A LIVELY ELECTRONIC COMPENDIUM OF RESEARCH, NEWS, RESOURCES, AND OPINION

Astronomy Education Review

Volume 2, Sep 2003 - Jan 2004
Issue 2

Is Content All That Important?

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Posted: 12/08/03

The Astronomy Education Review, Issue 2, Volume 2:186-189, 2004

I have been reading the ongoing discussion on "what students should learn" both in *The Physics Teacher* and the *Astronomy Education Review* (Camp 2001; Caton 2001; Goldader 2002; Pasachoff 2001, 2002a, 2002b; Sadler 2001, 2002; Seeds 2001). I have also participated in some of the discussions on the subject at the 200th and 201st AAS meetings.

Although the discussion on what students should learn does contain a mix of comments regarding course goals, instructional methods, methods of assessment, and the results of education research, content dominates the discussion in a way that might give the reader the sense that content is the most important component of a course. Outside this particular discussion, in course descriptions, in discussions about courses with other instructors, and in particular, during job interviews, I also find that content dominates. I want to emphasize here that content alone does not constitute a course. The content is just one component of a course and far less important than the course goals. I want to shift the emphasis in this discussion from course content to course goals, and to that end, I want to make two recommendations regarding course goals: (1) instructors should establish course goals that are independent of content and address the question, "why teach this course?" and (2) instructors should share both their course goals and the measurable student outcomes derived from those goals with their students. To augment these recommendations, I also want to comment on the topic of student misconceptions, which has received a lot of attention in this discussion on what students should learn.

In the first issue of the *Astronomy Education Review*, Brissenden, Slater, & Mathieu (2002) present a general model for the design and development of a college-level course, a model that is common in modern education circles. It is more or less the same model that I learned in the teacher certification program at Central Connecticut State University in 1992. In this model, the instructor first establishes a set of goals for the course that answers the question, "why teach this course?" From these goals, the instructor develops a set of measurable student outcomes. Based on the measurable student outcomes, the instructor then chooses the content, the instructional methods, and the methods of assessment for the course. The goals comprise the backbone that holds the course together. The measurable student outcomes serve to guide the day-to-day classroom experience. Content is embedded in the process; it is not the start of the

process. In other words, course goals precede course content.

The distinction between course goals and measurable student outcomes is an important one. Statements such as "the student should to be able to explain the phases of the Moon" or "the student should be able to explain how astronomers measure the temperatures of stars" are content-specific statements. These statements are much more akin to measurable student outcomes than course goals. If the purpose of teaching an astronomy course at the college level is just to impart some basic astronomical knowledge to our students, I think we have missed the point of a college education altogether. Consider in contrast the following statements:

- The student should be able to evaluate the evidence for a hypothesis.
- The student should be able to comprehend and evaluate popular scientific or astronomical literature.

These statements are independent of content. These statements get at the question, "why teach this course?" These are the types of goals that glue an entire course together. These are the types of goals that we can share as a community. (Those instructors interested in the question, "why teach?" should read *The End of Education* by Neil Postman.)

I also want to recommend that instructors share their course goals and their measurable student outcomes with their students. While teaching at Minnesota State University at Mankato, I designed an introductory astronomy course with 25 units. Each unit was dedicated to a small and precise set of measurable student outcomes, and each outcome was tied to one or more of the course goals. At the end of each unit, I presented the students with the measurable student outcomes on which the unit was based. Here is one example from the second unit:

- Be able to manipulate powers of 10.
- Be able to convert any number to and from scientific notation.
- Be able to define an Astronomical Unit and a light year.
- Be able to convert between units—for example, from miles per hour to meters per second.
- Be able to state the relationship between distance, velocity, and time, and solve simple problems using that relationship.

These measurable student outcomes followed from the goal that the students should gain experience in solving simple algebraic problems, and to a lesser extent, the goal that the students should develop a sense of "place" in the Universe.

My students had never seen anything like this before, a list of what I expected them to be able to do! I received numerous positive comments from my students on this device alone. Is there a good reason that course goals and measurable student outcomes should be a secret?

