Statement of Teaching Philosophy—Jiahao Chen

Good teaching means three things to me: being prepared, going the extra mile when necessary, and motivating students to care. I am lucky to have had many superb teachers over the years, both in university and before. They have shaped how I teach, both in informal mentoring of junior graduate students, and also in formal classroom settings.

One highlight of my time at MIT was watching Walter Lewin record his legendary physics lectures, replete with demos, for television. He later explained his teaching philosophy to me. It was simple, he said: no amount of ideology can substitute for being well-prepared for the classroom, and that meant knowing exactly what to cover in each lecture, and rehearsing the lecture at least twice before delivering it to students. This neatly encapsulates MIT’s signature style of learning by doing: Mens et Manus. He showed by example how the lecture format was far from obsolete for teaching introductory courses—what was often missing was expository clarity and student engagement.

I have also witnessed many excellent examples of lectures at the advanced level. Mehran Kardar’s one year course on graduate statistical mechanics is a masterful example of the art: he answered students’ questions not as interruptions of the didactic flow, but instead as if they were extensions of his originally planned lecture. In graduate school at Illinois, I was shown further examples of how to deliver elegant lectures on complicated subjects: Nancy Makri’s immaculate chalkboard derivations of path integral theories and Nigel Goldenfeld’s elegant presentations of phase transition theory, to name just two. I was also inspired by the dedication of others like Thom Dunning to modernize chemical curricula with the latest insights from physical and theoretical chemistry. These professors are first-rate, living examples of good teachers and good researchers.

My earlier teaching experiences have led me to appreciate how good teaching, at its core, about caring for students as people, and how such empathy helps teachers understand how students learn. Sometimes, empathizing with students means going the extra mile. As a middle school teacher, I found myself going outside the classroom walls to help students succeed whilst coping with personal challenges like parental divorces, gang violence or first breakups. It can also mean helping students achieve their goals, even if we wished for better. As an undergraduate tutor in my dorm, I was thanked by a student for helping him get a C instead of the F he was expecting. It was a sobering experience for me to work with students whose notions of accomplishment were to scrape through with passes.

In graduate school, by contrast, I was fortunate to work with many excellent students when I was a teaching assistant for the physical chemistry sequence at Illinois. In my last years as a graduate student, and also as a postdoc, I have had the pleasure of working with many graduate students in an informal mentoring capacity. I am also part of the K–12 videos project, which funds students to make science videos. I have helped to vet the technical correctness of these videos before public release. From discussing scientific details with student teams, I have also learned firsthand how misconceptions can survive formal schooling. This has made me pay special attention to how these misconceptions can be addressed in coursework or related activities.

As someone with interdisciplinary interests, I value the efforts taken by instructors to set the context of the course, especially in other departments. This helped me stay motivated to understand the material, particularly when faced with unfamiliar jargon. I discuss below the curricula I intend to develop, both at the freshman and upper division levels, and how I plan to contextualize material and provide illustrative examples and applications.

Chemical literacy for everyday life

When I was asked about my undergraduate major by people outside academia, I was struck by how often the response was: “Wow, chemistry is hard!” This attitude reflects how pervasive scientific illiteracy is in the general public. All too often, public discourse about science is obscured by histrionics and sensationalistic news reports about chemicals contaminating foods, medicines and consumer products. This has led me to think about how, as chemists and educators, we can promote scientific literacy and awareness in all students, majors and non-majors alike, of how chemistry is used in everyday life, and how we can make this more apparent in general chemistry curricula.

I have been inspired by a Harvard course entitled “Science and Cooking: From Haute Cuisine to Soft Matter Science”. This course covers many topics in physical chemistry such as emulsions (chocolate mousse) and partition coefficients (to make essential oils). The educational benefits extend beyond just chemistry: working with xanthan gum in lab not only demonstrates viscosity, but it also stimulates informed discussions about its presence in food products and why it is there. The success of this class can be seen by its immense popularity at the registrar’s office and the attention paid to it in the national media.
The Harvard course has shown us many possible ways to engage the public by providing many culinary contexts in which chemistry is shown to play an essential role. I propose to develop and teach such a course, and welcome collaboration with others interested in reforming freshman classes. Similar class material can be developed from the chemistry of other everyday items such as consumer products like shampoos and antifreeze.

Computer-aided learning for advanced courses

Of all the courses in the chemistry curriculum, physical chemistry is perhaps the most notoriously challenging. On top of the abstractions of atoms and molecules, the higher abstractions of wavefunctions and partition functions are introduced - mathematical entities whose relation to “real chemistry” is often abstruse. Motivating the study of the accompanying mathematical and physical ideas is also a manifest challenge for higher level courses.

To engender familiarity with these abstractions, I intend to use computer lab work as an integral part of my teaching of upper division undergraduate and graduate physical chemistry courses. For example, quantum mechanics can be reinforced by revisiting crystal field theory and ligand field theory. Working through these familiar theories in greater mathematical rigor will help familiarize students with quantum mechanical calculations and afford a new level of understanding of these theories. Computer algebra software can allow students to sidestep tedious algebra in favor of direct numerical calculations. An example from statistical mechanics would be to simulate Lennard-Jones particles to calculate virial coefficients and explain how molecular interactions produce nonidealities in fluid equations of state. Such projects could be assigned as homework in a graduate course, or as multiweek computer lab projects at the upperclassman level.

There are many benefits of exposing students to computational tools. They help students to tackle problems that are not manifestly contrived to have easy solutions, and hence to have a more realistic experience of working on scientific problems. They can do calculations sophisticated enough to revisit theoretical concepts from earlier courses and possibly make simple predictions to compare with chemical experiments, which integrates learning across the entire curriculum. Such experiences pave the way toward further advanced electives that I could teach: electronic structure theory, or a class covering classical molecular dynamics and quantum dynamics. Lastly, familiarity with numerical computations is an increasingly valuable skill within academia and also in industrial settings. For these reasons, a computational component to teaching physical chemistry can be a valuable pedagogical tool.

Courses I can teach

• General chemistry sequence for majors (CHM 201 sequence)
• General chemistry sequence for non-majors (CHM 231 sequence)
• Advanced undergraduate/graduate elective coursework
  – Mathematical methods for chemistry and physics (MAT 407 equivalent)
  – Electronic structure theory (CHM 502, CHM 513)
  – Dynamical simulations: classical molecular dynamics and quantum dynamics (CHM 509, 560)