Choosing Between Teaching Helioseismology and Phases of the Moon

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The back-to-back In My Opinion pieces in the September 2001 TPT were spurred by astronomy-education papers at the January 2001 joint AAS/AAPT meeting. Pasachoff and Caton dispute whether we should be paying more attention to those topics relevant to the lives of students (phases, seasons, constellations) or to the lives of research scientists (neutrinos, pulsars, and cosmology). Pasachoff advocates relegating familiar phenomena to elementary school classrooms or the dustbin of remedial college courses. Pasachoff and others may prefer to dismiss the disturbing truth that mastering basic concepts is difficult for students and complex topics almost impossible without learning the basics by focusing on phases and seasons. In doing so, they sidestep the message that most science teachers dramatically overestimate the impact of their own instruction in physics and astronomy unless they test for prior knowledge.

Phases and seasons (and in physics, kinematics and ray-tracing) stand as examples of basic topics that students find exceedingly difficult. Yet, they can become cornerstones for understanding more complex astrophysical models needed for understanding distance scales, pulsars, and the search for extra-solar planets. Phases and seasons are familiar physical systems whose models tax the underexercised spatial reasoning ability of most students, yet cannot be learned simply by listening to lectures or viewing pretty pictures. Without considerable time spent on such fundamentals, survey courses are just “an incomprehensible stream of technical jargon … in far too great a volume for significant understanding of ideas, concepts or theories to be generated and assimilated.”

So then, what should students be taught in survey courses? First of all, students should be taught skills and concepts that they can master. Pre- and post-testing is essential to gauge progress. They should be taught using the most effective methods and materials, well highlighted in TPT and AJP: concept mapping, peer instruction, demonstration prediction, model building, journal keeping, and observation. While learning the process of science is important, most students learn little of it from lectures on the scientific method or from descriptions of contemporary research. Generally, the only person learning in lectures is the one doing the talking. Students must be able to express and test their own ideas, an opportunity that too few of my 200 student teachers admit to experiencing in their undergraduate science courses. The naked-
eye Sun, Moon, planets, and stars provide a productive testbed for predicting paths and positions from pre-conceived models. While students are almost universally wrong, collecting evidence that conflicts with one’s own beliefs is often the most memorable part of a science course.6

The list of topics in introductory courses should be pruned back to those that have both terrestrial and astronomical application, such as angular measure and spectroscopy. Courses overstuffed with content produce students who are less prepared to succeed, should they choose to go on in science.7 As educators, we misuse our positions if we are motivated to use our classrooms to promote continued funding for our research or convince students of the vastness of our knowledge. How sad that there are those who teach science by elevating research in their particular domain, but ridicule and reject the educational research that could only help to improve their teaching. For the majority of students in our survey courses, ours is the last science course they will ever take. Let’s leave them with an experience that makes science relevant to their future lives.

References