The kick is in finding out stuff about stuff and sharing it with others

Philip A. Rea

A major imperative of teaching at any level is to provide students with the impetus, self-confidence and tools to teach themselves. We all teach ourselves in so far as genuine understanding ultimately derives from the internal construction of internal and external inputs. And, the ability to self-educate has never been more important than it is now. Biology, for instance, is an extraordinarily broad discipline, encompassing behavioral psychology through molecular biology to biochemistry and biophysics, and new developments emerge at a pace that even card-carrying researchers are hard put to keep up with. Any course of instruction cannot hope to be all-encompassing, and even if it could it would have to be updated at almost every turn each and every time the course is taught. Because this is neither practicable nor desirable, what students need from a modern biology course (any science course for that matter) is a notion of the current state of play, an understanding of how today’s conceptual and technical framework came into being and an inkling of where it may be going. Helping students get a grasp of where to acquire new information and how to integrate new developments is the task of what I call the “teacher-communicator-facilitator”... with stress on the ‘F word’, because it emphasizes our role as provocateurs rather than “know it alls” (which we’re not).

If we are to be better TCFs in introductory science courses there are three things, all of which are inextricably interconnected with and inherent to the scientific approach, that must be addressed. First, the uncertainties that many students have when it comes to the interpretation of experimental results and the manipulation of numerical quantities; second the discomfort often experienced when there is no choice other than to propose answers that are open-ended or encompass a range of values rather than a unique numerical quantity; and finally the fear we all have of being wrong or demonstrably fallible. Why? Because these are the very qualities—a facility for exploratory model building, number crunching and graphical analysis, hand-in-hand with the capacity to take risks and a willingness to prove oneself wrong—that we expect from our very best scientific researchers... “inquiry-based learners.”

So how do we bring students in on the act; how do we attempt to diffuse some of the uncertainties, discomfort and fears that are part and parcel of this thing we call “science.” Whether it be the science that scientists do or the science that non-scientists do?

First off, to be scientific about the art of science teaching, we must draw students into the process as collaborators. However, if this is to happen—and I appreciate that this may be a personal perspective not shared by all scientists—TCFs—a community-wide aesthetic/cultural connection must be struck. Brian Greene1 said it: “To be able to think through and grasp explanations—for everything from why the sky is blue to how life formed on earth—not because they are declared dogma but rather because they reveal patterns confirmed by experiment and observation, is one of the most precious of human experiences” and “a life without science is bereft of something that gives experience a rich and otherwise inaccessible dimension.” Wow! And it’s that “wow” that we must get across to the students. To succeed, the TCF must express the thrill of doing and the beauty in beholding the explanatory power of science, wrinkles and all, and what it has enabled and might enable us to do. Tired, overextended or not, put it out there—display energy and enthusiasm for the material at hand (fake it, if you must). Students respond to this if only by asking “what is it about this stuff that the TCF finds so interesting and exciting... maybe there’s something in it after all?”

How many of us have spoken to people who’d rather not hear about “science” because it’s hard-edged and takes them to an intimidating, cold and isolating place they’d rather not go; perhaps the place they were taken to in high school; a place they’d rather forget? To overcome this attitude, we must act as a community of scientists bent on exploring science as a uniquely social endeavor, not so unlike art in its aesthetic and technical appeal, while at the same time dispelling the myth of the impenetrable sophistication by deconstructing and reconstructing concepts from the standpoint of the pri- mary observations. The TCF and students get to engage jointly in a creative learning experience. Anyone who does science is familiar with and thrives on the sharing of results with colleagues, chats (sometimes heated!) about the latest paper they read or the occasional sortie into a friend’s lab to learn a new technique on a “need to know” basis. Indeed, rigorous, open and self-critical discussions are the powerhouse of science. Seldom are truly novel ideas the product of a single mind.

If science teaching is to be a true simulation of the process of science, we must do our utmost to turn introductory science courses into commu- nities of inquiry, to which the TCFs and students inhabit the same ter- ritory and collectively struggle with extracting “meaningful” information from the inevitably incomplete data sets that researchers have to contend with. The students in collaboration with each other and the TCFs come to experience the frequent anxiety and less frequent exhilaration of drawing tentative but testable conclusions for themselves. Working in groups as in “think-pair-share” or “break-out groups,” students get to learn from each other and are driven into the field by that ever-present scientific process. If you find or think that class size is such that many students are reluctant to contribute to discussions, for fear of being “seen to be wrong” in what is a very public place, consider using an audience response system or “clickers.” These systems permit students to respond anonymously in real time without the risk of being “found out” (of falling foul of the “Impos- ter Syndrome”). With clickers the TCF can ask a question, get responses from the group as a whole, provide further information or frame the question in a slightly different way, and get a revised response. In this way the students get the satisfaction of seeing how, as a group of “thinkers” or “scientists,” they can converge on a solution to a problem for which an answer is not immediately obvious. At the same time the TCF gets to dis- cover which facets of a concept or observation, or which questions are causing greatest difficulty for the students and adjust his or her line of at- tack in mid-stream.

Community membership is all about trust. To be an armor-clad TCF “who never gets things wrong” is a hideous misrepresentation of what it is to be a scientist (what it is to be you). So occasionally make reference to your own scientific difficulties or shortcomings; times when you got things wrong. This is not a declaration of incompetence, which might indeed be cause for concern from the students. Rather, it is an honest declaration, a potentially inspiring one, that despite your having had the same or similar difficulties to the ones that some, perhaps many, of the students are having, you eventually “got it.” For much the same reasons, when you find the mater- ial difficult, tell the students. It is inevitable that some concepts are difficult, difficult to explain, but this does not make them any less important or in- teresting; quite the contrary. Difficult concepts—one that fly in the face of common sense, our intuitions and preconceptions—are the ones most de- serving of serious consideration and reflection.

The feature of university life which most inspired me in my first year as an undergraduate was the realization that the people who were now teaching me were active scientists who had directly contributed to the subject they were teaching through their research and that their research was stuff from which they still got a kick. The true scientist-TCFs among them went so far as to openly welcome us into their community and engage us through open discussion of the material at hand; they wanted to share the fun stuff with others. This in combination with recognition of the fact that even my teachers who were active in the field had answers to some fairly basic questions and were prepared to admit to this, filled me with admiration for their humility and impelled me to learn more so that I might one day be al- lowed to play a very small part in tackling some of these questions myself. I would like to think that a few of the students with whom I come into contact are similarly affected by my efforts and those of my colleagues.


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