Teaching Statement

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Teaching the next generation of students and researchers is one of the most exciting parts of an academic career. As a teenager, I was an avid reader of The Feynman Lectures on Physics. These lectures left the lasting impression of how effective teaching can be. While reading them, I cultivated excitement about physics and science in general, developed a clear and intuitive understanding of seemingly complex phenomena, and was motivated to learn more on my own. These three responses – excitement, clear rigorous thinking, and motivation to explore further – are what I hope to elicit in students through effective teaching.

First teaching experiences

My first experience as a mentor was teaching other students in high-school. I enrolled in an AP Physics course, which culminated in two tests that examined the students' understanding of Newtonian Mechanics and Electromagnetism. However, due to a lack of school resources, the course only covered Newtonian Mechanics. After teaching myself introductory Electromagnetism, I started organizing after school sessions to help other students in the class prepare for the test on Electromagnetism.

One of my most vivid memories from that time was learning and then teaching Gauss's flux theorem for calculating the charge emitted by an electric object. While calculating the electric charge of an object can be done in differential form by integrating over the electric field per unit of area, Gauss's law provides a simpler and more intuitive alternative by considering the symmetries of the problem involved. I recall my classmates' expressions transforming from confused to engaged when they finally understood how to leverage Gauss's law. This moment was rewarding and led me to teach the same after-school class next year.

Teaching in graduate school

During my PhD in physics at the University of Chicago, I had the opportunity to teach classes for diverse audiences, ranging from introductory physics courses, to advanced graduate courses in mathematical physics, to outreach programs where I taught topics in STEM to students from under-represented communities.

I started off as a Teaching Assistant (TA) for a large introductory physics course with several hundred enrolled students. The goal of the course was to equip non-physics majors, mostly comprised of students majoring in other sciences such as chemistry, biology, and economics, with a basic understanding of concepts in physics. Like other TAs, I prepared weekly lectures and graded homework assignments, but shortly after the course started, I noticed that many of my students struggled with the subject matter.

I realized that, due to the time constraint and pace set by the syllabus, the lectures didn't provide the depth needed to fully master the material. Like my younger self in high-school, I organized voluntary evening sessions where I would devise unique physics problems that I thought best captured the main ideas from the lectures. These sessions had an interactive seminar format, and my students and I would go deep into understanding one particular physics problem. This depth enabled my students to better understand the fundamental ideas of the course, and I noticed substantial improvement among the students who attended these sessions. At the end of the year, I was fortunate enough to be nominated by my students for and then receive the **Physical Sciences Teaching Prize**, which was awarded annually to the **best TA across all science departments at UChicago**.

In addition to teaching introductory physics courses, I also had opportunities to teach more advanced undergraduate courses such as Statistics & Probability, Solid State Physics, Quantum Mechanics as well as graduate courses, such as Advanced Topics in Mathematical Physics. These latter courses focused on essential mathematical topics for theoretical physicists, such as complex analysis, group theory, and Lie algebra. I was given more freedom and was able to structure the curriculum. My lectures followed the intuitive example driven format that I had practiced in the earlier evening sessions after class – each class

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we would examine a few problems in depth, first understanding the main intuition or insight of the method and then deriving the mathematical formalism.

While it was rewarding to teach at the university level, I also noticed that less than 10% of PhD students in the physics department were female or people of color, and felt a duty to increase diversity in STEM fields by making them accessible to students who may have not had the same access to opportunities as myself or some of my colleagues. I volunteered as a teacher in UChicago's Science & Technology Outreach Mentoring Program (STOMP). Each week, STOMP teachers led after-school programs in under-represented communities on the South side of Chicago to educate and excite middle and high-school students about STEM topics. During my time at STOMP, I taught after school courses across a range of topics like star formation, making electric circuits, programming simple computer games, and photosynthesis.

Mentoring as a Postdoc

Although I changed fields from physics to machine learning when starting a Postdoc at UC Berkeley, the teaching skills and philosophy I developed transferred to mentoring undergraduate and graduate students at the Berkeley Artificial Intelligence Research (BAIR) Lab. As a Postdoc, I had the opportunity to develop mentorship skills by working closely with students as an advisor for their research projects.

Mentoring shares many similarities with teaching, but with the crucial distinction that the problems you're working on have not been solved and are not yet understood. As a mentor, I set the overarching research agenda and goal for each project I advised and worked closely with the student(s) leading the effort as well as collaborators involved. Since research deals with the unknown, most attempts to solve hard research problems fail and it is easy for students to get stuck. For this reason, and inspired by my mentor Pieter Abbeel, I've focused on an *insight driven research* philosophy, which frames research as the process of extracting insights on the way to solving an overarching research problem. Framing research from an insight driven perspective makes students less prone to disappointment when failing. Instead, if an approach fails, it is deemed a successful stepping stone if we were able to extract an insight and understand why. This approach has enabled the students I mentored to test hypotheses and get unstuck quickly without worrying about failure. As a result, in a short period of time, these students were able to achieve remarkable results [1, 2, 3].

This insight driven research perspective was first introduced in the weekly reading group sessions that I organize in the Abbeel Lab. The challenge with hosting insightful reading groups is that communicating frontier research ideas clearly is very hard. For this reason, our reading group sessions involve substantial mentoring and feedback prior to the actual presentation. Each week two students select a subject and two corresponding frontier papers of interest to the group. We then have a practice talk, where I help the students present the material clearly and iterate with them on their presentation. The final result is a presentation with the care and clarity of a course lecture and, for this reason, these reading groups have been very popular within the group, regularly hosting $20-40$ attendees. The aim of the reading groups has been quite similar to my general teaching philosophy – excite, explain clearly, and motivate further exploration.

Future Teaching Agenda

In the future, I'm committed and excited to teach at all levels – from getting kids excited about AI, to increasing exposure to STEM in under-represented communities, to teaching undergraduate and graduate courses, to mentoring students. At an undergraduate level, my diverse background will enable me to teach a range of courses (statistics, probability, machine learning, computer science). At a graduate level, I'm interested in teaching machine learning, statistics, deep learning, as well as related electives. There are two electives I'm particularly excited about. First, I would teach a course on *Unsupervised Learning*, which would focus on learning from data without supervision. Unsupervised learning has achieved several breakthroughs in the language and vision domains over the last few years, and I believe that it is an essential topic to cover for aspiring machine learning researchers. Second, I would also like to teach a course on *Reinforcement and Imitation Learning*. Over the last few years, both learning-based approaches to control have significantly advanced the capabilities of autonomous agents. As a parting thought, the academic career path is unique in its focus on both fundamental research and teaching, and I'm committed to both aspects. It's rare and exciting to both pursue answers to fundamental research questions while also teaching the next generation of the technical workforce.

References

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