Teaching Statement

The first week of undergraduate introductory mechanics my instructor – who looked every bit the part of a physicist with a chalk stained blazer and long grey beard – before losing the class to escalating droning lectures ran us through a demo. Breaking us into groups he set up force tables with two unbalanced masses and had us calculate at what angle and mass a third pulley would balance the system. As each group set their table and removed the holding pin to find a system in equilibrium the unmissable power of this lesson was felt - to demonstrate the materiality of the equations we had learned; their predictive power a connection to reality. A week later I had changed my major to physics. Nine years later I still hold this experience in mind and as a professor this connection between the equations derived and the reality they describe would be the central message of my teaching - one that I would will all students from pre-med to physics majors to take away from my classes.

Physics instruction comes with a unique set of challenges especially at the introductory level: the need to engage students from diverse educational backgrounds and with divergent educational goals in a subject which superficially can appear distant and remote from needs outside of curriculum guidelines. However, as a subject physics is perhaps unique in its omniscient presence in daily life. Helping students to peel back the glossy reflection of our world to see the underpinning machinery of nature would be a goal of my teaching – specifically to show that more than being dusty equations set to favor the mathematically inclined that physics is an indispensable part of everyday life from the effortless wielding of quantum mechanics found in the average smartphone to the hidden workings of relativity in the simplest google maps navigation.

To this end, my courses will invoke a three-pronged philosophy to physics instruction: light recitations, interactive student driven group demos, and low level computational simulations:

Recitation:

Acting as the lecture component to my courses, recitations would be as an accent to the students' personal reading of the course text – to point out particularly meaningful concepts, work over more opaque mathematics and to make concrete the physical meaning of methods utilized. By not handholding students through the course text via lecture time it will open possibilities to include a stronger hands-on component while also making the class less dispensable as it won't exclusively entail material they could ostensibly cover individually through reading.

Interactive demos:

Physics offers many opportunities to connect with the real world through simple mechanical systems whose outcomes are easily predictable through basic calculations (such as the anecdote described above). Such instances work to engage students and make concrete the connection between lessons and the world around them. My courses will entail simple mini-experiments which will allow students to test out the power of what they've learned as well as in-class group problem solving. This type of active learning will engage students while hopefully revealing the purpose of what they are learning beyond the end goal of a passing grade. It is my hope that such a component will engender the ability to see physics even outside the classroom and counter the trend one sees even among physics majors to not realize to apply their knowledge dynamically outside of class work.

Simulation:

The modern classroom has more ways than ever to utilize computers as a teaching instrument – a reality which becomes more powerful with new generations of students who have come of age with computers.

Furthermore, in all professions – science-based in particular – basic computing is becoming an assumed proficiency, with even mass media suggesting coding as the new blue-collar trade. In physics, not only has the ability to code become a necessity for those who wish to pursue jobs and advanced degrees but as a teaching tool it also provides fertile grounds for gaining insights to the physical meaning of even advanced equations. Fortunately, teaching software such as Modellus obscures the complexities of coding-based mathematical simulation behind a veneer which allows for students to build models through entering the necessary equations to describe a physical system exactly as they are taught in introductory physics classes. Once a model is built such software then opens a playground within which conditions can be trivially altered and the resulting perturbation to the reality described by the equations explored. Such exploration inevitably helps students understand at an intuitive level the physics taught in class while also providing them with a very low-level introduction to modeling.

This three-pronged strategy is especially well-suited to the unique demands of introductory physics courses – which are often the first encounter students have with a truly mathematical science. It will encourage students to see the meaning behind what they are learning hopefully exciting them while also planting beginning of the intuitive understanding needed for future success in physics or in interacting with the world around them. Furthermore, by teaching the subject from various perspectives my classes will engage students with different learning styles and proclivities while also introducing them to the breadth enjoyed in the field of physics. Beyond introductory courses, this philosophy will be adaptable as the physics becomes more complicated and the students more comfortable in their abilities. While advanced courses will call for more of a lecture component and will be less accessible to simple demos simulation of the physical world described through the equations of physics will become more approachable through modelling software – which is invaluable has intuiting the physics becomes more challenging.

Though my postdoctoral fellowship has been at a national laboratory, my training as a teacher did not end with the completion of my Ph.D. As a postdoctoral fellow at Oak Ridge National Laboratory my position has been somewhat unique. While the majority of my time is devoted to the development of my own research project a portion of it is allocated to the operation of a neutron powder diffraction beamline (HB-2A) at the laboratory's High Flux Isotope Reactor. Though developing my own program has been a tremendous source of growth for me; learning to convince other groups with disparate resources to collaborate, coordinating those collaborations as well as securing access to the neutron and x-ray beamtime my research relies upon perhaps the most unexpected new experience has been learning how to interact with users and help them perform experiments on HB-2A. The most significant duty of a beamline scientist is to help users run successful experiments - to interact with researchers from around the world from various backgrounds, fields and with widely varying levels of expertise. In practice, I have had to learn how to quickly learn other people's research so that I could help them best utilize the beamline's capabilities. Furthermore, since ORNL does not require users to be experts or even knowledgeable with these techniques, and new graduate students are often sent in the place of group leaders and principal investigators, I routinely have to instruct users not only on the use and theory behind the powder diffractometer but also in the reduction and analysis of their data. This teaching element is further emphasized each summer when the laboratory places undergraduate students with each beamline as part of a summer research experience program and hosts a neutron and x-ray scattering school - where I have held lectures on the techniques of Rietveld refinement. While I did not anticipate this element when I accepted my postdoctoral position, it has become an exciting and dynamic part of my position and it is a skill and joy which I believe will translate well to a professorship.