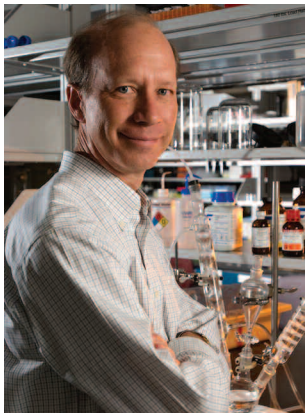
Teaching, Explained



Michael F. Hochella Jr.

Years ago, I had a rude awakening after I had finished teaching an undergraduate mineralogy course. The petrology professor who taught the next course in the sequence told me that he had given a simple, short test (one that would not count towards the students' grades) on the first day of class, not to check on my teaching, but to gauge the knowledge base of the students for more effective instruction—clearly a sound, educationally responsible idea. To his amazement, half of the students did not know the chemical formula of quartz. Many who thought they knew the formula wrote down "SiO_4." I was shocked. Only a month had passed between final examinations and my colleague's test.

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I had been very happy with that mineralogy course and those students. I was young, full of energy and enthusiasm. I tried to keep memorization to a minimum, and tried to make everything taught in the course directly relevant to the geosciences and/or to society. We went on several eye-opening trips, and not just to the field, but to the Smithsonian Institution and to a Corning plant where automotive catalytic converter substrates were manufactured out of synthetic cordierite. Clearly, however, something was missing. But what? I wondered. From what I know now about teaching, it turns out a great deal was missing.

I have heard it all before… you don't have to teach a teacher how to teach. Great teachers are born that way. For the rest of us, good or average teaching is strictly common sense, and that's good enough, we like to think. Besides, educational research is qualitative and "soft." Assessment of teaching comes from the success or failure of students on tests and student evaluations at the end of grading periods. If teaching does not go well, the reason is that students are not what they used to be. They are weak. Certainly, students dropping out of science programs in college are not talented enough to handle rigorous and demanding curricula. It is certainly not the quality of teaching that drives them away… Yes, I've heard all this for years, and dare I say, all these things have passed through my mind, too.

Yet all of these statements have been shown to be categorically false. How? Using the same "hard" quantitative scientific data to which any scientist is accustomed, published in rigorously peer-reviewed journals. These studies are often performed by scientists well trained in some physical science specialty, but also in cognitive psychology and modern educational theory. Studies of this nature can take years to complete, and knowledge advances and evolves over decades, just like in any other field of science. The articles in this issue of *Elements* were written by such scientists. If you are a college or university teacher in fields related to mineralogy, petrology, and geochemistry, read and trust these papers, and put them to work for you. They will help you train scientists, not just cover material. Further, strategies used in the classroom have related applicability to everyone in our profession, from laboratory to corporate scientists. For example, when you give a talk at a conference, you are effectively teaching. Whether you are trying to sell an idea to a reviewer of your proposal, to an advisory board, or to the public in an outreach setting like a museum, you are a teacher.

Personally, I know now that truly excellent teaching is a challenging task that requires much more than I was capable of through many years of my career. But this was simply because I didn't know any better. As I started to learn about cognitive psychology and how the human brain learns and organizes knowledge, I was amazed, and was left wishing that I had known about this much sooner.

This issue offers all of us relatively straightforward ways to improve our teaching. Better teaching translates into students and citizens that are better educated and, perhaps more importantly, turned on and truly appreciative of our science. One can argue that this is as important as our research, or more so. The insight, methods, and Internet aids available from this issue could make a big difference the next time you step into a university classroom, address upper management, prepare a talk for a conference, or converse with a funding manager. In fact, you will find in these pages what I was missing years ago in my mineralogy class. In a nutshell, what I was missing were the techniques of turning passive learners into active learners. I am no longer a talking head. I constantly demand classroom interaction, even when teaching large classes. Learning and retention are up, and my teacher ratings are nearly off the charts.

Educational research is offering a remarkable gift to science. This is low-hanging fruit that we cannot afford to miss. Helping to prepare the next generation of scientists and society, in the very best way possible, is simply too important. On the other hand, if we choose to ignore modern educational research through our arrogance, we do so at our own—and our students' and society's—peril.

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