Scientific literacy happens -- when students think for themselves

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Give college students less instruction and more freedom to think for themselves in laboratory classes, and the result may be a four-fold increase in their test scores.

So says Steve Rissing, a professor of evolution, ecology and organismal biology at Ohio State University. Rissing played a major role in revamping the way the university teaches its introductory-level biology courses.

“For one, we got away from the cookbook method of teaching concepts of biology in a lab course,” he said. “Instead, many of those classes now include real experiments that leave room for additional inquiry.”

The effort paid off. During a talk at the annual meeting of the American Association for the Advancement of Science in San Francisco, Rissing cited one particularly difficult laboratory experiment in which students worked with enzymes. Students often struggled through this exercise, and usually scored poorly when later tested on the implications of the experiment's findings.

Rissing asked the laboratory instructors – usually graduate students in biology – to use two different approaches over two academic quarters when teaching the experiment. Roughly 300 students, all taking an introductory biology course for science majors, were in each group. The first group used what Rissing calls the “cookbook method” – they followed step-by-step instructions on how to carry out the experiment

and display their results. These students were provided with a standard, prepared enzyme solution.

The second group of students had to prepare their own enzyme solutions from a piece of raw turnip. They were also given more freedom to think through their approach to the same experiment, and were encouraged to use critical thinking and hands-on discovery to come up with their approach.

At the end of their respective experiments, both groups of students were asked one simple question: Where do enzymes occur in nature?

About one out of five students (23 percent) in the “cookbook” group answered the question correctly. But 83 percent of the students who developed their own approach gave the right answer, which was that enzymes come from living tissue.

“The students in the first group were just as intelligent as those in the second group,” Rissing said. “They just lacked confidence. No teacher had ever asked them something as simple as how do they want to display what they saw in the experiment. They had always been told how to do that.

“Educators thought they were doing students a wonderful favor by giving them step-by-step instructions,” he added.

Rissing's overarching goal is to teach students to be independent and objective thinkers, to create a group of scientifically literate citizens who can intelligently discuss multi-faceted issues such as stem cell biology, evolution, genetically modified organisms and the like. This applies to science majors and non-majors alike.

“Right now, we just beat the beauty out of everything,” Rissing said.

“Students learn vocabulary. That's it. They don't understand evolution, nor do they understand the beauty of diversity.

“College graduates are going to have trouble having a meaningful public discussion about these issues if they don't have some perception of what these things even are.”

Some 40,000 students passed through Ohio State's introductory biology courses during the five years that Rissing directed the university's introductory biology program. While he's no longer the director, the students still follow the curriculum he helped establish.

The majority of students taking these courses aren't science majors and, in theory, may have very little interest in sitting in a biology classroom.

“So we liberated the non-majors curriculum,” Rissing said. “In most cases, instructors tended to teach watered-down biology to students taking these introductory classes.”

The curriculum for non-majors now focuses on the implication of “big picture” issues. Students enrolled in these courses are often required to read the New York Times each day and be ready to discuss science-related issues that make headlines.

“My job isn't to prepare these students for med school,” Rissing said. “My job is to help the students attain a level of scientific literacy so that they can contribute to a serious discussion on these larger issues.”

Rissing pointed out that scientific literacy rates in the United States have risen to 16 percent, up from 9 percent about a decade ago. He attributes that in part to changing how students, and ultimately their teachers, are taught.

“The most crucial players in fostering scientific literacy are the K-12 science teachers, but we teach those teachers in college,” Rissing said. “The college professors and scientists are ultimately the ones that foster public understanding and opinions of science.”

Source: Ohio State University