Finally, I want to address the topic of student misconceptions. In the discussion on what students should learn, the following question has appeared again and again: "Should we allow students to leave college with basic misconceptions about such ordinary things as the phases of the Moon and the causes for the seasons?" To address this question, let me first present some background material.

The National Research Council (NRC) has published an excellent book, *How People Learn: Brain, Mind, Experience, and School*. The key findings reported in this book (pp. 14-18) based on decades of research in education are as follows:

1. Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they may fail to grasp the new concepts and information that are taught, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom.
2. To develop competence in an area of inquiry, students must: (a) have a deep foundation of factual knowledge, (b) understand facts and ideas in the context of a conceptual framework, and (c) organize knowledge in ways that facilitate retrieval and application.
3. A metacognitive approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them.

The first finding of the NRC is perhaps the most important and has been touched upon in some of the articles on what students should learn, in particular those of Paul Camp and Philip Sadler. I want to emphasize here that the first finding of the NRC should not be interpreted to mean that our principal goal in the classroom should be to address the misconceptions that our students bring into the classroom. Education research tells us that if we want to teach a particular concept, we must be aware of the common misconceptions associated with that concept and assist our students in confronting those misconceptions.

Although *A Private Universe* (Schneps & Sadler 1988) is familiar to most of us who teach astronomy, let us not forget that Comins (2001) has identified over 1,600 misconceptions that students have about astronomical subjects. With so many misconceptions afoot, we are bound to leave most untouched in the classroom. Let us also recognize that astronomy is a field of study rich in difficult concepts. It is impossible to share with our students all of the concepts in astronomy in the course of a semester. This is where the third finding of the NRC is critical. I interpret this finding to mean that we should help our students develop a sense of skepticism about their own views of the Universe, to develop tools to confront their misconceptions, and to take charge of their own learning.

To summarize, then, I recommend that all instructors first consider the question, "why teach this course?" before choosing the content for the course. The answers to this question should remain independent of the content of the course. I recommend that all instructors share with their students their goals and the measurable student outcomes derived from those goals. In choosing the content, the methods of instruction, and the methods of assessment for a course, instructors should be aware of the common misconceptions that students bring into the classroom and address those misconceptions when the occasion arises. Furthermore, instructors should make use of those methods of instruction and assessment that help students take command of their own learning outside the classroom so that our students become future learners rather than dazed and confused and disaffected primates who cast stones at the stars.

I thank Gina Brissenden, Andy Fraknoi, and Sidney Wolff for their comments on the first draft of this letter.

References

Brissenden, G., Slater, T. F., & Mathieu, R. 2002, The Role of Assessment in the Development of the College Introductory Astronomy Course: A "How-to" Guide for Instructors, *Astronomy Education Review*, 1(1),1.

Camp, P. J. 2001, What's Wrong with This Course?, *The Physics Teacher*, 39, 516.

Caton, D. 2001, What Should Students Remember?, *The Physics Teacher*, 39, 382.

Comins, N. 2001, *Heavenly Errors*, New York: Columbia University Press.

Goldader, J. 2002, Letter to the Editor: Comment on Jay Pasachoff's Article "What Should College Students Learn"?, *Astronomy Education Review*, 1(2), 134.

National Research Council. 2000, *How People Learn: Brain, Mind, Experience, and School*, Washington, DC: National Academy Press.

Pasachoff, J. M. 2001, What Should Students Learn?, *The Physics Teacher*, 39, 381.

Pasachoff, J. M. 2002, What Should College Students Learn? Phases and Seasons? Is Less More or Is Less Less?, *Astronomy Education Review*, 1(1), 124.

Pasachoff, J. M. 2002, Pasachoff's Points, *The Physics Teacher*, 40, 196.

Postman, N. 1996, *The End of Education: Redefining the Value of School*, New York: Vintage Books.

Sadler, P. 2002, Further Discussion, *The Physics Teacher*, 40, 198.

Sadler, P. M. 2001, Choosing Between Teaching Helioseismology and Phases of the Moon, *The Physics Teacher*, 39, 54.

Schneps, M., & Sadler, P. 1988, *A Private Universe*, Pyramid Films.

Seeds, M. 2001, More on Teaching Intro Astronomy--Science as a Way of Knowing, *The Physics Teacher*, 39, 517.

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