Teaching Statement

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I can't remember the exact moment I decided that I wanted to become a teacher. I do know that it must have happened at some point during my junior year of high school. That was the year I took AP Physics with Dr. Eugene Logusch—a man who to this day remains one of my favorite teachers of all time. Before taking that class, I didn't like math or science very much. But Dr. Logusch changed all that. He could explain things in a way that made perfect sense, and all of the math we did had a direct application to everyday life. By far my favorite part of the class was mechanics. I still remember doing a homework problem on designing a banked turn in order to prevent cars from slipping off the road. That I could use mathematics to predict a car's fate based on the configuration of the road, and then actually design the road in order to prevent people from getting hurt, was amazing to me. Suddenly, for the first time, I found myself interested in science, engineering, and mathematics. Dr. Logusch had shown me both the beauty and the utility of science, and in doing so, he made me love it. It was then I knew I wanted to do the same thing for future generations of students.

There is strong evidence in the education research literature that one of the best ways to engage students—particularly in science and engineering—is *project-based learning*, in which students actively develop their own solutions to open-ended, real-world problems [1]. During one of the three summer semesters I served as the Instructor of Record for an Introductory Dynamics course, I personally designed such a project-based learning exercise on air resistance in sports. During the first week of class, I divided my students into ten groups. I then gave each group a spherical ball from a different sport (from ping pong to kickball). Over the course of the next two weeks, I covered the theory behind air resistance in the context of Newton's laws of motion. For the project report, which was due at the end of the summer, I asked my students to address two questions: first, whether they felt it was necessary to account for air resistance in their respective sport, and second, how accurate the theoretical model for air resistance is for that sport. They did this in three steps: (i) deriving and solving the equations of motion for a projectile in the presence of air resistance, (ii) designing a simple experiment to determine the so-called drag coefficient for a spherical object, and performing their experiment on the ball assigned to their group, and (iii) comparing their experimental results to their theoretical predictions. The students were free to design any kind of experiment they wanted, provided it could be done using tools available to them (such as the digital cameras in their cell phones). In the end, the project was a success—so much so that it was incorporated into the fundamental structure of the course, and it has been used in one form or another every semester since. It is worth noting that enrollment in the course is much greater in the fall and spring than it is in the summer, but since the project does not require any equipment beyond what students already own, it was possible to scale the project to the larger classes at no additional cost to the instructors or the department. The results of this project are summarized in a paper [2] that I presented at the ASEE 2016 Annual Conference & Exposition.

Of course, it would be irresponsible to ask students to tackle an open-ended problem without also giving them the skills they need to complete it, and arguably the most important skill of all in engineering is *critical thinking*. In order to foster critical thinking skills in my students, I am a firm proponent of presenting concepts rigorously, in a logical order, and (if appropriate) from first principles. If done correctly, I have found that, far from turning students off, this can actually make them more excited about the subject. In my Introductory Dynamics class, for example, I took the classical approach to Newton’s laws of motion, limiting their applicability to infinitesimal particles, and presenting Newton’s second law in terms of linear momentum in addition to acceleration (so that the more advanced rigid body equations would follow naturally). This was sufficient to get the students started on the project. Later in the semester, when it came time to consider rigid body motion, we “constructed” a rigid body from a system of particles and actually *derived* the governing kinetic equations step-by-step using Newton’s laws. This was a departure from the way the course is traditionally taught. However, the feedback I received in my end-of-semester evaluations was overwhelmingly positive. When asked to list my strengths and weaknesses as an instructor, one student wrote, “I expected this class to be the hardest and worst class I would ever take, but the instructor did an amazing job of making the material interesting and comprehensible.” Another student responded, “John cares A LOT about our knowledge. He is realistically one of my best professors,” and when asked for suggestions to improve the course, the same student wrote, “I would suggest other courses take an example from John.” One student even approached me in the hallway the semester after taking my class, and told me that I had made the fluid mechanics class she was taking much easier to understand. Based on these (and similar) comments, as well as my students’ performance on the project, homework assignments, and exams, I believe that my presentation of the material was both effective and engaging.

In conclusion, I have learned many things by teaching Introductory Dynamics, not the least of which is that I genuinely love teaching. It was fun for me to plan and deliver engaging lectures, to come up with thought-provoking homework and exam problems, and to watch my students tackle an open-ended group project I had designed. And the great thing is that everything I have described here readily transfers to any science or engineering class, whether at the undergraduate level or at the graduate level. Whichever courses I teach, though, my goals will always be the same. I want to show my students the beauty and utility of science and mathematics (just like Dr. Logusch did for me), to inspire in them a love for the subject, to enable them to pursue the subject further, to help them achieve greater understanding, and, ultimately, to help them become successful engineers. That is my passion, and I am looking forward to making a career of it.

References

[1] W. H. Leonard and J. E. Penick, "How do college students best learn science?," *Journal of College Science Teaching*, vol. 5, pp. 385-388, 2000.

[2] J. W. Sanders, G. Hermann and M. West, "Scaling-up project-based learning for a large introductory mechanics course using mobile phone data capture and peer feedback," in *Proceedings of the ASEE 2016 Annual Conference & Exposition*, New Orleans, LA, 2016.