Teaching Statement

Jason K. Moore

My interest in mechanical engineering began during my childhood where I spent many hours making, tinkering, and discovering how the built environment functioned. These hands-on experiences allowed me to develop a desire to discover the connection to mathematics, physics, and science in order to improve my projects. Once that realization occurred, any barriers I had towards learning the engineering fundamentals were lifted. I hope to bring similar kinds of experiences and motivation to the students I teach.

Teaching Philosophy

Traditional engineering pedagogy focuses heavily on lecture-based theoretical courses paired with few hands-on laboratory courses. The aspects of creativity, team work, realistic constraints, and an infinite possibility of problem solutions are too often absent. These aspects are needed to develop the practical side of engineering that students will require in their future careers. Often, only the students who participate in extracurricular projects, internships, or research positions make the connection from theory to practice early on in the curriculum. Thus, the traditional structure may not be the best way to maximize student understanding of engineering principles and instill the agile problem solving methods they will need in the future.

Although there are variety of motivational reasons students pursue engineering, I believe introducing the applied engineering practices early in education will build passion and interest. Once this door is open, it is much easier to weave in the skills the students need to become stronger engineers in their future careers. I would like to see a curriculum that mimics the actual practice of engineering through an iterative pattern of posing realistic problems followed by a search for the necessary fundamentals, culminating in the application of new knowledge to arrive at a solution. Like my childhood experiences, this model provides interesting realistic problems that allow students to discover the engineering fundamentals as opposed to presenting all of the fundamentals before the interesting problems arrive.

Engineering students are capable of creating and solving problems when they enter college. We should enrich their entire experience (especially in the first year!) with challenges from real-world problems that leave them begging for the knowledge and tools that they typically have to slog through during their first years of school. Richard Miller, President of Olin College, often draws an analogy between engineering students and violin students: “Can you imagine not playing the violin until your fourth year of study? Violinists start making sounds with their instrument the first day of lessons.” An engineering curriculum could allow our students to draw the engineering bow across the strings the minute they step into the classroom. For these early project-based courses to be effective, however, the latest pedagogical developments must be utilized to maximize learning potential.

Practical Classroom Examples

In my courses, I try to provide students with open-ended problems that lead into larger projects instead of problems designed for rote learning and traditional exams. This approach more closely mimics the practice of engineering. I combine this approach with rubric based assessments that set the bar for mastery for improving student outcomes and effective assessment. I attempt to have a good mixture of group and individual work, leaning more heavily toward the former so students are prepared for the needs of industry. I also have been working to orient my classrooms towards active learning. My best example is the utilization of “computational thinking” that makes use of live coding in class. I have setup a JupyterHub server that students log into via laptops, tablets, and phones during class that provides an interactive engineering computational environment. This allows access to my interactive textbook that students use as a reading guide while I provide examples paired with short computing exercises to periodically assess learning. I have developed a related workshop for other practitioners with my colleague

Allen Downey from Olin College of Engineering which has been successful. I use exam reflections surveys to provide self-guided preparation for subsequent exams. Lastly, another very important method that I make use of is rapid in-class assessment; at every break, each student provides me with anonymous quick feedback: one line comments that share what they didn't understand and what was effective. This allows me to adjust my teaching after the break based on the feedback. I tie this in with collected feedback before, during, and after the course to have data to back my teaching decisions.

All of these methods are backed by evidence from education research. To keep up-to-date on topics like these, I follow the education research literature, especially the summary literature aimed at practicing educators and attend "teach the teachers" style workshops as much as possible. I have worked closely with the UCD Center for Educational Effectiveness and the UCD Engineering Education Learning Community these past four years to improve student learning in my courses and for my department.

Prior Experience and Future Interests

A teacher is often at their best when they know their material well. I spent most of my graduate school years in the UCD MAE department and now four years on the faculty making me intimately familiar with their undergraduate and graduate curriculum. I have taught a number of the available courses as a teaching assistant, lecturer, and professor. At the undergraduate level I have strong experience with the dynamics and controls courses along with mechanics and machine design curriculum. I have taught "Engineering Graphics and Design", "Manufacturing Processes", "Introduction to Mechanical Vibrations", "Mechanical Design", "Mechanical Systems Design Project", "Vehicle Stability", and "Analysis, Simulation and Design of Mechatronic Systems". I have also taught "Multibody Dynamics" at the graduate level. I believe my prior experience makes me quite versatile and able to teach a broad variety of courses.

In evidence based practices and innovations in the classroom. Some highlights from the last four years are:

- developed a design competition and exchange program with Meijo University (Nagoya, Japan) on the cultural influences of robot and machine design
- flipped a mechanical vibrations class by utilizing "computational thinking" and project oriented learning with a custom designed interactive textbook and deployment through a JupyterHub server
- created a design studio classroom space that facilities active learning for our design courses
- created extensive rubric based assessment for written and oral communication in the capstone design course
- created a set of twenty Jupyter notebooks on multibody dynamics for in-class use and accompanying publicly available videos
- developed a transit bus bicycle rack design project which included reverse engineering, concept generation, and lightweight prototyping
- solicitation and mentoring of over 90 industry, government, and non-profit supported design projects spanning the mechanical engineering discipline
- co-awarded a $5M Department of Education grant to create interactive OER engineering textbooks as part of the LibreTexts project
- co-wrote a book on teaching with Jupyter
- co-developed a workshop designed to teach STEM educators effective methods to teach with computation

There are at least four undergraduate courses that I would like to co-develop in the future that are influenced by my research endeavors: 1) a first year problem solving with data, simulation, and engineering computation, 2) an upper level applied robotics and controls course centered around hands on work with robotic vehicles, 3) an upper level elective focusing on project based assistive device design, and 4) an introduction to computational optimization.

At the graduate level, I am also well prepared to teach many courses in dynamics, control theory, biomechanics, optimization, software engineering, and vehicle dynamics. I would like to continue to teach advanced multibody dynamics from computational perspective. Additional ideas include developing a course focusing on the design, simulation, and optimization of legged biomechatronics that aligned closely with my post doctoral research. Students will learn about neuromuscular modeling, mammalian gait, and get exposed to the latest tools in the field (OpenSim, Biomechancal ToolKit, ROS/Gazebo, IPOPT, etc). Lastly, I would very much an experimental biomechanics oriented course would also nicely complement the computational oriented one to prepare students for applied work in the field.

My course topic strengths are not entirely based on UCD MAE offerings. I have spent time at Delft University of Technology, Old Dominion University, Cleveland State University, Stanford University, and with the Software Carpentry non-profit where I have gleaned both new course ideas and methodologies to provide stronger connections to industry. I have experience in teaching computational methods for data science. I have given numerous workshops and tutorials to scientists and engineers on simulation, optimization, and data analysis. I have been trained by the Software Carpentry organization in pedagogical methods and teach two-day workshops around the world to introduce scientists and engineers to the best practices and methods in scientific computing. The mechanical engineer of the future will be additionally tasked with data driven engineering. The engineering curriculum will need to adapt to bring data science into many of the core courses for our students to stay competitive in the job market, which I am ready to do.