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

Astronomy Education Review

2011, AER, 10, 010401-1, 10.3847/AER2011008

Seven Concepts for Effective Teaching

Andrew Fraknoi
Foothill College and Astronomical Society of the Pacific, Los Altos Hills, California 94022
Received: 03/18/11, Accepted: 03/22/11, Published: 04/14/11

Abstract

This essay is addressed to astronomers and astronomy students who will go into a school, college, or other educational setting and want to think more deeply about what happens in the learning process. These are seven key ideas for improving our teaching that those of us working in science education at all levels have found especially useful. These concepts are not original with me but are mostly borrowed from great teachers, educational researchers, and astronomy education pundits. Over the years, I have collected and refined such ideas and thought *AER* readers might enjoy thinking about them, too. The good news from research into effective astronomy teaching is that we *do* know how to teach well; but like everything worthwhile, it takes some effort to get good at it.

This essay is addressed to astronomers and astronomy students who will go into a school, college, or other educational setting and want to think more deeply about what happens in the learning process. These are seven key ideas for improving our teaching that those of us working in science education at all levels have found especially useful. These concepts are not original with me, but are mostly borrowed from great teachers, educational researchers, and astronomy education pundits. Over the years, I have collected and refined such ideas and thought *AER* readers might enjoy thinking about them, too. The good news from research into effective astronomy teaching is that we *do* know how to teach well; but like everything worthwhile, it takes some effort to get good at it.

1. CONCEPT 1: "LEARNING IS NOT A SPECTATOR SPORT"

Lecturing in class is very appealing to those of us who learned that way and *can* learn that way. However, lecturing is one-way learning; like much of radio programming, it's going out, but it's hard to know whether or where it is arriving. Researchers tell us that students generally can listen for only about 15–20 minutes at a stretch, and then their attention begins to wander.

So, what else can one do in an educational setting, besides lecture? What would be two-way learning? Astronomy education researchers recommend trying small-group collaborative hands-on activities. But this requires that we, the instructors, switch from being the "sage on stage" to being a "guide on the side." The trouble is, as astronomer Mike Zeilik says, that many educators want "air time." They really like to talk. The lesson from educational research is if you like to lecture, and want to lecture, go for it; just don't do it all the time and or for a long time. (Segments, interrupted by activities, are good). Get students actively involved in their own learning as often as possible.

2. CONCEPT 2: "COLLABORATION BEATS COMPETITION"

There is no need to make an introductory astronomy unit or program like the *Survivor* show on TV. In any learning environment, it can be better to encourage students to work together and to support each other. After all, most jobs and even intellectual enterprises today require participants to do effective teamwork. When you

approach a class period like an Olympic trial, those who don't "score high" get discouraged pretty quickly. However, if everyone's input is solicited and valued, everyone feels part of the team and more open to learning. This is why good teachers find ways to draw in a much wider group of students than those who happen to raise their hands first.

3. CONCEPT 3. "EVERYTHING TAKES LONGER THAN YOU THINK"

New teachers and classroom volunteers often underestimate how long some activity or discussion will take under real classroom conditions. For example, when teachers switch from straight lecturing to including group activities, they often predict that the change will take less time out of their curriculum plans than it actually requires. Whatever you are planning during your astronomy unit or course, build in some time for unexpected issues and questions.

Another area where faulty time estimates come in has to do with what happens when we ask a class or audience if there are questions. When people who know a lot about a subject are videotaped, it's amusing to time how briefly they wait between asking for questions and then moving on if there aren't any—or how short a time they wait between asking the audience a question and then answering it themselves. Typically it is a much shorter time than students need.

Think of attending a lecture on modern music or art, being given 60 seconds to look at a painting or hear part of a musical piece and then being asked a question about it or being asked whether you have a question. Most likely you'd just stay quiet. You need more time than that just to get oriented in your thoughts about the painting or the piece. We need to be patient with students new to astronomy and give them time to collect their thoughts. In my classes, I like to think of finding and opening a bottle of water and taking a long cool drink between the time I ask something and look for an answer. Often, I actually take that drink and look away, so students can compose themselves and their thoughts for participation.

