What Do Students Know?

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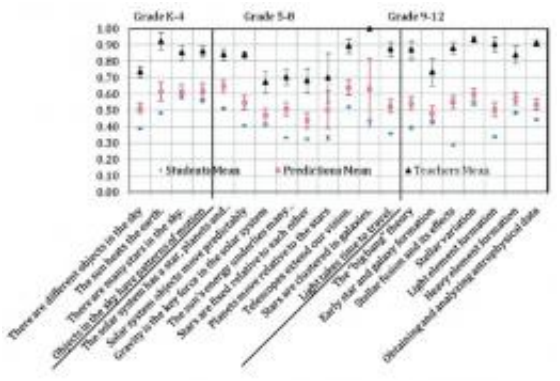

This chart plots the mean score of students (blue dots) and their teachers (black triangles) to sets of questions in the science categories labeled, and grouped by Grade. 1.00 means all correct answers, and 0.00 means all wrong answers. Red circles are the teachers estimate of how their students would do - they are uniformly too optimistic. A score of .8 was defined as signaling "proficiency" - no student groups were found to be proficient in any subject; in a few cases even teachers were not proficient. Credit: P. Sadler, et al, 2010

Black holes, frozen worlds, the "big bang," supernovae -- when it comes to telling strange and compelling stories, astronomy and space science educators can draw upon these and other denizens of a celestial zoo more outlandish than the animals in any earthly zoo. There is more to astronomy, however, than incredible objects and extreme theories. The underlying concepts on which astronomy is based are the traditional elements of physics, chemistry, and earth science. Interest in astronomy can thus provide the motivation for learning these fundamentals.

The National Research Council and the American Association for the Advancement of Science have for years been working to determine what students know about science and how they learn it, and to find better ways to teach them. States have adopted their guidelines and standards to establish their own science education goals. Astronomy education is an important part of the overall picture.

Students have many disturbing misconceptions about the universe, and a team of researchers at SAO have been studying what they are and quantifying their effects. Phil Sadler, Harold Coyle, Jaime Miller, Nancy Cook-Smith, Mary Dussault, and Roy Gould have just published their findings and recommendations in the Astronomical Education Review. They analyzed hundreds of different K-12 tests, multiple choice and otherwise, that were administered to both students and their teachers.

The SAO group has long been expert in the study of popular misconceptions that are hard to shake, and that color a person's basic understanding of the underlying science; thinking that the earth experiences summer when it is closer to the sun is one example.

Here are some other common and disturbing misconceptions reported by the team: for high school students, that telescopes are put into space to get closer to astronomical objects, that the universe is getting hotter, and that astronauts have traveled beyond the moon; for grades 5-8, that there is no gravity in space, that the sun is not a star, and that other stars are closer to us than is Pluto.

There are lots of other examples; occasionally some teachers share the misconceptions. The SAO group has over the years authored textbooks and other tools that are particularly attentive to explaining and preventing science misconceptions.

The SAO researchers studied how these apparently seductive

misconceptions could distract students away from choosing the correct answer in multiple-choice tests. They argue that such "distractors" should be included in evaluation tests but note that most often are not, and therefore that results from tests designed to measure student understanding are misleading, and that evaluation of the pedagogy is therefore inadequate. The team also found that teachers across the board overestimate their students' understanding of basic ideas, in part because of emphasizing detailed memorization over basic conceptual understanding as probed by misconceptions.

One result of their work, besides a new appreciation of the importance of identifying and addressing misconceptions, is a set of new assessment tools for K-12 astronomy and space science that can be used to determine the strengths and weaknesses of students, and help schools plan for teachers' professional development.

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