

Essay on the Freshman Year Experience
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I am a scientist. In retrospect, it is therefore surprising to me that I and my many colleagues in colleges and universities have focused almost exclusively thus far on what we teach in our science classes, instead of focusing on what our students are learning. Honesty is one of the central values of our science culture. It is therefore past time to be honest about the results of our present way of teaching science. Speaking generally, we have failed to communicate either the excitement or the nature of science to most of our undergraduates. This failure applies not only to the many non-majors who take science as a distribution requirement, but to far too many of our science majors as well.

To me, one of the most profound messages of the “Reinvention” report is its emphasis on providing a qualitatively different educational experience for every college student in their freshman year. Science provides an ideal venue for exposing students immediately to inquiry learning, and there is no better place than a research university for doing so. Research universities often make work in a research laboratory available as an option to their upper level science majors. As a professor at Princeton University for 10 years, I accommodated 4 juniors and 4 seniors in my laboratory every year. Almost invariably, whether or not their projects were successful by the faculty’s account, the undergraduates in our biochemical sciences department ranked the research that they carried out for their senior thesis as the highlight of their undergraduate careers.

The challenge to us all is to find a way to bring a similar, if less intense encounter with the real world of scholarship to every student, and at the same time to provide this experience much earlier – with the hope that it will profoundly affect their attitude to education and thus their subsequent undergraduate careers.

There are two major obstacles to creating such a profound change in our approach to science in the early college years. The first is the challenge of getting to scale. The scale problem is dealt with today by offering first-year science courses in an auditorium, with hundreds of students being taught in a large group. By lecturing for just three hours, a professor can generate more than 1000 “student contact hours” a week. However, in my experience, it takes six hours or so to prepare well for an hour of lecture, even if a course has been given before. So the hard question to ask our faculty should be: how else might you use 20 hours a week that is much more meaningful, both for you and for your students?

If a collection of modern technologies are used to replace the dissemination of knowledge in traditional lectures, the 20 hours could be spent in ways that take advantage of a scientist’s well-developed skills as a coach of guided inquiry, eliminating most of the unproductive preparation time. For example, anyone who has

taught recognizes the self-learning that occurs when one is forced to explain something to a student. There is therefore a great deal to be said about the benefits to all concerned from an educational system in which a faculty member skillfully guides outstanding undergraduates to help teach to their younger colleagues the material that they mastered one or two years earlier. Some inspirational examples have been provided on this Web site as a demonstration proof of what is possible in this regard.

The second major obstacle is a lack of will among today's science faculty. Everyone I know in academia seems to be overworked these days – too many committees, too many grant applications, too many emails, too many science majors and graduate students in need of advice and help. Why should improving what all undergraduates understand about science have a high priority on their already overbooked agendas?

Fear is the most powerful motivator for most human beings. Speaking personally, I have a real fear that the rationality of modern societies will be jeopardized without a major new effort by the scientific community to teach science in a different way. We all need to think much more deeply about what we are trying to accomplish in our first-year biology, chemistry, physics, and earth sciences classes for undergraduates. When we teach, how many of us have the primary aim of giving such students enough exposure to scientific reasoning and scientific culture to enable them to appreciate science as a very special, evidence-based way of knowing about the natural world? And yet, without this appreciation, we have no right to expect that our democracy can continue to prosper in a world that is becoming evermore complicated due to the accelerating advances in science and technology.

If nothing else, we all should have received a wake-up call from last year's decision by the Kansas State Board of Education to challenge the idea that the Earth is more than 10,000 years old. If we allow the public to accept the Board's contention that the methods that science has developed to discover that the Earth is in fact billions of years old have no special validity, then why should they believe that smoking is dangerous for their health, that the water they drink is safe, or that a massive, atmospheric CO₂ accumulation from fossil fuels poses a real potential danger?

It is science, through its discoveries of the regularities of the natural world, that allows us to reliably predict the future consequences of current actions. In my opinion, it is giving all students confidence in this assertion, and a deep understanding of why it is true, that should become the central focus of every introductory science course that is taught to undergraduates.

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