4. CONCEPT 4: "LESS IS MORE!"

There is no way to teach all of astronomy in one semester or one short unit. There is so much information in our field now, it's like going to WalMart and trying to buy and use one of every item on the shelf in four months. Your basket will be full, but your ability to enjoy any one item during that period will be limited severely.

If you get a chance to include some astronomy in a class, it's best not to worry about "fitting it all in." Consider what you really want students to take away from each class. Is it some particular sequence of information, a habit of mind, a spirit of inquiry, a notion of awe? If an astronomy unit can just give students a sense of the power of scientific thinking, an appreciation of the way everyday phenomena on Earth connect with the sky, or that feeling of fascination about how alien things out there really are, you will have done a wonderful thing for the students. And, whatever topics you teach, make them deeper than wide.

5. CONCEPT 5: "NEW KNOWLEDGE MUST CONNECT WITH PRIOR CONCEPTIONS"

Students are not blank vessels waiting to be filled. They're more like ball-park hot dogs—they are already full, although not necessarily with material you would approve of. We all need a mental framework to guide us through the world, and students put one together throughout their lives.

Prior beliefs are like lunar brecchia—put together from broken fragments produced at different times in a person's history—from experience, reading, TV, the Web, friends, school, folk wisdom, etc. For learning to happen, new knowledge must connect meaningfully with students' old knowledge. If those of us trying to get new ideas across are not aware of and dealing with these prior conceptions, we often fail to engage the students' long-term understanding.

For example, astronomy educator Phil Sadler has done some wonderful research on the idea that kids believe you can ultimately see in the dark, even if it is completely dark, if you just wait long enough. This comes from a

lifetime of experience with streetlights, moonlight, the glow of illuminated dials, or light from the rest of the house seeping into any dark room. Until you bring these ideas out and discuss them clearly, students will have a hard time with the notion that you need light or electromagnetic radiation to detect objects in space.

6. CONCEPT 6: "GIVE AND GET IMMEDIATE FEEDBACK"

Because older students have learned to wear a "class face"—a neutral expression that seems neither too interested nor too bored, so the teacher will not focus on them—it is sometimes hard to know what is going on in their minds as we teach. Often, it is when we are most convinced that we have done a brilliant job in getting a concept across that we discover that the students are lost, distracted, or stuck.

One way *not* to get feedback is to ask "Does everyone get it?" Few students (or audience members) have the nerve to say no in front of everyone. Instead, the best way to get feedback is to give students a chance to demonstrate their understanding—with an activity, a question to discuss in small groups, a two-minute paper, or a fun problem. Some teachers like to take votes on questions, or give students (in small groups) a chance to apply their understanding to a whole new situation related to the topic at hand.

7. CONCEPT 7: "DON'T GIVE WALNUTS TO BEGGARS WHO HAVE NO TEETH!" [OLD PORTUGESE PROVERB]

The proverb sounds cruel at first reading, but the more you think about it, the more you can see the sense in it. If students are not ready or equipped to learn some concepts, then not even the most inspired and eloquent teacher is going to be able to get it across to them. Many astronomers in a classroom for the first time, just bubbling over with enthusiasm, make the mistake of talking to the students at too high a level, using technical terms that the students haven't mastered, or breezing through their material at a speed that is more appropriate for a colleague.

If you take the time to find out and consider the level of preparation and the skill at abstract thinking that the students have acquired, and then tailor your activities and presentations to that level and skill, you will be far more effective in getting the students to move from where they are to a new level of understanding.

Good teachers take many years to fully appreciate and put these seven concepts into use. Don't be discouraged if your very first foray into a classroom doesn't produce instant success or enlightenment. If you are lucky, repeated interaction with a group of students in a classroom or informal setting will teach you as much about learning as you teach them about astronomy.

ACKNOWLEDGMENTS

The author would like to thank Dennis Schatz, Alan Friedman, Cary Sneider, Ed Prather, Gina Brissenden, Tim Slater, Suzanne Gurton, David Bruning, Phil Sadler, and many other colleagues who have, over the years, provided some of the inspiration and learning that led to these seven points.

ÆR
010401-1–010401-3