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Teaching statement

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Many people with doctorates in mathematics or science love their research and hope that it is enduring, important, and that it makes an impact on the world. However, in my opinion, the greatest contribution one can make is not though research, but rather through teaching. My best teachers, some of whom have made large personal contributions to their fields as professional scientists, musicians, mathematicians, or literature professors, have claimed to have had a bigger effect on the larger world outside their respective fields because of the impact on their students as opposed to the impact of their particular innovations. Furthermore, I truly learned to study from some very talented and dedicated music professors before I learned to study from my mathematics and science professors. The effects of these people's work as teachers will ripple though our society in very profound ways through all of their students. On the other hand, the poor teachers I have studied under have also left a lasting impression. In the best cases, my understanding was limited; in the worst cases, I have carried, sometimes for years, the misconceptions they instilled. Teachers have enormous power; teaching effectively can open doors to understanding, teaching poorly can close doors and waste the student's valuable time, and teaching wrong information can not only close doors but cause lasting problems that can take years to rectify. Thus, teaching accurately and in a compelling manner is a responsibility that I take extremely seriously.

Because of the nature of mathematics and physics as foundational sciences, there were, where I started teaching, two distinct sets of students: those with a desire to become future members of the fields, and those who took classes to satisfy requirements and often despised the material I was teaching. These two populations required two different teaching styles, both of which I will briefly discuss.

¡P¿In a sense, the students who represent the future of our field are the easiest to teach. They already want to learn, they are eager, they take their professors seriously, and they invest the time it takes to learn the material. The baseline for teaching these students is a lively, accurate presentation of the classroom material. Beyond this, I believe that it is best to present the material in a way that is parallel too, but does not duplicate, the textbook being used for the course. The material must be made interesting and relevant; it is very important to present both the wealth of well-studied material along with more modern examples that are currently under investigation. Moreover, the students must be given the tools for further study which include a list of current, past, and particularly useful references as well as the oral history that goes along with our field. Along with the relevance of the material, I also attempt to present the students with an accurate flavor for what working in a particular field entails with respect to daily work routines. I do this to create a realistic picture and to combat the NOVA impressions many young students of mathematics and science have developed. Such discussions are an attempt to avoid “tricking” the students into choosing to study mathematics or physics for the wrong reasons. Finally, in classes for physics and mathematics majors, the students must be pushed as individuals. Each person will have their own learning style and interests, and these must be addressed carefully.

¡P¿Students who are attending a class I am teaching solely to satisfy a requirement (e.g., pre-health science students) present a whole different set of issues. First, the class may be their first and last exposure to my field. Thus, I have to spend some time persuading them that what they are studying is useful and interesting (and when they are at the voting booth and filling out polling information, worth funding). If they leave my classroom both hating and not seeing the value of mathematics or physics, I have failed. Because these students are taking the class solely as a requirement, it is important for me to understand the reasons why a course is required. For example, an engineering student may need various tools for future study, a molecular biologist might need the basic background, and a pharmacy student might be required to take mathematics or physics to foster analytical thinking that is different from the memorization of the early biology and chemistry classes. Moreover, I have a responsibility to both accurately represent our field though teaching and to limit the volume of the material so that it can be taught to the level of depth required for understanding. Thus, there is a balance must be struck between the needs of those outside the field requiring the class and the desire of those of us representing the field to do justice to the material. This is a question of teaching with an emphasis on the set of facts or techniques that make up the field versus the emphasis on the framework that is the field. In my opinion, the framework is the most important and should not be neglected to pack more facts or techniques in a semester. However, the framework can be constructed with emphasis on the important facts and techniques as applied to particular applications. Thus, which facts and techniques are taught can largely be chosen depending on what the students are being prepared to study. For instance, examples from the applied fields can easily be substituted for the more classic examples used in mathematics or physics that may be of limited value to, for instance, a future doctor or pharmacist.

¡P¿Finally, large introductory classes usually have a very diverse population that requires creative teaching techniques to reach a broad set of students. It is helpful to keep in mind that some individuals are primarily auditory learners while others may learn best though visual or tactile. Being rigid in teaching style is unhelpful with the best and most interested students; it is damaging to students who are struggling and who many have little appetite for learning the material.

¡P¿My physics teaching experience consists of various teaching duties at the University of Wisconsin at Madison. I have taught introductory physics to non-science majors (pre-health science, etc) for which I usually had on the order of 75 students per semester. Before I began spending significant portions of time at the Santa Fe Institute, I spent a semester as the head teaching assistant which involved organizing and supervising the teaching assistants and the grading for the aforementioned introductory physics class of approximately 500 students. I have also taught introductory physics for scientists and engineers which usually involved teaching only 40 students. I also worked as a teaching assistant trainer for a year. In my later years as a graduate student when I was no longer teaching to support myself, I worked as a substitute teacher in the mathematics department teaching calculus, advanced calculus or applied analysis, linear algebra, and as a private tutor for a wide range of undergraduate and graduate mathematics classes. I have included a list of courses I am comfortable teaching below.

**Undergraduate physics:** introductory physics with and without calculus, modern physics, physics for poets, classical mechanics, electrodynamics, statistical mechanics, quantum mechanics.
**Undergraduate mathematics:** calculus, ordinary differential equations, linear algebra, advanced calculus or applied analysis, analysis, dynamical systems, game theory, topology, numerical analysis.
**Graduate physics:** classical mechanics, nonlinear dynamics, computational methods, econo-physics, sta-

tistical mechanics, time-series analysis.
**Graduate mathematics:** ordinary differential equations, classical mechanics, dynamical systems, bifurcation theory, learning theory.

**REFERENCES**:

Professor J. C. Sprott, Department of Physics, University of Wisconsin-Madison
Professor U. Camerini, Department of Physics, University of Wisconsin Madison