

Critical Point Citizen science

Science courses aimed at non-scientists face formidable obstacles. **Robert P Crease** discusses two ambitious approaches that seek to overcome the hurdles

Science so permeates modern life that it is surely desirable for all students, and not just those aiming to become scientists, to receive some training in its knowledge and skills. Yet science courses aimed at university students majoring in other subjects face a bind. On the one hand, they must incorporate a significant amount of mathematics and scientific knowledge if they are to be effective in teaching the science relevant to the modern world. On the other hand, they must appeal to students with little or no background in maths and science.

This clash usually dooms such courses. If they weaken the science and maths component, they become more *about* science than genuine science courses – versions of what is often pejoratively called “physics for poets”. If they do not weaken it, they risk being too intimidating and difficult for the target audience. Earlier this autumn I sat in on the first classes of two ambitious courses that seek to overcome this problem in different ways.

At the frontier

Columbia University’s “frontiers of science” course is compulsory for all first-year undergraduates. It is part of the core curriculum, which aims to give each student “a rigorous preparation for life as an intelligent citizen in today’s complex and changing world”.

“Frontiers of science” is Columbia’s largest single course. Once a week, students attend a one-and-a-half-hour lecture and a two-hour seminar. The lecture is given in the university’s theatre, where the 560 or so students fill the orchestra pit and spill onto the balcony. The seminars are smaller, consisting of groups of 20 students each, and taught by professors and postdocs selected following an international search.

At the first lecture this year, course director Don Hood – a research psychologist at Columbia – explained that the course is designed to illustrate how scientists think, to cultivate a scientific approach to the world, and to teach students the rudiments of four frontiers of science: brain and behaviour; astronomy; climate; and evolution. Hood lectures about the first, while three other professors lecture about the other frontiers.



Model approach Michael Marx with “Cosmic Chris” – a portable detector that students can use to measure the rates of cosmic rays in different locations.

The course seeks to interest students via charismatic teachers and well-organized lectures. From talking to students, I gather that it does this quite well. The danger, however, is that science students may often find it too elementary to be interesting. It seeks to get over this obstacle in three ways: by teaching students about frontiers of sciences other than the one that may interest them; by including material on the social importance of science; and by demonstrating by example how to speak clearly and appealingly about science to non-scientists. This last component is not often taught even in science classes, and is something at which the Columbia professors excel.

In the lab

Meanwhile, Stony Brook University runs an “introduction to experimental research” course that takes a different tack. It takes place in the Nuclear Structure Laboratory in the basement of Stony Brook’s Van de Graaff building among dozens of scintillation counters and the infrastructure for monitoring them that is associated with a project called Mariachi (Mixed Apparatus for Radar Investigation of Atmospheric Cosmic-Rays of High Ionization). The course has no formal lectures or seminars, but instead thrusts its dozen students almost immediately into self-designed research projects to detect and study cosmic rays.

At the first class, physicist and course director Michael Marx gave a talk on cosmic rays, during which he explained how to make and test the efficiency of scintillation counters, and showed how to take and analyse data in online notebooks. He also began to prompt students to generate questions

about cosmic rays that could be answered using the counters.

Each counter, consisting of a scintillator and photomultiplier, is housed in a padded but formidable-looking black case equipped with wheels and locks that was originally designed for high-powered rifles. “It’s the perfect rugged container for a light-sensitive detector,” says Marx. Thanks to a grant from the US National Science Foundation, Marx and his collaborators on Mariachi have been able to buy and install 100 counters at Stony Brook and a dozen nearby high schools.

The beauty of the course is that, while cosmic rays are scientifically interesting because they provide clues to the origin and structure of the universe, they allow important research can be carried out without using much maths. This allows Marx to get students and teachers with a range of backgrounds involved in a scientifically viable project with significant connections to wider scientific issues in cosmology. Even physics students like it because it is a lab course much less micromanaged than most; students develop their own projects rather than being told exactly what to do.

Students learn to generate questions, discover that some questions do not have answers, and find that many answers lead to new questions. They are even allowed to pursue blind alleys. In a previous year, students from the Young Women’s Leadership School in Harlem, a participating high school, discovered that cloud coverage does not reduce the number of cosmic rays reaching Earth, but they developed a clever instrumental design in order to reach that conclusion.

The critical point

The predicament of a science course designed for all students, both those who are and those who are not intending to become scientists, is somewhat like that of trying to give a tour of a city to a mixture of tourists and future inhabitants – the two groups have very different interests and they want very different information. The analogy is somewhat strained; all students, whether interested in science or not, will go on to live in a society that is permeated by scientific issues. Yet it reveals the basic dilemma of such courses. The courses at Columbia and Stony Brook universities seek to provide two clever models for seeking to face that dilemma without compromise, and provide worthy models that might be copied elsewhere.

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