An Activities-Based, Historical Approach to Classroom Instruction

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(1) Who you are

(2) Your project

(3) The results of your project (the meaning of results is broadly conceived)

(4) How other faculty might replicate your project/do something similar/etc.

A. The Teaching Innovation

Since 1985, I have taught PHY 151, Introductory Astronomy, thirty-one times to a total of nearly 3,000 students. Four years ago, in response to modern science-education research and my own dissatisfaction with the traditional lecture-based approach to teaching, I recast my curriculum in a historical framework, tracking the development of humanity's conception of the universe. A key element is a series of in-class, paper-and-pencil activities by which my students, working in teams, recapitulate the epic advancement of astronomical thought, from the rudimentary observations of prehistoric skywatchers to the development of modern astrophysics in the 20th century. These activities, based on the original methods and observations of history's greatest astronomers, were published in 2009 by Jones & Bartlett Learning, a major science textbook publisher, as the *Astronomy Activity and Laboratory Manual* (http://www.jblearning.com/catalog/9780763760199/).

The activities are designed to be implemented in a lecture hall. As such, they require no specialized equipment or individual materials beyond a pencil, straightedge, and common calculator. The necessary mathematical background – basic elements of high-school algebra, geometry, and trigonometry – is introduced on an as-needed basis for each activity. While essential to the execution of the activities, the mathematics also serves to reinforce the quantitative reasoning skills of the non-science-major students who take the class. Lectures take up no more than half the class period and are largely supplementary, providing background and context for the day's class work.

Results of the project

Beginning- and end-of-semester assessment tests indicate that students are learning the targeted ideas of the curriculum, such as the evolution of scientific ideas (science as a cultural process); the nature, scope and evolution of the Universe; crucial astronomical quantities and physical laws; roles of observations, experiments, theory and mathematical models in science; and so on. (Average normalized gain = 0.45, compared to traditional lecture-based science classes, 0.23±0.04, and active-learning modes of science instruction, 0.48±0.14. (Hake, "Assessment of Student Learning in Introductory Science Courses," 2002))

The new activities-based format has raised student attendance (classwork counts significantly toward the course grade), retention, and active involvement in the astronomy class. I engage with my students on an individual or small-group basis. Even in a class of 100 students, I am able to guide a significant number of my students in their work, turning the lecture hall into an interactive space, rather than a place to passively sit and listen. (There are also one or two teaching assistants.) Enrollment in the follow-up course PHY 251, Intermediate Astronomy, has more than doubled (from 12 to 30) since the new format was introduced in PHY 151.

How to replicate the results

I am attempting to replicate this active-learning process in my other courses, such as PHY 251, Intermediate Astronomy, and PHY 225, Introductory Experimental Physics. An activities-based approach can certainly be adapted to courses outside the sciences. Note that I have not abandoned the lecture entirely – not all course material can be effectively presented in the context of student-centered discovery – but I have recognized (and research supports) that the limited attention span of students restricts the duration of passive learning. There are many ways to directly engage students through relevant, challenging activities. If the instructor is the only person talking in the classroom for an hour, something is wrong.