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It's Time to End 'Physics for Poets'

Submitted by Edward Morley on April 13, 2006 - 4:00am

At the small liberal arts college where I teach, we have recently undertaken a wholesale revision of our core liberal arts curriculum. This is the set of requirements -- some specific courses, some chosen from a range of options -- that all students at the college must take before graduation. For professors in the natural sciences, this revision has required a good deal of thought about the content and nature of science courses offered to a non-major audience.

Conventional wisdom -- usually unquestioned -- has it that there are three basic elements that go into making up a good non-majors science course. First, the class should cover a relatively narrow range of topics. The classic "Physics for Poets" survey class, which attempts to cover an entire field in one semester, is almost always a disaster, satisfying neither the students taking it nor those teaching it. It's better to restrict the course to a subset of a given field, and spend more time covering a smaller range of topics.

Second, the topic chosen as the focus of the course should be something relatively modern. Students respond much more positively when they can immediately see the relevance of the material. Ideally, a good non-major science class should deal with either a "hot topic" in current research, or something connected to an ongoing public policy debate. It's much easier to engage the students in a subject if they're likely to read about it in *The New York Times.*

The third element is perhaps the most important: the course should involve the minimum possible amount of math. Many of the students who are the target audience for these classes are uncomfortable with mathematical reasoning, and react badly when asked to manipulate and interpret equations. This final characteristic is also the main reason why I am profoundly ambivalent about such classes.

Science for non-majors offers an important chance to reach out to students outside the sciences, and try to give them some appreciation for scientific inquiry. This is critically important, as we live in a time where science itself is under political assault from both the left and right. People with political agendas are constantly peddling distorted views of science, from conspiracy theories regarding pharmaceutical companies and drug development, to industry-backed attempts to challenge the scientific findings regarding global climate change, to the well-documented attempts to force religion into science curricula under the guise of "intelligent design." It's more important than ever for our students to be able to understand and critically evaluate competing claims about science.

I worry, however, that our approach to teaching science as a part of a liberal education is undermining the goals we have set for our classes. Despite the effort we put into providing classes that are both relevant and informative, I am troubled by the subtext of these classes. By their very existence, these classes send two damaging messages to students in other disciplines: first, that science is something alien and difficult, the exclusive province of nerds and geeks; and second, that we will happily accommodate their distaste for science and mathematics, by providing them with special classes that minimize the difficult aspects of the subject.

The first of these messages is sadly misguided. Science is more than just a collection of difficult facts to be learned. It's a way of looking at the universe, a systematic approach to studying the world around us, and understanding how things work. As such, it's as fundamental a part of human civilization as anything to be found in art or literature. The skills needed to do science are the same skills needed to excel in most other fields: careful observation, critical thinking, and an ability to support arguments with evidence.

The second subtext, however, is disturbingly accurate. We do make special accommodations for students who are uncomfortable with science, and particularly mathematics. We offer special classes that teach science with a minimum of math, and we offer math classes at a level below what ought to be expected of college students. Admissions officers and student tour guides go out of their way to reassure prospective students that they won't be expected to complete rigorous major-level science classes, but will be provided with options more to their liking.

It's difficult to imagine similar accommodations being made for students uncomfortable with other disciplines. The expectations for student ability in the humanities are much higher than in the sciences. If a student announced that he or she was not comfortable with reading and analyzing literary texts, we would question whether that student belonged in college at all (and rightly so). We take the existence of "Physics for Poets" for granted, but nobody would consider advocating a "Poetry for Physicists" class for science majors who are uncomfortable with reading and analyzing literature.

The disparity in expectations goes well beyond simple literacy. I was absolutely stunned to hear a colleague suggest, to many approving nods, that all first-year students should be required to read *The Theory Toolbox*. We would never consider asking all entering students to read *H. M. Schey's Div, Grad, Curl, and All That: An Informal Text on Vector Calculus,* even though the critical theory described in *The Theory Toolbox* is every bit as much a specialized tool for literary analysis as vector calculus is a specialized tool for scientific analysis. Yet faculty members in the humanities can seriously propose one as essential for all students in all disciplines, while recoiling from the other.

This distaste for and fear of mathematics extends beyond the student body, into the faculty, and our society as a whole. Richard Cohen, writing in *The Washington Post,* wrote a column [1] in February in which he dismissed algebra as unimportant, and proclaimed his own innumeracy.

"I confess to be one of those people who hate math. I can do my basic arithmetic all right (although not percentages) but I flunked algebra (once), barely passed it the second time -- the only proof I've ever seen of divine intervention -- somehow passed geometry and resolved, with a grateful exhale of breath, that I would never go near math again."

It's a sad commentary on the state of our society that a public intellectual (even a low-level one like Cohen) can write such a paragraph and be confident that it will be met with as many nods of agreement as howls of derision. If a scientist or mathematician were to say "I can handle simple declarative sentences all right (although not transitive verbs)," they could never expect to be taken seriously again. Illiteracy among the general public is viewed as a crisis, but innumeracy is largely ignored, because everybody knows that Math is Hard.

Fundamentally, this problem begins well below the college level, with the sorry state of science and math teaching in our middle schools and high schools. The ultimate solution will need to involve a large-scale reform of math and science teaching, from the early grades all the way through college. As college professors, though, we can begin the process by demanding a little more of our students, and not being quite so quick to accommodate gaps in their knowledge of math and science. We should recognize that mathematical and scientific literacy are every bit as important for an educated citizen as knowledge of history and literature, and insist that our students meet high standards in all areas of knowledge.

Of course, the science faculties are not without responsibilities in this situation. Forcing non-science majors to take the same courses as science majors seems like an unappealing prospect in large part because so many introductory science courses are unappealing. If we are to force non-science majors to take introductory science major courses, we will also need to commit to making those courses more acceptable to a broader range of students. One good start is the teaching initiative [2] being promoted by Carl Wieman, a Nobel laureate in physics Carl Wieman who is leaving the University of Colorado to pursue educational reforms at the University of British Columbia, but more effort is needed. If we improve the quality of introductory science teaching and push for greater rigor in the science classes offered to non-majors, we should see benefits well outside the sciences, extending to society as a whole.

As academics, we are constantly asked to look below the surface to the implications of our actions. We are told that we need to consider the hidden messages sent by who we hire, what we assign, how we speak to students, and even what we wear. Shouldn't we also consider the hidden message sent by the classes we offer, and what they say about our educational priorities?

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