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Minneapolis, MN 55455-0434,
E-mail: rmoore@tc.umn.edu

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Publisher: Wayne W. Carley

Editorial Staff: Kay Acevedo, Cheryl Merrill

ABT Production Office:

12030 Sunrise Valley Drive #110,
Reston, VA 20191-3409, Phone: (703) 264-9696,
Fax: (703) 264-7778, E-mail: nabter@aol.com,
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Guest Editorial

We Teach Biology Backwards

Open the laboratory manual and read the instructions. Get some basic understanding of the concept, follow the instructions, and see if you can come up with the "right" answer, the answer that matches existing theories about how the biological world works. So it goes in thousands of biology classes nationwide and at all levels. Students move from generalization to "experimental" specifics which "should" match the generalizations. They do or do not get the "right" answer. But science doesn't work this way!

There are, in fact, many "scientific" methods. Darwin observed diverse organisms and fossils around the world, and developed his ideas based strictly on his observations. He had no hypothesis and did no experimentation. Watson and Crick did no experimentation either. They gathered ideas from the results of other peoples' experiments, brainstormed, built models, and deduced the structure of DNA. Gregor Mendel experimented on an extensive scale, demonstrating that experimentation is one of many ways of doing science. But one wonders what his initial "hypothesis" might have been, or whether he was, at first, simply messing about in the garden trying to find out how inheritance works. But in all these cases, observations and evidence accumulated, and based on these findings, generalizations were made about how the biological world works.

Of course, there isn't really a "scientific" method, there's a "people" method. A small child in a high chair dropping oatmeal on the floor is making observations that will lead to un verbalized generalizations about gravity and adult behavior. We all do this every day. It's the only way we can know about the world—observations that are multiple and diverse have to be organized in some way by our brains. Our ability to make good generalizations determines how well we get along in life.

Why is it then, that we go about teaching biology backwards? We start by teaching the generalization, and then move to the specifics. Most "experiments" and "investigations" that students are required to do are exercises that have been repeated many thousands of times with outcomes that are entirely predictable. The only variable is student error. There is nothing experimental or investigational about them. It's the exact opposite of how science is done.

How should we proceed? The easiest way is to turn labs around. Don't provide the generalization at the start. Give students materials and minimal instructions, and then refuse to say more. They will produce some results; emphasize that their results are completely valid—they can't be "wrong." Then ask, "What do they mean?" Help them develop the generalization, the concept they need to understand. Note that the changes to be made involve timing and discussion, not materials and preparation. It's not more work, it's just better teaching.

These ideas are not new. The terms "learning cycle," "inquiry" and "constructivism" are applicable. We need to continually apply these methods so that our students understand how science really works.

Dan Wivagg
Department of Biology
Baylor University
Waco, TX 76788