Educational Leadership: December 2006/January 2007 | Volume **64** | Number **4**
Science in the Spotlight Pages 48-54

Snapshots of Science in Practice

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A science teacher opens an early college founded on students asking and answering their own questions. A science school reaches out to the science community. A science specialist teaches both students and teachers. A school district uses a historic site to integrate its science curriculum. A university pilot tests an engaging food safety curriculum. Read on to discover how some schools are raising the bar on science instruction and motivating students and teachers alike.

Empowered to Ask

Ardi Kveven

When I started working with cutting-edge scientists who were conducting hydrothermal vent research, I had an epiphany as a learner and science teacher. I realized that the scientists didn't have the answers to my questions; they just had more questions. This experience changed my understanding of how to teach science effectively.

As a result, I discarded step-by-step lab procedure instructions and encouraged my high school students to make observations and to ask and test their own questions. Although it took a while to guide students away from asking, “Is this on the test?” I was amazed at their ability to design and conduct experiments. This realization, coupled with my frustration with the constraints of the large comprehensive high school in which I worked, led me to establish an early college whose curriculum is founded on students asking and answering their own questions.

The Ocean Research College Academy (ORCA), founded three years ago with the support of the Bill and Melinda Gates Foundation and Everett Community College, embraces the questioning nature of science. With a current enrollment of 70 students from 14 area high schools (and with enrollment increasing by 15 percent every year), the ORCA program accepts students who have been evaluated by a written application, college readiness test scores, and a math placement interview. Ninety percent of the first graduating class enrolled in universities with the attributes necessary to persist to a bachelor's degree. Regardless of their major (only half of our students major in science), we want students to continually ask questions and apply scientific principles to their everyday lives.

Science provides the impetus for asking questions, but ORCA students become lifelong learners in all disciplines because they are empowered to become active participants in their education. ORCA students earn 16 credits every quarter in math, science, English, and history. In every discipline, instruction is scaffolded to provide all students with the basic knowledge and skills necessary to conduct rigorous intellectual inquiry. The following snapshots show this approach to learning.

A 16-year-old student came face-to-face with a challenge while in the field collecting shipboard water samples measuring temperature and salinity. From laboratory experiments she had conducted, she understood that colder water is denser than warmer water. The ocean normally has warmer water at the surface and colder water at depth. However, at this sample

station in Puget Sound, her collected samples from various depths showed the colder water layered on top of the warmer water.

She was forced to grapple with this incongruity. Her data were her data—they were neither right nor wrong—but what was she to do with the information? She questioned what she knew, reflected on it, and finally was able to explain this unexpected result: Colder freshwater had flowed in from a river and layered on top of the slightly warmer and salty ocean water. Discovering this explanation on her own empowered her to continue to question, evaluate, and explain what she saw in the world around her.

Another student wondered why jellyfish glow in the dark. Her initial question led her to do research with a premier jellyfish researcher who worked at a nearby research university. Her testable hypothesis on the photoperiod and recovery time of jellyfish yielded new findings (including how different species respond to a chemical light signal) as well as a full tuition scholarship to the University of Washington.

One student discovered her passion for birds when she was observing seagulls at the beach. She questioned whether bird feces carried and spread disease. This question and others led her to take classes that involved conducting research on birds. Recently, this student participated in an internship with a Dartmouth ornithologist conducting field research in San Diego. She is the first high school student ever offered this position, which is normally reserved for graduate students.

During our project week, in which students explore topics of interest with no grade attached, one student created his own monitoring project in a lake by his house. To answer the question he'd formulated—How polluted is the lake?—he built his own bottom-sampling device and borrowed water-sampling equipment from a local government agency. He continued to work on the project for the rest of the year, developing the sampling protocols and conducting his research both in and out of class. The student wondered whether there was a cheaper and faster way to measure water quality than the standard chemical tests. He adapted a river-testing protocol—using the presence or absence of bottom-dwelling organisms as an indicator of water quality—that was not commonly used in lake settings. He submitted his paper and preliminary findings to the Ecological Monitoring and Assessment Network and was invited to present at the organization's international conference. Even though this student plans a future in medicine, his critical-thinking and problem-solving abilities stem from hands-on science experiences that originated simply from giving him the power to ask his own questions.