Teaching Statement - Bain

My philosophy of teaching is centered around research-based pedagogical techniques, bringing energy and enthusiasm to every class, setting clear expectations for students, and working to make exceptional course resources. I have taught in a variety of classroom settings including independent studies, small ~10 person courses, studio-style courses with ~70 students, and large lectures with over 200 students. I am comfortable teaching in all of these environments and find that each presents unique challenges. Regardless of the setting, I value every opportunity I have to work with bright and enthusiastic students to discuss how the universe works at the most fundamental level. Through promoting student engagement, effective communication, and emphasizing the development of problem-solving skills, I strive to establish a classroom culture that values positivity, inclusivity, and intellectual growth.

At the SC Governor's School for Science and Mathematics (GSSM), a public residential high-school for juniors and seniors gifted in STEM, I have taught both calculus and algebra based introductory physics courses. Each course incorporates peer-instruction, inquiry-based activities, and hands-on lab work. I have developed my own sets of hands-on experiments for these courses as well as a complete set of virtual labs for students learning remotely. During a year of virtual instruction due to COVID-19, my students completed a wide variety of lab activities that incorporated online simulations, data analysis projects, and virtual card-sorting activities. All of my labs (both virtual and in-person) help students grow their skills in experimental design, data collection and analysis, and technical communication. Labs also serve as a valuable opportunity for structured group work with each student taking on a specific role each week.

As an Instructional Assistant Professor at the University of Houston (UH), I taught lecture and studio-style introductory physics courses (based on NCSU's SCALE-UP curriculum), all of which incorporated evidence-based techniques. Similarly to how I run my classes at GSSM, my lectures at UH were built around students solving conceptual and computational clicker-style questions. Incorporating these problems and polling students for answers provides a variety of benefits. Solving problems in class helps to keep students focused and allows them to periodically check their understanding in a structured way. Polling also gives me real-time feedback on the class's level of understanding of a topic which helps me decide whether further discussion is needed. I also find that these problems prompt more pointed questions from students as they discover exactly where they may be confused on a problem. In addition to prompting students to solve conceptual clicker-style problems as we introduce new concepts, I also like to pose follow-up problems to each worked example. These problems range from completing an unfinished step in the worked example to calculating the result to a variation of that problem. My courses incorporate a mix of conceptual questions, computational problems with simplified set-ups and context-rich problems. This allows students to practice the basics of a topic while also seeing important connections between physics and fields such as biomechanics, engineering, and statistics.

The backwards design model developed by Wiggins and McTighe in *Understanding by Design* plays a central role in how I design courses. This methodology involves first deciding upon specific learning objectives for a course and answering questions such as "what skills should students master" and "what broader ideas are most important for students' enduring understanding." After establishing these goals, I work to establish what constitutes acceptable evidence that those learning objectives have been achieved. In physics classes, proficiency is generally demonstrated through timed exams, homework, pre-lab/pre-lectures, lab, and in-class participation. However, since exams often play a heavily weighted role in course grades, they must be meticulously designed to closely align with the course's learning goals. The last step in backwards design is planning instruction (i.e. lectures, demonstrations, labs, and activities) that is targeted to helping students achieve the prescribed goals of the course. Throughout my career I have found that designing courses in this way, along with ensuring that course syllabi are consistently implemented, make the expectations of the course transparent for students. Setting clear expectations and establishing achievable benchmarks are essential for helping students feel that they can succeed in a course.

Technology plays a central role in my courses. I enjoy experimenting with new platforms that can make course resources easier to use and more effective at motivating students to engage with the material. I have used a variety of platforms including WebAssign, TopHat, and Mastering Physics, as well as LMS's such as Blackboard and Canvas. In all classes, but especially those with large enrollments, online homework systems are helpful at providing students with instant feedback on their homework and can help emphasize mastery, which can otherwise be difficult to do with a large number of students. Many platforms such as TopHat, iClicker, and TurningPoint, provide mechanisms for students to answer a variety of different types of clicker-style questions from a mobile device. Technology can be incorporated into classes in a variety of novel ways to facilitate student-teacher interactions, provide helpful resources, and create new innovative activities. As a part of the studio-style course I piloted at UH, I developed a number of tutorials for students using the TopHat platform to go along with inquiry-based activities adapted by UH faculty from McDermott's famous *Physics-by-Inquiry* curriculum. These tutorials integrated short readings, guided problem-solving, interactive online simulations, and instructional videos. At both GSSM and UH, I have consistently made all of my course resources easily accessible online and post grades in such a way that students can always know where they stand in the course.

Working with students in office hours plays an important role in helping students to succeed and is one of my favorite aspects of teaching. At both GSSM and UH, I have generally been quite successful at getting many students to regularly attend office hours which I often run in a classroom. These meetings help me pinpoint where individual students are having trouble and have shown me patterns of issues facing students. I often use these meetings to discuss effective study habits and concrete ways to improve problem solving skills. Office hours are also a great way to get to know students individually. Online platforms such as WebAssign's Ask Your Teacher, Slack, and Discord can also be invaluable resources for efficiently fielding student questions effectively for large enrollment classes. Students appreciate being able to easily and quickly get in contact with their instructor. One of my priorities as an instructor and/or course coordinator for large courses will be establishing pipelines for quickly and effectively fielding student questions and building an online community for problem-solving.

In addition to my experience with studio-style courses at UH and highly interactive high-school courses, I have experience with other research based curricula. As a graduate student, I served as an in-class facilitator for an introductory physics course that was taught using Michaelsen's team-based-learning curriculum. Through Duke's Preparing Future Faculty program, I had the opportunity to learn about NCSU's SCALE-UP curriculum with Dr. Robert Beichner's Physics-Education-Research group. I also completed Duke's Certificate in College Teaching program, in which I took courses on teaching that covered a wide variety of topics including syllabus construction, visual design, classroom management, and teaching diverse audiences.

I have a wide array of research interests both within and beyond the realm of physics education. One particular area of interest is in developing resources and policies in a data-driven way to improve large-enrollment introductory courses. High DFW rates often plague these courses for a host of different reasons. Working closely with faculty, I plan to collect extensive data on student performance, demographics, and backgrounds as well as develop surveys to help identify how students interact with the course in order to identify various indicators that may predict student success or failure in physics courses. Before leaving UH, I was working to analyze student responses to introductory physics exams and better understand what topics students are mastering. I am also interested in applying advanced statistical techniques including building machine learning models to analyze university wide student data. Such techniques could also be applied to statewide/nationwide educational datasets in order to create better models for predicting student success in secondary/post-secondary education and beyond. Using natural language processing techniques, such models could also be built to better understand course evaluations, applications for admission, etc. This research could also create opportunities for students to participate in research with a relatively low barrier to entry but that requires skills that are widely applicable in industry.

In recent years, many universities have expanded access to online courses and resources. With expanding enrollments and the remote learning options made available for many students during the pandemic, more students and faculty have become comfortable with online modalities. I am interested in designing high-quality, innovative online courses and resources for students, especially in introductory physics/astronomy courses. Such courses may be able to draw more students to take physics, give students an alternative if they have issues attending in-person classes, and create new and interesting resources to help the department achieve its educational goals.