tional labs, she notes, "are often designed so that the student is searching for a known answer. They can easily become boring and make the student feel like science is only about being a technician rather than about making discoveries."

Richmond's summer lab course is different. For one thing, she welcomes students with little hands-on lab experience because it only makes them more eager. "What the kids really want is to get in the lab and do things," says Tom Dyke, head of the University of Oregon's chemistry department and an REU participant. "So even though they may not be up to speed on such things as quantum mechanics, we've resisted the idea of giving them courses."

Another unusual facet of the 10-week course is that the research projects are real and can take as long as 7 years to complete. Relying on topics that require sophisticated lab equipment—high-speed lasers and high-resolution spectroscopes—the students cover anything from designing a hypothesis to wrestling with faulty lab equipment.

Students are also required to give an individual presentation about their part of the research at the end of the summer. "It's just like in graduate school, where there's a deadline, and the students feel that they can never possibly get the results they need, and they're up late the last night trying to get their talk ready," says Richmond. "But they always pull it off because they've been working and thinking hard."

When Richmond first proposed this notion, NSF was looking for professors like her who were willing to open their labs to undergraduates. But she wanted to place the lab in Oregon's then 8-year-old Chemical Physics Institute because she felt that operating a lab at the boundary between two major fields had major advantages. Explains Richmond: "We try to understand chemistry by using good physics—so it is intellectually very challenging. But the students who come here have typically never heard of our field: The whole idea of how important physics is to chemistry and vice versa is new to them. This overlap just opens up new worlds."

PHOTOS BY JACK LIU

Just do it. Oregon's Geraldine Richmond wants her students to do more than study chemistry from a book—she sends them out for a summer of lab experience.

This idea nearly cost Richmond her grant, thanks to the typical first reaction of funding agencies to multidisciplinary science. Neither the physics nor chemistry reviewers at NSF wanted to claim her project. "It did come close to falling between the cracks," says George Rubottom, an NSF program director in the chemistry division, which finally adopted it. What makes Rubottom so happy with NSF's role is his knowledge that, in its seventh year, Richmond's project is proof positive that genuine lab experiences do keep students' eyes on the graduate-school prize. Between 85% and 90% of those who have attended Richmond's summer lab have later entered doctoral programs, a figure that is 10 percentage points higher than the average for all recipients of these NSF undergrad research funds.

But despite her success, Richmond cautions other schools against mindlessly copying her effort. It is very demanding on a professor's time, she says. "Something like this should never be taken on lightly, because you can't just stick the kids in the labs; they need supervision and guidance." And her colleague, department chair Dyke, adds that there's generally no payoff in terms of "research output" because 10 weeks isn't long enough to obtain meaningful results.

Still, Dyke considers Richmond's brainchild an "excellent program, simply because it draws many students into chemical physics who may have gone into other fields. It's a very powerful recruiting tool." And as if that were not enough, the professors also get a charge from the students' enthusiasm. Says Richmond: "They are like a bright spark in the summer."

–Virginia Morell

Novel Course IV: Survival Skills 101

Michael Zigmond is tired of hearing excuses.

The University of Pittsburgh neuroscientist is fed up with shoddy overheads, illegible slides, and speakers who simply read their papers. "There's almost an ethic that it's not important to do a good job communicating science to our peers," he says. "What's viewed as the only matter of importance is the science itself."

Zigmond may be fed up, but he's not surprised. Few researchers receive any training in career craft, he points out. "We're just expected to know how to do all these things once we get a job." But rather than pointing fingers, Zigmond has begun treating the problem himself: He's teaching the art of making presentations—and a great deal more.

Zigmond's course, for graduate students and postdocs, is officially titled "Professional Development"; informally, it's "Survival Skills." Although not unique—similar courses are sprinkled across the United States, including at elite institutions such as Harvard University and the University of California, Berkeley—Zigmond's course contains features that make it stand out. For one thing, it's more practical: Zigmond will even discuss what printer fonts work best in a poster or grant application (bold for the title, serif for the body), on the theory that applicants need every edge in the fierce competition for funding and recognition. The Zigmond course is remarkably broad as well, including lectures on:

- Career opportunities in academia, government, and industry;
- The tools needed to land jobs, including interviewing techniques and negotiating skills;
- Writing scientific papers and grant applications;
- How to balance teaching and research loads;
- How to handle ethical quandaries; and
- Enhancing opportunities for women and minorities in science.

