Statement of Teaching and Research Philosophy

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In a recent editorial in Science, Timothy Goldsmith wrote:

> "In view of the enormous impact of science and technology on the human condition and the insights that science brings to an understanding of the world, these subjects occupy an astonishingly marginal place in a liberal education. This deficiency surely contributes to the disjunction between scientific consensus and political will on issues as diverse as stem cell research and global warming."[1]

As a teacher of physics the challenge I face is how to engage and excite students about the wonders of the natural world around them. Our society is becoming ever more reliant on their ability to be conversant with physical principles and their technological applications. They are increasingly being called upon to understand not just what is possible, but how and why. However, popular western culture tends to discourage depth of knowledge and understanding in favor superficial attributes to such an extent that by the time students come to college they have a natural aversion to subjects that are seen as "too hard," especially the physical sciences. Students like this are in danger of living their lives without ever fully appreciating the beauty of the natural world around them, or developing the skills of critical thinking they will need to address the key issues mankind will face in the future.

In fact, critical thinking and problem-solving skills are some of the most important assets that physics has to offer students, no matter what their major field may be. When I am teaching freshman students in an introductory physics course (many of whom are engineers and consider physics a "necessary evil") I take great pains to point out that long after they have forgotten the equations they crammed into their head for the exam they will find that they will still possess the skill to attack difficult problems. In fact, for most introductory students it is not the physical principles that they find difficult to grasp – we all at some level have an intuitive understanding of Newtonian mechanics from our everyday experiences – it is the rigorous application of a problem solving method that stresses breaking down complexity into manageable parts that they struggle with.

However, despite the utility of critical thinking and problem-solving skills, as a physicist what I strive to leave students with is a sense of wonder and awe at the world around them. As an undergraduate, I remember occasions when I would leave class with a sense that because of what I had just learned the world was different for me somehow. Because of something I had learned, some insight I had gained, my universe was a little

[1] Science, Vol. 297 (13 Sept. 2002) p. 1769

less mysterious, and a great deal more beautiful and awe-inspiring. I treasure these memories and I try as hard as I can to instill the same sense of wonder in my students. I find that this is essential when teaching graduate students, who often get lost in the complexity of a subject and lose the ability to step back and appreciate what they are really trying to accomplish.

All of this takes an enormous amount hard work. Contact time with students is critical, whether it is a few minutes spent answering questions before or after class, office hours, review sessions, or casual hallway conversation. A professor must be interested in and willing to engage thier students in order to communicate the excitement that he or she feels for his subject.

The pedagogy of teaching physics presents unique challenges. For undergraduate students, great effort must be made to engage them in the learning process – it is too easy to fall into the trap of dull, repetitive lectures! I try to approach lectures as a guided conversation between myself and the students, where their participation in understanding is key to the learning process. For graduate students the topics are far more specialized and focused, and the students do not need to be convinced of the value of the experience – they are there because they choose to be. However, it is still important to take time to step back from the details of the course to encourage the student to ponder the wonder and beauty of what they are learning.

For undergraduate students who are interested in a career in physics, active participation in research as early as possible is extremely important. This gives the student the opportunity to put into practice the critical thinking skills and knowledge that they are developing in a real-world situation, and builds their excitement and love of science. It shows them that what they are learning goes beyond the classroom experience and is an indispensable continuation of the educational process. In addition, many of these students do valuable work and have made substantial contributions to the research they participate in.

I have been very fortunate to work with a number of very bright, very motivated students (graduate and undergraduate) in the past and I am thrilled to find that I have gained as much from the relationship as they have. The process of teaching and mentoring has forced me to re-examine my assumptions and fundamental understanding and engage in a process of continual renewal. Because of my teaching I believe that my research efforts are substantially improved and I am able to continue to maintain a fresh perspective and creative outlook when attacking new problems.

My approach to teaching is a reflection of my approach to physics research. I take a great deal of pleasure in attacking complex problems, not because they are complex, but because by breaking them down and systematically unraveling the mysteries they hold I can hope to gain insight into the fundamental physical principles at their core. For this reason I have always been fascinated by the physics of the strong interaction. In principle, we have a complete theory of Quantum Chromdynamics that describes all aspects of the interaction. However, we currently do not possess the mathematical tools to perform

complete calculations for most interesting aspects of the theory. This situation is a wonderful opportunity for an experimentalist, where detailed measurements can expose the hidden beauty of the underlying physics that our theoretical understanding can only begin to hint at. It is the joy that I find in this pursuit that I try to communicate to my students, the joy of dedicating oneself to a difficult task and slowly realizing the rewards of that determination.

The students that we see in our classes today will participate in the critical decisions we face as a society, even as a species. I believe it is imperative that I do everything that I can to see that they leave the classroom with the critical thinking and problem solving skills to face future challenges, as well as an appreciate of the beauty and wonder of the natural universe.