Why do I value improved science education? As an astronomy educator, I am in the position to bring change across such boundaries as gender and educational access, which is a powerful motivator for me. In this “gateway science,” we have a unique opportunity to reach out to that portion of our audience who might otherwise miss out on solid, authentic experiences with science, whether we’re considering an undergraduate student taking her required science credit or a visitor to a science center.

Many worthwhile goals can, and do, prompt calls for astronomy education reform: Do we want every person to have a working knowledge of astronomy? Do we want taxpayers to be enthusiastic about funding us? Or are we trying to attract students with particular aptitude into STEM careers? In my own work, I'm concerned with basic scientific competency, which to me means an understanding, developed through experiences with inquiry, of the social, creative, and communicative process through which scientific knowledge falters, falls apart, and ultimately grows. Traditional science education focuses too much on answers and very little on questions, creating the impression that science has nothing to do with everyday life and is nothing more than a collection of facts, and that scientists are in the business of making assertions from a position of authority, rather than arguments from a base of evidence. To my mind, developing this competency sets a foundation for a future career, but also fosters engagement with and enthusiasm for the scientific enterprise.

Instead of approaching science education as the transmission of facts organized by content area, I advocate an approach that considers science literacy to be not unlike verbal literacy, and that views inquiry as a commonplace tool used in ways similar to language. Science is a tool for approaching questions, tasks and problems. Just as we learn language by listening, speaking, reading and writing, and observe and practice it at home, at school, from stories, from nursery rhymes, and from songs, these inquiry skills can only grow if they are experienced and practiced in a variety of contexts. Asking interesting questions, formulating guesses from previous knowledge and from reasonable inference, designing and carrying out an investigation, and synthesizing evidence into a convincing argument related to the initial questions are not simple tasks, but complex skills. I come from a rather unusual perspective on this topic, holding a degree in English in addition to physics and astronomy. Through my work with Cornell's Knight Institute for Writing in the Disciplines, first as a writing tutor and then as an instructor of a First Year Writing Seminar, I've come to believe that the educational stumbling blocks in literacy and science competency are inextricably linked. It's not, in my mind, a coincidence that students have difficulty differentiating between an “argument” and an “assertion” in their written communication while also struggling to recognize pseudoscience or carry out meaningful laboratory investigations. A basic lack of understanding of the collection and presentation of evidence to draw a reasonable and well-supported communication reverberates through all academic subjects and into real-life situations that demand an ability to ask questions, adopt a skeptical approach, and analyze information.

We cannot teach the 'scientific process' by telling audiences about a concrete set of steps to be followed, any more than we could teach rhetorical argument by telling people about a set of techniques without providing
the chance to practice. Fortunately, these more authentic contexts exist for astronomy education; formal and informal astronomy education and public outreach experiences can artificially provide some of them, but as our learners become more comfortable with the “language” of science, it is my hope that they would start to recognize that they are encountering it in movies, in newspapers, in their doctor’s office, and everywhere else they look. I think that inquiry-based science education works well, in part, because learners are able to apply their own pre-existing strengths to problems, and through these experiences they are also able to cement those strengths and extend them to new contexts. In this way, learners “translate” between what they know to be true and how they discover new truth. Inquiry-based astronomy education helps people learn to negotiate the path from ignorance to knowledge, and it differs from traditional science education by acknowledging and incorporating the existence of questions, unfamiliarity, uncertainty, trouble, and decision-making along the way.

I've worked with, and am refining my practice of, several innovative teaching techniques. While we are helping learners develop inquiry as an available “tool in their toolbox,” we also have to practice with our new teaching devices, since it's not always easy or intuitive to place more emphasis on discussion, communication, or inquiry activities in a “brains-on” learning environment. I particularly focus on using writing as a pathway for science learning, whether students are writing a short caption for a planetarium display, critiquing the quality of a Wikipedia article, or comparing cosmology to creation mythologies. In a large-group setting, the think-pair-share discussion and lecture tutorials developed by Prather, Slater, Adam and Brissenden (2008) appeal to me because they are fun, because groups I've worked with respond to them enthusiastically and with full engagement, and because they model the action and communication of scientific growth. In outreach activities, discussion section, or laboratories, I strive to make use of existing astronomical databases, citizen science projects like Galaxy Zoo, and tools like Project CLEA labs that leave room to explore. The backwards-faded-scaffolding model for inquiry based activities, which asks learners to start with the simple step of evaluating whether a conclusion is supported by evidence, was developed by Slater, Slater and Lyons and combines inquiry with the verbal literacy model, while acknowledging that inquiry skills must be learned and practiced, and that developing good research questions is no simple task. These activities all deal with science as a social, communicative behavior and stress the abilities that our learners bring to the table with them: an ability to argue verbally, an understanding of primitive concepts like light and dark, hot and cold, and at least some investment or interest in astronomy. At the same time, these kinds of activities expand on those existing abilities, and make critical thinking a force of habit. This emphasis on developing inquiry as a skill permeates my teaching philosophy, and these principles are at the heart of Joseph Schwab's meaning when he wrote, “Authority consists not in possession of information, but in possession of competence in inquiry.”

References

