think explicitly about their own learning styles; about the types of skills and strategies that continually surface in scientific coursework and research; and about the specific patterns of thought, logic, and informed choice that lead to the solution of a scientific problem. These are topics that have implications beyond the physics classroom: whether or not they become research scientists, students can use these lessons throughout their careers. By integrating these connective activities into my courses, I hope to give science majors and graduate students not only a deeper understanding of course material but also a more realistic sense of what it means to be a scientist and a member of a scientific community.