"We're trying to teach graduate students and postdocs all the things that those of us who have survived [in science] learned by trial and error," says Zigmond.

What do his clients say? "It's really improved how I come across in my talks," says Emory University's Meghan Burke, a former postdoc at Pitt. "I used to just

get up there and talk about everything I've been doing in the last 4 months. But now I'm much more aware of the message I'm trying to get across, and I don't get so lost in the details."

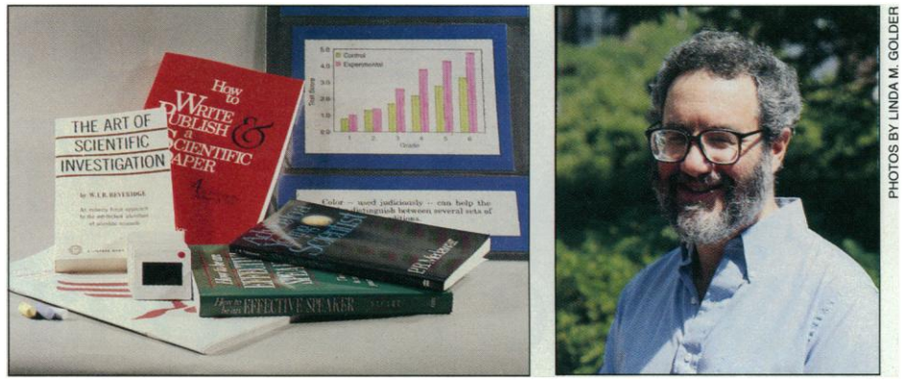
His admirers aren't confined to the Pitt campus. Tom Fox, associate dean of graduate studies at Harvard Medical School, praises the scope of Zigmond's lectures and notes: "There is a lot about the sociology of science that is just not obvious." Issues such as first authorship on a paper are not only difficult to understand, says Fox, citing one example, but disagreements can be very disruptive. "In an ideal world students would learn most of these things from lab mentors and professors," says Fox. But not all mentors have the ability or inclination to provide that type of instruction, he adds.

Because Zigmond allows students to pick from among his offerings, attendance provides a gauge of what they think will count most when they emerge into the hurly-burly of real science. To no one's surprise, sessions on grantsmanship and writing for journals can draw as many as one quarter of the neuroscience department's more than 200 graduate students and postdocs, while a discussion of women in science attracts less than a dozen students.

Zigmond began developing his series of survival skills workshops nearly a decade ago, and his journey hasn't always been a smooth one. "It's hard to convince grad students, postdocs, and faculty that this isn't just baby-sitting," he says. But after developing 25 workshops and finally integrating them last year into a single course, Pitt officials agree that the effort is worthwhile and likely to be needed for a while longer. The course is necessary, says neuroscience department chair Ed Stricker, because it sends "a message that we are oriented to talk about these issues. It really has improved the whole environment of support for the students. And that's what we're here for."

To Zigmond, the need is obvious. "The business community has been doing this for years," says Zigmond. Now, thanks to him and colleagues at other schools, practical career tips may also become a staple for training the next generation of scientists.

–Robert F. Service



PHOTOS BY LINDA M. GOLDER

Life lessons. Michael Zigmond is trying to change his profession from an art to a science.

Reader Feedback

This special supplement is our first attempt to analyze the system that trains tomorrow's scientists. Next year we'll take another look, and we're counting on you to help make our coverage interesting and relevant.

Specifically, we'd like your answers to the following questions:

1) What did you most like/dislike about this year's special section? Why? _____

2) What would you like to see us write about next year that we didn't have space to cover this year? _____

3) We'd also welcome personal anecdotes relating either to the topics discussed in this issue—from the quality of entering freshmen and computer-assisted learning to interdisciplinary research and industrial collaborations—or to other aspects of science education that might be worth exploring. They can be sent in with your reply, or separately, via e-mail, to: jmervis@aaas.org.

One more thing: To help us assess reaction to our coverage, we'd like to know a little about you. (All personal information will remain strictly confidential.)

Name and title: _____

Are you an AAAS member?

☐ yes ☐ no

Place of employment (include phone number): _____

Primary scientific field: _____

Thank you

Please return this form to:
Jeffrey Mervis, c/o *Science*,
1333 H St. NW,
Washington, DC 20005
Or fax (202) 371-9227.