OWNING the scientific method Through Active Learning

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Contributing Writer

When I first began to teach introductory biology, my teaching goals centered on conveying content knowledge. That is, my objective was to cover a list of topics to a certain level of detail. As I gained experience, I realized that one of the most essential concepts we convey to our students is not content knowledge, but process knowledge: the scientific method, what it is, how it is applied, and its limitations. In many introductory biology courses, discussion of the scientific method occurs right at the start of the semester, when many students (particularly non-science-major students) are at their most apprehensive. The scientific method can seem like a foreign concept, something that "those wacky scientists" do, replete with jargon and formality. But to succeed in the course, all students must learn about the scientific method, and the best way to do that is through active participation. How can teachers make uninitiated students comfortable enough to dip their toes into the scientific waters? I've found that with a minimum of prompting, most students can see that they are, in fact, inherently familiar with the scientific method (often to their great surprise). Thus, one important point that I try to convey right away to my introductory students is that they *can*, and indeed they *do*, apply the scientific method in their every day lives.

The key is to make a connection between the formality of the scientific method (hypothesis, methodology, results, conclusions, etc.) and their normal mode of thinking. I start with an every day example: Imagine that you have completed your homework and you want to relax by watching TV. You push the power button on the remote and nothing happens. I'll ask the first student in a row "What would you do?" That student will make a suggestion, such as "Check the batteries," "Whack the remote," or "See if the TV is unplugged." I then ask the next student how they would apply that idea. They will make a suggestion such as "Change the batteries" or "Check the power chord." I make up results of that inquiry and provide them to the next student, saying that the TV still doesn't work, so what now? We continue down the row, students making suggestions, testing them, and deciding what to do next, until on the third try I tell the students that they were successful and the TV now works.

I then turn to the next row in the classroom and ask them to recast what just occurred using the formal terminology of the scientific method. We'll start with an observation ("I observe that the TV isn't turning on") and then the first idea. I force the students to use formal phrasing, such as "I hypothesize that the TV isn't coming on because the batteries are dead", which usually elicits some chuckles. We continue this way through designing an experiment, conducting the experiment, collecting data ("I checked the plug and it was in the wall"), drawing conclusions ("My hypothesis that the TV was unplugged is not supported by the data"), and then revising the hypothesis and repeating for each of the three ideas presented by the class.

Such an exercise quickly reinforces that the scientific method is just another way of describing *how they act and think every day*. They quickly see

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Another View: *Owning the Scientific Method, continued*

that we all conduct a dozen such inquiries a day, we just don't formalize them. To reinforce this point, I give them a homework assignment: write down three more instances of conducting a scientific inquiry that occur over the remainder of that day. First, they must write the examples as a standard narrative, describing the events as they would to a friend. Next, they must rewrite each example in the language of the scientific method (as if writing a lab report). I begin the next class by having students read each other's examples. They range from the mundane to the slightly profound, but they are all real and personal.

I further reinforce the common use of scientific inquiry during the first lab. I join the students in a circle with a cardboard box in the center. I ask one student to observe the box. (Unseen by the students, the box has a cardboard partition inside it as well as a rubber ball, a dice, an envelope half-filled with sand taped to the inside of the box, and a cotton ball.) The first student makes an observation and hands the box to the next student, who states a hypothesis. As the box is passed around the circle, successive students design an experiment to test the stated hypothesis, gather data, and draw a conclusion. If the students have settled upon a correct idea, I open the box, revealing and removing the object, and the students start again. This continues, giving each student multiple chances to participate, until students conclude, "The box is empty." At that point, I reveal the presence of the cotton ball, demonstrating that the scientific method has limitations; it does not always bring scientists to correct conclusions.

Through this series of exercises, I hope to guide the students into a state of ownership of the scientific method. Once students appreciate that they, too, apply the scientific method in their everyday lives, I can begin to teach them specific course content placed within the established context. This is a good first step in helping students to succeed in the course and in developing the next generation of "citizen scientists."

Major Starter Grants

The following are the new Major Starter Grant Awardees for year 7.

Name	University	Project Title
David Davido	KU-L	Viral and Host Responses to HSV Infection
Michael Johnson	KU-L	The Impact of Dopamine Signaling on Fragile X Syndrome Behaviors
Hiroshi Nishimune	KUMC	Voltage Gated Calcium Channels as Scaffolding Proteins for Synapse Formation
Chris Thorpe	KSU	Tail Morphogenesis in Zebra Fish

Pilot/Bridging Projects

The following K-INBRE Pilot/Bridging projects were awarded for year 7.

Primary Investigator	University	Title
Chang, Kyeong Ok	KSU	Bile acids in the replication of Hepatitis C virus
Michel, Kristin	KSU	Transcriptional profiles of Anopheles gambiae hemocytes
Singh, Chingakham, R.	KSU	The role of RNAbinding initiation factors in protein synthesis
Von Ohlen, Tonia	KSU	Identification of transcriptional targets of Ind
Wei, Qize	KSU	Pitx2regulated genes in leftright development and cardiac morphogenesis
Huan, Jun	KU-L	Cellular pathogen gene identification via graph data mining
Tang, Liang	KU-L	High resolution structure of the type III secretion system
McCarson, Kenneth, E.	KUMC	CNS Sites Where Estrogen Modulates Hyperalgesia
Nothnick, Warren B.	KUMC	AEBP1 and ovarian physiology
Vivian, Jay L.	KUMC	Generation and analysis of a mouse model of KlippelTrenaunay symdrome
Wright, Douglas E.	KUMC	Role of Myelinated Cutaneous Axons in DiabetesInduced Proprioceptive and Balance Deficits