The Prepared Practitioner

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Constructivism and Conceptual Change, Part I

Constructivism is the basis for standards, inquiry-based instruction, and a candidate for buzzword of the decade. But what is constructivism?

The word *constructivism* can refer to a philosophical view on the nature of reality. Philosophical constructivists say that reality is ultimately in the eye of the beholder, and that there is no surefire way to prove there is such a thing as objective reality. Reality is ultimately personal, relative, and created by the individual. Buddhists who believe that the "real world" is ultimately illusion, and individuals who find the picture of reality in *The Matrix* film intriguing, might see a certain appeal in this view.

Constructivism can also refer to how people learn. Most science teachers will find constructivism as learning theory more relevant to their professional lives. This begins with the radical notion that human beings have brains, and that learners' experiences affect how they understand science concepts. Students come to class with many ideas about how the world works. Students may be unaware they even have the ideas, and their ideas may differ from those accepted by the scientific community. This point is relevant even when you discuss a topic about which students would be expected to know little or nothing, like a brand new, abstract science concept.

As examples, consider Newton's first law—an object in motion remains in motion, unless acted on by another force—and the biological concept of photosynthesis: plants use light as an energy source for making food. Students often believe that an object in motion comes to rest, unless acted on by another force. That is because just about everywhere in everyday life objects in motion do tend to come to rest. For plants, it is pretty abstract to think in terms of light being a necessary component in making "food." It is more common for students to think of plant food coming only from the soil. I will be writing more about this latter point in a future column.

Constructivist learning theory grew from Piaget's ideas and posits that when you tell students about an idea, they will unconsciously compare what you say with all the rest of their knowledge and experiences. One of three things will happen as a result. First, if the students' knowledge fits pretty well with their beliefs and experiences, then it will be assimilated, find a nice home, be easily recalled and understood, and you'll feel like a successful teacher.

Second, if the knowledge fits poorly with the students' knowledge and life experiences, then their minds could basically reject the knowledge. Students will say the idea doesn't make sense, doesn't seem reasonable, or is just plain stupid. This is the type of situation in which students may memorize something that they do not really understand, and forget what was "learned" soon thereafter. You won't feel like a successful teacher.

This could happen with the photosynthesis example if the students were incapable, for now, of being able to think of something intangible—light—as being a necessary component in making food. Truly understanding photosynthesis may require both the ability to think about the topic with abstract reasoning and radically changing one's definition of the whole concept of food, not only when thinking about plant biology but with everything. Thinking about light as a component in making food to some extent requires understanding the abstract idea of potential energy stored in chemical bonds.

Third, the new ideas could change everything, with students ultimately accommodating the topic by understanding many things differently—reorganizing their cognitive structures, in the language of learning psychology. A look of excited understanding appears on their faces, light bulbs appear over their heads, and you feel like a very successful teacher.

This could happen with the Newton's law example if a student previously thought in terms of everything's natural tendency to be at rest, and the student now was able to understand the concept of friction. True understanding here can involve a major shift in thinking, applying the friction concept all over the place—just as it was a big deal in science's history when thinking shifted from an Aristotelian worldview to a Newtonian worldview.

If you think about learning as occasionally asking students to change their common sense worldviews toward a view that is inevitably more abstract, you can see why true conceptual change is difficult. There are, however, things you can do to increase the chances students will make these conceptual leaps. And that will be the topic of the next column.

Alan Colburn (acolburn@csulb.edu) *is a professor of science education at California State University, Long Beach, and author of* The Lingo of Learning: 88 Education Terms Every Science Teacher Should Know *from NSTA Press.*