**Ewin Tang. Teaching statement.**

As researchers, we have the lofty view that our work is pushing the frontier of all knowledge. However, our biggest concrete impacts may well be through teaching, mentoring, and our other, somewhat more human endeavors. I find this work exciting and important, and will discuss here how I try to make it count.

**Teaching.** In my mind, courses in my area—theoretical computer science, quantum computing—have two primary aims. First, such courses should build practical skills: problem-solving techniques, familiarity with technical resources, and clear communication of mathematical ideas. Second, courses should communicate the aesthetic of the field. Students should come away with an understanding of the general shape of ideas: what kinds of questions do the researchers care about? What kinds of answers can this field can provide? What does the field find beautiful?

Courses are often geared towards the former, as demand for computer science fundamentals grows increasingly large. The latter is more difficult to communicate, and is often left by the wayside in the name of pragmatism. But this should not be neglected: what is the point of learning ideas without understanding why people find them profound, and the questions people were considering when generating them? Understanding the 'point' of a field in its broader context is key for cultural literacy. A software engineer will need to understand big O notation, but perhaps just as often will need to, say, decide whether a theory result about their problem has any bearing on their work. This need is particularly pressing in my field of quantum computing, where students could see flashy headlines about groundbreaking new algorithms every other week. Interpreting these claims is important, and does not require much in way of technical skill, but merely a solid grasp of what kinds of things we can and can't prove about quantum computers.

Beyond this, my belief is that practical skills and context go hand in hand, with effective teaching marrying the two to deepen understanding beyond the sum of the individual parts. Studies suggest that connecting new ideas to familiar ideas improves recall ability [DRMNW13], and communicating ideas with a narrative make them far more salient. The ability to understand a field at a high level is empowering to students: it clarifies why the perspective you are teaching is so valuable, while giving them the intuition to identify when it is not the right tool for the job.

In the summer of 2023, I gave a series of lectures at the Park City Math Institute on my work in quantum-inspired algorithms to early graduate students, with accompanying lecture notes and problem sessions. I had previously TAed for undergraduate and graduate courses; but here, I was given greater freedom and responsibility, in designing the course structure, creating problems sets, managing a TA, and leading problem sessions. My teaching is informed by the following principles:

1. Focus on presenting the *context* of technical ideas, to connect them to other perspectives about the world;

2. Maintain *empathy* with students, in order to individualize teaching to their particular backgrounds and reduce any overhead preventing their learning;

In my five lectures, I implemented these principles, focusing on drawing connections to a broader context, and relating ideas to concepts more familiar to the audience. Two lectures on quantum machine learning, the context of the work; a lecture on approximation theory, a mathematical topic which is typically avoided in talks on this subject, but which provides crucial intuition; and two lectures on my work; recalling and mirroring the first two lectures to identify the parallels between the theories. In the problem sessions, due to limited time, I focused on problems not based on proofs to elicit deeper conceptual understanding, e.g. connecting the lecture to more familiar ideas; using the lecture's definitions for simple (yet deep) computations; and asking students to think about why the results don't contradict with existing literature. I asked for feedback throughout, and consistently received a very positive reception.

My teaching experience is mostly in a transmissionist, lecture-based style of teaching. However, I am inspired by a variety of perspectives, both about alternative theories on what the subject matters of mathematics and science *are* [L99; F82]; and alternative styles of teaching [D88; L09], including those through exciting technology-enabled mediums [V11]. Though I value the emotional salience and scalability of the 'sage on a stage' model [K93], I remain interested in understanding the space of possibilities in teaching and learning, be they radical reinvisionings or minor tweaks. I will refine my understanding of this over the coming years, by continuing to experiment and expand my teaching.

**Popularizing.** The output of our work as researchers is not just theorems and proofs, but ideas. Therefore, I treat my job as inextricable from the process of disseminating ideas. So, in addition to my efforts to disseminate quantum algorithms research to researchers, like the aforementioned course and surveys [TT24], I try to share the beauty of theoretical computer science to the broader public.

My popularization focus has been on Wikipedia. Wikipedia is a gem on the modern internet, and is often one's first exposure to any new topic. Despite this, articles often suffer from jargon-laden 'bloat', making them inaccessible to all but the expert reader. So, clear and effective writing on technical topics on Wikipedia has an outsized impact on the public. I made my first edit at an edit-a-thon hosted at STOC 2019. Since then, I have made 500 edits across 30 articles in topics around quantum information, probability, and TCS, with the goal of popularizing and communicating concepts in these fields. Articles I edited include *Grover's algorithm*, *Decision tree model*, and *Computational complexity of matrix multiplication* (which I created). I also co-organized an edit-a-thon at FOCS 2023, where I guided researchers into making their first edits and creating their first articles. This has been immensely rewarding; I will continue organizing edit-a-thons and working to make Wikipedia a better resource for TCS.

**Mentoring.** In grad school, I often advised students on career and research advice. One such student, Christopher Kang, I started giving guidance to as a freshman. I gave advice to him regarding applications and interviews, and, when he expressed interest, made him my TA for my course at PCMI, where we worked closely together to develop materials and re-learn the relevant concepts (which are useful to his work as well). He is currently doing his PhD in quantum computing at the University of Chicago, and I am excited to see where he develops as a researcher.

Now, as a postdoc in Berkeley, I have done several research projects with junior grad students. I adapted my mentorship role to each student, developing technical skills with some and discussing research taste and career choices with others. Mentorship must be highly tailored to the mentee, but as a professor, I will have two central aims which, in my experience, facilitate growth for anybody:

1. build a supportive and productive environment for students;
2. create tight and consistent feedback loops with students.

First, as a professor, I will work to build lab groups and physical spaces that people find stimulating. My experience is that the best ideas do not come from isolated geniuses, but emerge from productive environments. I will implement structures that I have seen be helpful in the past, including using lightweight project management strategies, to whatever extent these can work for research; and dedicating energy to furthering the interests of students, whether academic or perhaps more frivolous in nature. Overall, my goal is to maintain consistent enthusiasm and understanding in the career of mentees. Grad school can be grueling at times; the least advisors can do is to make the moment-to-moment process more enjoyable.

Second, learning a skill is easiest with immediate, clear feedback: this is the principle behind the advice to review games after playing them to improve in chess, or to record and listen to yourself to improve in a musical instrument. What makes research difficult as a skill (and, in my opinion, what makes it most rewarding) is that often, one does not have this feedback, which leads to time on dead-end directions and, for students, fatigue and loss of motivation. As a mentor, I try to minimize needless struggle by providing rapid and consistent feedback on students' research. This can take whatever form the student is comfortable with, including brainstorming at a board, discussing papers in group meetings, and answering technical questions over text. Ultimately, the goal is to convert struggle into growth; making this process more efficient frees up students to focus on the high-level questions in research. These are the kinds of questions I'm still trying to find answers to.

## References


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