Active Learning

Biology Students Discover That a Question Makes a Perfectly Good Answer

At first glance, this Biology 100 class looks and sounds like any introductory science course: A lecture hall packed with 200 freshmen. The bobbing heads and low buzz of conversation, even as the instructor is speaking. But take a second listen. There's an undertone of intense engagement in that sound. And the professor, **Phil Sokolove,** is hardly droning away behind a lectern. Instead, he's striding up the aisle, a wireless microphone in hand. "All right," he says, "we've just heard a description of the cell cycle. Now, what kind of question would you ask if you wanted to find out more about this process?"

He hands the mike to a student, one of many with her hand raised. He's able to greet her by name, thanks to the badge that she — like everyone else in the class — is wearing. She momentarily confers with three classmates sitting around her, and responds, energetically, "I'd want to know what makes a cell want to start to divide." A few rows over, another group of students spiritedly indicate their opinion that a different question is even more compelling, so — with the professor's quick assent — she passes the mike along with the aplomb a talk-show host might envy. This freshman evidently knows the rituals of daytime TV — but, as her question shows, she's developing a flair for thinking like a scientist, too.

By Vince Ercolano
Photographs by Doug Kapustin
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Taking Responsibility for Your Own Learning

Two UMBC departments, Biological Sciences and Education, are trying something new in Biology 100. Also known as Concepts of Biology, it's an otherwise traditional large-lecture/discussion-group course taken mostly by freshmen, with about a third of the class consisting of Biological Sciences or Biochemistry majors.

Since 1995 one large-lecture section each fall semester has been set aside for a teaching technique called active learning, which Biological Sciences Professor Phillip Sokolove, perhaps its most enthusiastic advocate at UMBC, describes as using "whatever means possible to challenge students to take greater responsibility for their own learning."

"Experienced teachers, K through 12, will tell you that learning students' names is one of the most important things you can do," Sokolove says; so on the first day of class each student in the active-learning section of Biology 100 receives a simple name badge. The professor wears one, too.

Besides making students easier to identify for the teacher, they help break the ice within the four-member "teams" into which Sokolove segments the class. (Team members are selected in a random drawing, and work together on in-class exercises throughout the semester.) Sokolove explains to students that using the badges reflects practice at professional scientific symposia; they're also reminded that wearing the badges is "a nonverbal means of participating" that counts toward their grade.

In the large-group setting of Biology 100, the success of active learning may come down to a humble piece of modern electronics: the wireless microphone.

"It changes my role, subtly, from the person in charge to the facilitator," Sokolove says. "Science is asking questions," he says, and the microphone enables the professor to prod students toward fruitful inquiry by, in effect, shrinking the room.

Access to the microphone encourages participation, says **Lily Alemi '99**, an Interdisciplinary Studies major from Timonium, MD, "because you don't have to worry if you have a soft voice."

"I was nervous at first" about using the microphone, says **Tyrone Spady '99**, a Biological Sciences major from Clinton, MD, "but it's good because a lot of people don't project really well."

In the large-group setting of Biology 100, the success of active learning may come down to a humble piece of modern electronics: the wireless microphone.

TEST YOURSELF

A Sample Question Given to BIOL 100 Students [from a take-home assignment]

Your sister, age 38, has a lump on her breast that has been diagnosed as cancerous.
A common combination of treatments for breast cancer is lumpectomy (surgical removal of the tumor and a small amount of surrounding tissue) followed by local radiation therapy. Her oncologist has suggested instead that surgery be followed by treatment with tamoxifen, an antiestrogen drug that blocks hormone receptors.

Should your sister follow her doctor's advice? Why or why not?

Share your answers by e-mail to sokolove@umbc.edu.

Sokolove cites the example of a student with diabetes who took the microphone in hand one day to say, "I've always wondered how insulin works." That inquiry became a thread that ran through the course.

Using What Students Already Know as a Springboard

The "teach-to-the-test" mentality still common in elementary and secondary classrooms discourages the spirit of inquiry crucial to doing science. "Getting kids to ask questions again," Sokolove says, is perhaps his biggest challenge. "They do it naturally when they're small — for example, the kid who says, 'I set it on fire because I wondered what it would do.' But they learn in school that teachers want you to answer questions, not ask questions."

"The challenge is to undo this," he asserts.

The following take-home assignment typifies the emphasis on using students' knowledge base as a springboard: "You are a track star scheduled to compete in a 1,500-meter race next week. Your coach tells you to load up on carbohydrates the day before the track meet so that your body will have plenty of energy in reserve for the race. Is the coach correct in her advice? Why or why not? Cite evidence to support your position."

For the assignment, Sokolove placed emphasis not so much on finding the "right" answer but on doing research. (Students had to list sources; one, to Sokolove's amusement and gratification, consulted a member of the UMBC track team, among other sources.) They had to write a defendable response, and, perhaps most important, "two questions of their own that resulted from the research they had done."

