



Biologist Diane Ebert-May suggests teachers spend twice as long preparing classes as teaching them.

but do not know how to engage the students,” she says. “You need to understand the learner, understand the learner’s prior knowledge and understand how to motivate the learner.” The best teachers, says Dimitrov, use various approaches, including active learning and frequent assessments. That philosophy sums up a technique called ‘scientific teaching’, which builds on the standard lecture format.

“The notion that ‘If I cover it, they learn it’ is fatally flawed,” says Ebert-May. Her research shows that students retain more when lectures are enhanced by interactive lessons and lots of feedback (D. Ebert-May *et al.* *Bioscience* 47, 601–608; 1997). The best way for researchers to teach science, says Ebert-May, is to treat the classroom as if it were a lab, getting students to ask research questions, do literature reviews, conduct research, analyse data and present results. “You want to have people working together to solve complex problems,” she says.

#### EXERCISING THE BRAIN

Roark uses this approach when teaching about how nerves drive muscle-cell function in her introductory biology course. She gives each student a ‘neuron token’ with a voltage value, then arranges the students into ‘neural networks’. They must work out whether a particular muscle cell in that network will contract. “The students have to turn on their brains in my classroom,” says Roark. “They can’t just sit there and take notes.”

Pagiamtzis likes to challenge his students with problems that have unexpected solutions. For example, as part of the standard electronics curriculum, he asks them to calculate the level of amplification of a two-pole amplifier. They usually use a simplified formula called the Miller approximation, and most come up with the wrong answer. But with enough prodding, students come to understand that the usual formula is not valid at high frequencies. They will remember the lesson better for having discovered it

for themselves than they would for having been taught it directly, says Pagiamtzis.

Although coming up with challenges requires a lot of effort, the work pays off — and not just for the students. Pagiamtzis has found that searching for special cases and exceptions to use in exercises deepens his own knowledge and understanding of the subject. His experience agrees with the conclusions of a study published last month, which quantitatively shows that teaching helps to enhance graduate students’ scientific skill sets (D. F. Feldon *et al.* *Science* 333, 1037–1039; 2011). The authors suggest that coming up with multiple study designs and research premises for use in the classroom honed the graduate students’ own thought processes.

Tobias Langenhan, a physiologist at the University of Würzburg in Germany, finds that teaching and testing his students helps him to think about where to put his future research efforts, as well as how to refine his teaching. “You realize that some of the principles you teach are very well substantiated in terms of experimental results and that others are not,” says Langenhan. “Flipping back and forth between teaching and research tells me where I should invest more time in explaining, and also where the pieces in the dogma we are trying to explain to the students are missing.”

Not only did Pagiamtzis’s classroom experiences force him to gain technical mastery of his subject matter, but the interpersonal skills that he learned have been invaluable to his industry job. He uses those skills when he explains the intricacies of computer chips to marketing people, or technical problems to managers. An important part of that exchange, he says, is being a good student by actively listening. “In essence,” says Pagiamtzis, “we are always learning from and teaching each other.” ■

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#### EUROPEAN UNION

### Single patent system

The European Union (EU) should adopt a universal patent system with English as its official language, suggests a white paper released by the Charles III University of Madrid on 12 September. In *The EU Patent System: To Be or Not To Be*, researchers argue that the existing system impedes innovation. Currently, patents can be filed in any language, and every EU nation has different stipulations, legal requirements and costs. Marco Giarratana, an associate professor in business strategy at Bocconi University in Milan, Italy, and a co-author of the report, says that a universal system in English would encourage innovation by lowering translation and other costs. He also argues that a shared language for patents would boost mobility among young scientists.

#### GRADUATE STUDENTS

### Career options clarified

A new group aims to help graduate students to learn about their options for scientific and other careers, particularly outside of academia. Announced on 8 September, the Commission on Pathways through Graduate School and into Careers has been formed by the US Council of Graduate Schools and the Educational Testing Service. Patrick Osmer, chairman of the commission and vice-provost for graduate studies at the Ohio State University in Columbus, says that the group is polling students about their knowledge of career options, questioning those who have graduated about their career paths and asking employers in various sectors about their needs. The findings will be out in April 2012.

#### UNITED KINGDOM

### Home enrolment lagging

Meagre growth in postgraduate science, technology, engineering and maths enrolment by UK natives could put courses at English universities in long-term jeopardy, says a report from the Higher Education Funding Council for England, out on 9 September. The low growth coincides with large rises in international enrolment, says the report. Any decrease in overseas enrolment could threaten the “future viability of courses and the overall sustainability of these disciplines” by reducing university income. But the council says that recent rises in native undergraduate enrolment should carry over into postgraduate totals.