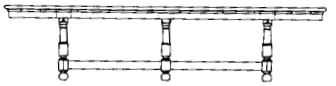
Reflections on Teaching



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When I first began teaching chemistry and physics, what excited me about working with high school students was the opportunity to design my own curriculum and pedagogy—to create an approach to learning that enabled the students to discover many of the central concepts without my needing to directly tell them "the answer." I found it challenging to accomplish this 26 years ago, and I still find it challenging today. The central questions then and now were ones of balance: To what extent do I make the students responsible for their own learning? When should I step in with an explanation? What level of rigor should I expect from them? What constitutes an enjoyable classroom experience? Over the years, I have tried to create a classroom structure that addresses these questions, but I don't know if it's the best environment for my students. Distilling my uncertainty into an essential question makes me ask, "What is my role in the classroom?"

A number of years ago, while planning for the new science building, the physics teachers met with a consultant who asked us to describe how we structured our classrooms. In essence, she asked us to describe our roles. I remember saying that I thought of myself as a guide: I know the terrain and can bring my students there, but once there, they must take some responsibility for the experience they have. To use a fishing analogy, I can put them on the fish, but at that point it's up to them. I do not know how successful they'll be, and I

cannot guarantee they'll all enjoy the same thrill in that moment a fish makes a solid strike. This analogy oversimplifies my work as a teacher, but it helps me identify the quiddity of my role, and in a recursive way, it has helped guide me as I plan my teaching.

TECHNOLOGY AND THE GUIDE

Teaching chemistry and physics affords me the opportunity for (or possibly the illusion of) student-centered discovery and learning. The lab benches and equipment in my classroom beg to be used, and it's very easy to come up with activities that keep my students busy. What is harder to do is to come up with meaningful work that leads to real understanding. I try to design my lab work in a way that forces the students to observe and measure carefully and to think deeply. I want the lab to be a place where my students are confronted with evidence of how the world works. We can't really do experiments, as there isn't time, but I want to make sure students are thinking critically as they work through a procedure. Technology has helped me achieve this goal, especially in physics, where computer-aided data collection and analysis has the potential to free students from the drudgery of measuring, bookkeeping, and plotting. I say it has the potential to do so because many students can make efficient use of the computer as a tool and can make technology fulfill its promise of quick and accurate data collection and analysis. Unfortunately, however, some students get so bogged down in the details of how to use the software that they may never even appreciate or make meaning of the physics concepts embedded in the lab work. To risk overusing my "guide" analogy, they are preoccupied with the intricacies of a GPS device and never look up to admire the view.

I want my students' classroom experience—their time around the table—to be collaborative, compelling, and creative. These goals put a great deal of responsibility on the students; they must prepare thoroughly the night before and come to class ready to engage with both the material and their classmates. In my chemistry and physics classes, problem solving is a necessary part of placing the students in charge of their learning, giving them the opportunity to apply the concepts they are learning to problems of varying levels of difficulty and then requiring them to come to class the next day ready to present and discuss their work. For most students, this routine works very well; even if

they can't solve all the problems the night before, they are able to contribute, and they can learn from their peers in class the next day. I can feel that a class is successful if all I have to do is help facilitate the process, if all I have to do is help manage their teaching of each other. This requires some planning and judgment—it returns to questions of balance—and I am left trying to decide what constitutes a worthwhile homework assignment. I have high expectations for what my students should be able to accomplish outside of class, and my hope is for them to be able to engage in the reading or the interactive website, make sense of the concept that the reading or website is trying to convey, and then apply that concept to the problems. On most days, most students meet my expectations, but occasionally I overreach, and the class isn't able to make much headway on the assignment. Then I become the center of attention, with the class looking to me for the "answer," and I feel I've let them down by not giving them the opportunity to figure things out for themselves. If I have to pass judgment on the "correct" way to think about a chemistry or physics concept, and if all eyes are on me, I feel that I've failed; it's as unsatisfying as being forced to explain a joke.

PATIENCE AND DISCOVERY

In some ways, the entire enterprise seems artificial. In order to give the students some ownership for their learning, I need to be circumspect in how I share my knowledge. I need to "tell the truth, but tell it slant" as Emily Dickinson said, and let my students make their own discoveries and find meaning in chemistry and physics. This approach takes time and requires my patience, both of which are usually in short supply. At times it would probably be expedient to simply give my students the answer and move on. I think some of my students would be grateful if I were to do so. I remember a visit to a few of our physics classes by Melissa Franklin, a physics professor at Harvard. After seeing one of Brad Robinson's classes, in which he had the students in the lab trying to discover an important relationship, she said to him, "That was interesting, but why don't you just tell them that impulse equals the change in momentum and move on to problem solving?" Of course, we have an answer to that question: We believe there is value in our students' having to navigate a path toward understanding. But having a belief in something isn't the same as having evidence that our approach is superior to a lecture-based classroom, and so the question nags.

