

# College Professors in High School Classrooms

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He's new at the game. Bill Greenough of the University of Illinois-Urbana-Champaign may be a novice at addressing high school science classes. But this APS Fellow is a fast learner.

His first try with the 30-plus students of a high school senior advanced placement class that he addressed in a Washington, DC, suburb didn't go as well as he would have liked. The students didn't interrupt him even once in the course of his hour long presentation. His performance was a bit too much like the "default model of the talking-head lecturer" that Greenough is anxious to abolish from the classroom. Why didn't the students speak up? Were they rendered speechless in the presence of a *university* researcher?

The answer was simpler than awe, actually, and Greenough's second class at Wootton High School in Rockville, Maryland, on that same day proved it with its much livelier level of interaction. This too was an advanced placement class of more than 30 senior students, but the critical difference was Greenough's invitation at the class session's outset, encouraging student participation. Greenough told students to feel free to pitch in with questions and comments throughout the lecture.

The Wootton class is taught by science teacher Lesli Adler, Greenough's partner in this new professor and high school teacher mentor relationship. Adler's students got involved in the discussion, popping questions and actively trying to figure things out. That's the direction Greenough believes K through 12 science education should take. And, apparently, even a college professor can learn something about teaching in the high school classroom!

## Pre-college Science Literacy

Why is Greenough doing this? "Basically, what I feel is that if I can do something to improve the quality of science education at the pre-college level, I am willing to invest a piece of myself in doing it, because I think it's very important," he said.

By no means is Greenough preparing for a second career as a high school science teacher, and he isn't trying to tell Lesli Adler and her fellow teachers how they should be doing their jobs. He does plan to meet with Adler's classes at regular intervals, communicate via email with individual students, and gain access for the students to certain National Institutes of Health events.

"To be honest, I don't think any college professor can tell a any good high school teacher very much about how to teach. The high school teachers are the ones in the trenches," he explained. "A science researcher like me can serve as a source of up-to-date information, involvement and interaction with what's going on in psychology and neuroscience and understanding how these events and discoveries relate to the rest of the field. I can then try to integrate that understanding into the high school curriculum a little more than it is being done now. That's our basic purpose," he said. Greenough th

inks it's a mission to which other psychologists also might want to subscribe.

### **Enriching Connections**

So now the 65 or so high school students have a link with a research psychologist who has a long and brilliant research record. Greenough has been doing ground breaking research in neuroplasticity in learning and memory since the 1970s, starting with much of the work that shows that most animals growing up in enriched environments have bigger dendritic fields and more synapses per neuron than those in unstimulating environments. In the late 1980s and 1990s, he and his colleagues have been moving beyond neuroanatomy and getting into the physiological and molecular aspects of neuroplasticity.

"We've been saying that the brain really is organized differently in these animals with enriched environments-now we can prove that. And we've been studying how something as ephemeral as a nerve impulse or synaptic transmission gets translated into a change in physical structure."

Because of this work, Greenough was tapped by the National Research Council for its study of recent developments in learning sciences. He expects the NRC report to propose "a fairly radical, revolutionary change in the way math and science are taught." The report is to be published this spring.

### **Neuroscience Literacy**

From the NRC effort it was just one short step to Greenough's own active involvement with pre-college science teaching. What started it off was his contact with Gail Burd, an associate professor in the department of molecular and cellular biology at the University of Arizona. For four years she has been organizing special workshops for pre-college science teachers at the annual meeting of the Society for Neuroscience. She is now chair of the society's committee on neuroscience literacy.

At the Society for Neuroscience's annual meeting in November in Washington, DC, about 30 high school teachers and a similar number of scientists took part in the science literacy workshop. Teachers, many of whom brought along their best students, were guided by their university mentors to some of the especially interesting research posters and some of the more general-audience oriented lectures. Teachers also selected topics of interest to them and their students, with the mentors serving to help translate the information to a more lay level.

"Our broad overall goal," Burd said, "was simply to help high school teachers understand neuroscience better than they did before-not just those areas we might select for them in a few short workshop sessions, but whatever areas of neuroscience they might be interested in." The workshop sessions filled only a small part of three successive days, so there was ample time left for teachers to attend the symposia and other sessions of the annual meeting, often together with their scientist partner/mentor.

Greenough and Adler both attended the sessions, and the keynote speaker for the workshop was APS Fellow Larry Squire of the Veteran's Administration Medical Center-San Diego.

### **Two-way Education**

The teacher-professor ties are not one-way relationships, Burd emphasizes. Her own four-year partnership with a Tucson, Arizona, high school science teacher, Mary Petti, “gives me a real understanding of education,” Burd says. “College professors are not taught to teach. But I’ve learned a lot about teaching through my partnership because Mary Petti is a wonderful teacher.”

The science literacy effort doesn’t stop at the high school level. In Rockville, Maryland, Alder is involved with elementary school science education on a volunteer basis, so Greenough’s efforts conceivably could influence the science awareness of the youngest pupils as they begin to learn to read.

### **Countering Folk “Wisdom,” Capturing Interest**

As keynoter of the science literacy workshop, Squire demonstrated how the cutting edge of brain research can be conveyed in an exciting way. He talked about brain organization in its learning and memory functions, using lots of what he called “folksy little things, before getting on to the more serious stuff.”

For example, he asked how many people had heard about “the 90 percent unused part of the brain.” They all raised their hands. Squire told them the unused part doesn’t exist and scientists don’t know where the idea came from. “The whole brain is busy all the time, but the 90 percent notion probably has something to do with the general cultural idea that we can all do better than we ordinarily do.”

Squire drew the teachers and kids in through yet another well-worn bit of folk “knowledge” by asking how high the brain is located in the human head. Most audience members pointed to the eye level. Squire projected thereupon a cutaway that showed the eyes located below most of the brain- with the optic nerve’s horizontal path projecting in beneath the brain.

With their interest now captured, Squire pointed out that memory is really an outcome of perceptual expertise. He illustrated this with the well-known chess board experiment from Simon and Chase where the board is flashed for five seconds. Experts can practically reproduce the board after five seconds, whereas non-players can barely recall five pieces out of 25, Squire said.

Then, Squire rapidly read two paragraphs. One paragraph gave information about the structure of the school-11 classrooms, so many students, so many grades, and such and such a computer or sports program. The teachers took it all in, looking completely calm and collected, Squire noted. Then he read a second parallel paragraph about the structure of 11 brain areas, four neurotransmitters, and other details that equaled the memory load of the first paragraph, with no new words. And the teachers all started laughing when they saw how hard it was to remember one paragraph but not the other.

Squire also explained declarative memory, which involves the hippocampal system and allows recall of what we did today, or yesterday, or during our childhood. He said the key moment for learning is the moment of input, but other important factors include the number of repetitions or rehearsals and how much cognitive organization can be brought to what is being learned. He discussed other kinds of learning and memory ability, amnesia, and the phenomenon of priming. Interestingly, amnesic patients show normal priming and normal memory in habit learning, skill learning, and motor skills, he pointed out.

“We tend to believe that humans learn everything by memorization,” Squire explained. But in the lab scientists have been able to show that some non-motor tasks are learned by habit, as the learner constructs the task probabilistically. “If you tried to memorize the task you would get all confused, so you have to go with the ‘gut feeling’ that this or that one *feels like* it’s been right most of the time. So that kind of learning seems to be spared in amnesia patients as well.”