Statement of Teaching Philosophy

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A defining belief for me is that everyone can learn physics, and that it is a lifelong source of self-confidence to make even a small amount of progress in this. Why do I believe everyone can learn physics despite its notorious reputation? The fact is that although physics requires one to develop habits and abstractions that seem quite removed from everyday experience, these abstractions are actually not more complex than everyday activities. We are of course very used to our everyday activities, so we may not often stop to contemplate their complexity, but stepping on or off a moving vehicle, throwing a ball, speaking, running, etc., each demonstrate that the vast majority of us are capable of remarkably complex visualization and abstraction.

I liken learning in general and learning physics and mathematics in particular to weightlifting. Not everyone is going to become a weightlifter, let alone a great one. However, most everyone can, if they want to, get very strong lifting weights. Similarly for physics and mathematics: most anyone that is willing to take the time to repeatedly work at physics and mathematics can master everything we teach to undergraduates. The question is mainly how much interest and dedication a student has, and since time is finite and interests abound, of course only a few are going to choose to go far in these subjects.

In the Core Curriculum, Mathematical and Scientific Understanding are grouped together to form one of the pathways to knowledge. Physics was the original motivation for a great deal of mathematics, most notably both differential and integral calculus (which were developed by Newton to understand mechanics and gravitation, respectively). Although the Core Curriculum considers mathematical and scientific understanding to be distinct, in physics, they have repeatedly gone hand in hand. This is not the place to argue for the importance of an education that embraces all four pathways identified in the Core Curriculum. Let us take that as a given. I simply wish to note that physics is an excellent vehicle for establishing the pathway of Mathematical and Scientific Understanding.

Having discussed both my belief that everyone can learn physics, and the subject's importance, we get down to the pragmatic matter of actually teaching it. Here we have real-world difficulties that every faculty member of whom I have asked advice struggles with: (a) how to communicate their own passion and approach to the subject, and (b) how to create the expectation and commitment to do the work necessary to make substantial progress.

Students have come up through a system of standardized tests and frequent evaluations, that while understandable and important, totally colors their attitude toward learning. It is very difficult, in one classroom and in one semester, to re-orient a student to learn for the love of learning rather than to get a grade. The struggle with physics problems returns us to the analogy of lifting weights. The weightlifter benefits from the struggle with the weight, not the achievement of lifting it. Similarly, it is the process of working at physics problems, not the achievement of being able to solve a certain set of them, that builds a student's ability to quantitively understand physical systems.

Because I can only change attitudes so much in one semester, I take a hybrid approach. I rely on assignments, quizzes and exams to keep students focused. However, at every opportunity, I emphasize understanding and problem-solving rather than memorization of a fixed set of facts or techniques. I know this is frustrating for students. They want to know which types of problems will be on the exam, and they want to know how to recognize and get the right answer for those problems specifically. They have been doing this fairly successfully for so long that they are hardly aware that there is another way to approach a subject, and they are skeptical that learning for the sake of learning will pay off more in the long run.

To communicate passion, I rely repeatedly on their and my own real-world experiences. Other things being equal, I generally avoid videos and simulations. Of course I could show a video in astronomy that shows the path the Sun appears to take through the sky, and that would be easy both for me and for the students. The video would have certain diagrams and bullet points that they would be expected to recognize in an assessment. However, there is a distance from the actual physical subject matter in this approach that limits the passion it can engender. What do I do instead? I bring out actual physical models of the Earth's rotation and orbit. I have them get up and in pairs orbit one another, while simultaneously spinning. I take them outside the classroom to our plinth and have them watch the Sun's shadow change from minute-to-minute and day-to-day. Is this as effective as showing a video? I don't really know yet. I haven't been doing it for long enough. It is certainly harder. I do know that it is authentic to my own sense of the marvelousness of the world and it is visceral in a way that I hope leaves the students with the feeling that they are always practicing physics.

One more matter that I would like to touch upon, despite the fact that this statement is already long, is that I repeatedly try to develop critical judgment rather than arguments from authority. A very recent example of this for me is teaching about the existence of dark matter. I harbor a certain amount of skepticism about dark matter myself. That said, the evidence has piled up overwhelmingly for its existence. (This evidence includes galactic rotation curves, gravitational lensing, clusters and superclusters of galaxies, and models of even larger scale structure and of the non-uniformity of the cosmic microwave background.) Of course, I can't cover all this evidence in detail in the week or so that dark matter and large-scale structure gets in an introductory astronomy course. However, what evidence I can cover, e.g., the galactic rotation curves, I always try to cover from the position that the student can themselves understand the experimental data and feel the force of the evidence and its interpretation, instead of relying on my or others' opinions.

It is my hope that we get better and better at helping all of our students appreciate the reasons for learning physics and be successful making progress at it. It is my hope that the students see science's place clearly in the context of the Core Curriculum, and that they learn from physics the simultaneously quantitative and critical faculties that will help them to more fully enjoy their own experiences, and to become the leaders we need for a better world. In any given subject in any given semester, only a fraction are going to bloom this way, but in combination with all the departments, we can hope that all of our students will find a time and place in their undergraduate careers to blossom. When I am not successful at this, it weighs on me like it does on others. When it happens with even a fraction of my students, it gives me renewed enthusiasm for being a teacher.