Earlier, I mentioned that our student-centered approach works well for most students. For a few students, though, this method seems more of an obstacle than a path to understanding. They can't make much progress on the homework, and they get little out of the class discussion the next day. I try to help these students. I meet with them for extra help sessions, I encourage them to work with a classmate on the homework, and I pair them up with a classmate who I think can help them with the lab work or with our discussions of solutions to homework problems. I feel that all of this helps, in some cases more than others, but I'm left questioning whether our pedagogy is appropriate for these students. I think they can feel let down by the Harkness method, which I believe offers our students a way to gain a richer understanding of chemistry and physics. The success of most of my students reinforces my belief, but this success of the many can also reinforce feelings of inadequacy for the struggling few. There is a high degree of exposure around the table—that's the point of the table—and although the goal is to have everyone work together toward a common understanding, the communal nature of the process cannot help but point out who is thriving and who is not. This is the risk of our pedagogy—it is the risk our students take in coming to Exeter. Given the potential of allowing our students to have a high degree of ownership of their learning, I think it is a risk worth taking.

ALL TEACHERS ARE FRAUDS

As much as I'd like to think my students and I are engaged in a shared experience as equals around the Harkness table where anyone can be the teacher, we can't ignore that I hold the power of assigning a grade to their work. I have never been comfortable with this power. I have tried to convince myself that I wield it in a manner that is clearly explained, consistent, and fair, but I am always reminded of a talk by Peggy McIntosh, a professor at Wellesley College, given at a teachers' workshop at Westtown School many years ago. She said that all teachers are frauds. Of course she meant to be provocative, to get our attention, but her point was that the profession of teaching has no manifesto of best practices, leaving us all to make it up as we go. This "freedom," which is what attracted me to teaching in the first place, can deceive us. She went on to say that feeling fraudulent is a necessary part of the work. We must "mine the fraud within" in order to be at peace with the unique social construct of

the classroom and have any hope of being effective. In this light, my having the responsibility to assign a grade, along with my students' having to earn a grade for the course, should keep us striving to do our best. I don't think I could assign grades to my students if I didn't feel I'd made a real effort to work with them through the term. Although I can take some comfort in the fact that the discomfort I have with being the final arbiter of my students' work has been the subject of scholarly work, I am still left doubting the grading policies I have devised and my judgment in administering them.

I stated earlier that teaching chemistry and physics allows for the creation of a student-centered classroom in which guided inquiry can lead to a real understanding of the concepts. Ideally, such learning takes place, but there is a tension between giving the time necessary to have this approach be effective and using the time allotted to us in a school year to cover the "canon" of topics in an introductory course. My colleagues and I are always debating how to use the time we have, and we're always wishing we had more. This tension is acute in the Accelerated Chemistry course (Chemistry 319) which offers exceptional students the opportunity to take a college-level course as their introduction to chemistry. The offer comes at a cost. Although Chem 319 isn't called an AP course, students have signed up for the course with the goal of doing well on the AP exam in early May. They are expecting to be well prepared for the exam and, hence, are expecting me to efficiently lead them through the course. To further torture my "guide" analogy, this is a forced march through an impressive landscape with little time to enjoy the scenery. Working through all the material they need to understand places a large burden on their time; they become "canon" fodder (sorry), and they lose the opportunity to explore a topic in depth. In the past, this has made the 319 course challenging to teach, but the future appears to offer some relief as The College Board has reduced the number of topics in the AP chemistry curriculum.

I think that my progression (my development) as a teacher is not so much linear as cyclical, ranging out from a central belief in the students' need for ownership of their learning. This belief, along with my enjoyment of chemistry and physics, my love of the terrain I guide them through, has sustained me through 26 years of teaching high school students, and it has allowed me to try new approaches and new technologies without losing sight of that center. This belief has been my polestar, allowing me to explore and incorporate new ideas mainly from my colleagues who represent the biggest fringe benefit of teaching

at Exeter. This belief is the fulcrum on which I try to maintain the balance between the self-discovery I want for my students and the leadership they want from me. As I look ahead, I will continue trying to fine tune that balance and, I hope, add to my repertoire of assignments and laboratory work that engage my students. I will continue to push them just enough so that on their own and with their classmates, they will have to work for, reach for, understanding.