The different conclusions the students reached "were aired in class discussion to illustrate the importance of scientific discourse and to allow students to gain experience in defending the interpretation of their research findings."

The question about the track athlete's food choices also became a means by which students began to grasp processes such as digestion and cellular respiration. "Students could thereby learn key facts and concepts in an applied context with guidance from the instructor, rather than feel they needed to memorize them from lecture notes or the textbook only because they might be on the next exam," Sokolove says.

Tyrone Spady says this approach caught him off-guard. "Initially I was frustrated, but that was compounded by still being in the high school mode," he says. "It wasn't what I was used to. It wasn't 'Identify the three structures involved in, etc.' They were application questions."

Susan Blunck, an assistant professor of science education in UMBC's Department of Education, concurs. In completing such an assignment, she says, "students are being challenged to apply key biology concepts and principles. Cognitive research shows that people must

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A Sample Question Given to BIOL 100 Students [from a midterm exam]

In a study of snails living on two adjacent city blocks in Bryan, Texas, allele frequencies were analyzed at five different gene locations. Greater genetic variation between snail populations was found for snails living on opposite sides of the street than between local populations of snails living on the same block. The most appropriate interpretation of these results is that:

A. disruptive selection is causing the two snail populations to diverge.
B. the street is a major barrier to gene flow between the populations on the two blocks, and the differences seen are due to genetic drift.
C. directional selection is acting on snail populations located on the same block.
D. the snails on opposite sides of the street belong to different species.
E. stabilizing selection is acting on the snails that live on the same block.

Answer = B

use knowledge in a variety of contexts for them to truly understand."

"Specific items of content may appear at any point in the semester," Sokolove says. He cites the example of a student with diabetes who took the microphone in hand one day to say, "I've always wondered how insulin works." Resonant with opportunities to provide insight into the process of metabolism, that inquiry "became a thread that ran through the course," Sokolove recalls.

Coming Out From Behind Closed Doors

Professors "typically talk to each other about their research, but we tend to teach behind closed doors," Sokolove has written.

Thanks to his ties to the Education Department (he has also worked with Dr. **Wendy Saul** on the Elementary Science Integration Project) and his outspoken advocacy of active learning, through, among other means, a column in ***The Retriever***, he has become aware of — and encouraged — efforts elsewhere on campus to implement aspects of active learning, in particular, learning groups that resemble the teams formed in Biology 100.

For instance, in Political Science 432, a pre-law course on civil rights, students form "courts" of six or seven members that sit and work together in every class. In Biology 451, an elective in neurobiology, students work in groups of four to six to answer questions derived from a research paper on a "topic of the week."

Active learning might be more widespread, Sokolove believes, if it weren't so time-consuming: "It's an enormous amount of work." His active learning section of Biology 100 takes up "110% of my time," he says.

Going Empirical

Key to making the case on behalf of active learning, Sokolove and Blunck agree, is empirical data. "There is a set of long-term questions that are important to me," Sokolove says. These include how majors perform later in the biology sequence, and if those nonscience majors who take the active learning section ever take another science course.

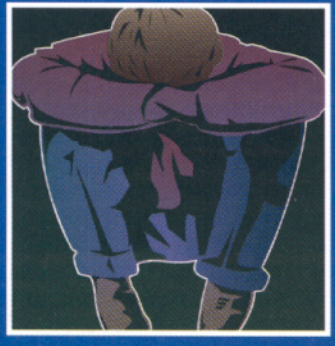
Sokolove and Blunck are doing pre- and post-surveys of all participants in the section, to assess their changes in attitudes and grasp of key concepts in regard to biology. Blunck says, "Phil and I are teacher/researchers. It's critical that we collect evidence of how this approach is working; without this evidence, we can't go very far."

Their initial impressions of student performance under an active learning regimen are, they say, heartening. Their data show that, on multiple-choice final exams, students in active learning are performing as well as or better than students in the more traditional lecture sections.

Tyrone Spady says he would gladly participate in an active learning class again: "You feel more comfortable when you see the big picture. It helps you keep things."

Some students take Sokolove's willingness to admit he doesn't know the answer to a question — or his preference in many instances to let students figure out the answer themselves — as signs that the professor may not entirely know what he's talking about.

Sokolove finds this last criticism intriguing. "It shows — in a backhanded way — that I've been successful in my objectives."



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A Sample Question Given to BIOL 100 Students [from a take-home assignment]

It's getting toward the end of the semester at Watsamata U., and you're feeling stressed out and overwhelmed. As you walk to class, you see a notice that invites students to come into the health service for free screening for depression. That afternoon you decide to go. The results of the screening indicate that you are, in fact, exhibiting the symptoms of depression, and you are advised to contact your regular physician for possible medication with one of the newer class of antidepressants such as Prozac or Zoloft.

Before you visit your doctor, you decide to find out the answers to the following questions:
How do these antidepressants work? If I'm taking one, can I consume alcohol without danger? Can they interfere with any other medication? Can I overdose, and what can be done if I do?