MATHEMATICS TEACHING

Project NExT Helps New Ph.D.s In the Classroom–and Beyond

The ceremony, held 2 hours before the opening banquet of the summer meeting of the Mathematical Association of America (MAA), had the festive air of a graduation. The honorees filed forward to receive certificates, returning to their seats with whoops, cheers, and high jinks. But these "graduates" already had doctorates in mathematics. The celebration marked the end of their year as fellows of Project NExT, an innovative new program that represents a generational change in the way mathematicians enter the teaching profession.

T. C. STEVENS

Getting together. NExT fellows confer at one of their teaching workshops.

Project NExT, an acronym for "New Experiences in Teaching," was born amid the ashes of a disastrous job market in the mid-1990s and nurtured by the ferment of pedagogical reform at the grade-school and college level. The program aims to prepare new Ph.D.s for the challenge of classroom teaching, to give them "a jump start into the profession," says co-director James Leitzel, a number theorist and specialist in teacher preparation at the University of New Hampshire in Durham. But in its 3 years of existence, the program has turned into something more: a nationwide network of young faculty, and a leadership training program for the mathematics community. "It's a rare example of a program that everyone thinks is wonderful," says Kenneth Ross of the University of Oregon in Eugene, a former MAA president.

Leitzel and project co-director T. Christine Stevens of St. Louis University conceived of NExT in early 1993 while Stevens was serving as a Visiting Mathematician at MAA headquarters in Washington, D.C. They were motivated, Leitzel recalls, by the sense that mathematicians were not prepared by their graduate training to move into the classroom, especially at a time of fundamental changes in the way mathematics is taught. For example, many new faculty at that time had no experience with calculus reform, a movement to align calculus instruction more closely with theories of how students learn (*Science*, 23 April 1993, p. 484). In addition, Leitzel and Stevens saw an opportunity to build a sense of community among younger mathematicians, who were fighting over an unexpectedly scarce supply of job openings. "The time was right," Leitzel says. "There was a disconnect between the preparation that graduate students were receiving and what was actually happening in the classroom."

To remedy that "disconnect," Leitzel and Stevens devised a program in which each year, about 70 Project NExT fellows have their expenses paid to three national mathematics conferences. They choose the fellows on the basis of their potential impact on their department and the department chair's letter of support for the participant. For 2 days before the conference, the fellows attend workshops devoted to various aspects of the teaching profession: Topics range from the latest research on how students learn mathematics to self-organized panels on how teachers can keep their research alive at 2-year or 4-year colleges. That's necessary because relatively few NExT fellows—only 5% to 10%—have jobs at research universities. During the school year, participants keep in touch with each other and with designated mentors through an electronic list server.

The Exxon Educational Foundation agreed to pick up the program's tab for 3 years, and has been sufficiently satisfied to renew its funding for 3 more years at more than $200,000 per year. "Project NExT, in our mind, is the standard for our programs," says Robert Witte, senior program director of the foundation. "That doesn't mean it's perfect, but it's way ahead of second place." Leitzel and Witte note that no formal evaluation has so far

New Physics Profs Get a Helping Hand, Too

Mathematicians aren't alone in focusing new attention on teacher training after the Ph.D. is earned. Concerned that "the lack of attention to good teaching at the research universities sends a subtle but significant message to graduate students," Kenneth Krane, a nuclear physicist at Oregon State University in Corvallis, borrowed a page from the Project NExT notebook (see main story) and organized the first "Workshop for New Physics Faculty." Last October, 50 physicists at the beginning of their teaching careers attended the intensive 3-day workshop, held at the national headquarters of the American Association of Physics Teachers (AAPT) in College Park, Maryland.

The participants, who were nominated by their department chairs, were treated to demonstrations of teaching techniques such as group learning and "peer instruction," and several talks by specialists in physics education. Unlike the "Project NExTers," most of the AAPT workshop attendees are employed at research universities.

Although it is too early to judge the program's success, the participants who reconvened at last week's AAPT meeting in Denver for a panel discussion of their experiences were enthusiastic. Of the innovations they learned about last fall, the clear favorite of the panelists was peer instruction, developed by Eric Mazur, an optical physicist at Harvard University. In this method, the teacher poses conceptual questions every few minutes during a lecture. Students vote on the one of four possible answers, debate their answers with one another, then vote again. Most of the time, the percentage of correct answers increases dramatically, but if the teacher is not satisfied, he or she can cover the point again. Martin Gelfand, a condensed-matter theorist from Colorado State University in Fort Collins, likes the method because "it doesn't require a radical revision of the curriculum," but gives the teacher a better idea of the students' difficulties.

The National Science Foundation has funded the first 3 years of the workshop, at about $100,000 per year, through its Undergraduate Faculty Enhancement program, with the possibility that the funding will be extended. If it is, Krane points out that, with 50 new physicists passing through the program each year and only 175 Ph.D.-granting programs in physics in the country, "we'll have one faculty member in each department who's been through the workshop and can encourage the new ones." He adds: "I look forward to seeing them advance in rank, to tenure and chairmanships. We can have a significant impact on the culture of physics teaching." –D.M.

been conducted of how NExT participants fare, but that will be done during the second 3-year grant period.

In an informal survey, project participants say they are more than satisfied. Jose Giraldo, a 1994 fellow, says that in his first year at Texas A & M University at Corpus Christi, his colleagues were not interested in the ideas for change he brought from graduate school—for example, using graphing calculators in the classroom and assigning students small projects throughout the term. After a year of struggling for permission to try these techniques, he recalls, "I was going to quit." Giraldo says that what he learned at NExT workshops helped bring his colleagues around, however. "It gave me credibility and confidence. If I mentioned an idea for reform in teaching, I'd support it with references," he says. Now, he adds, his department is "completely behind me."

Project NExT has also made it easier for young mathematicians to make the contacts they need to advance in their profession. In the sometimes intimidating atmosphere of a national conference, all they need to do to find a friendly face is look for the colored dots on name tags that signify project participants. "At a large conference, with few people around that you knew, you could just walk up to someone with a dot and start talking—instant companion," says Heather Hulett of Miami University in Ohio, who attended the first NExT workshop in 1994.

As a result of such contacts, numerous NExTers have gotten involved in regional activities or committees of the MAA; and the board of the Young Mathematicians Network, an independent Web-based organization, is composed entirely of NExTers. Moreover, their positive experiences keep them coming back to national professional meetings. "By bringing young mathematicians to meetings several years in a row, you show them the value of contacts," says John Ewing, executive director of the American Mathematical Society. "Most young mathematicians learn that slowly, over many years, or never learn it at all. Project NExT fellows have it handed to them for free."

Could Project NExT serve as a model for similar programs in the other sciences? The physicists apparently think so, and have started a similar program (see sidebar). "If you look at the bare-bones structure, it's discipline-independent," Leitzel says. "There are three principles: to connect new Ph.D.s with the broader community of their discipline, to acquaint them with the issues of teaching and learning, and to provide a support network for them."

–Dana Mackenzie

Dana Mackenzie is a writer in Santa Cruz, California.

PHYSICS

Snare for Supernova Neutrinos

How do you see into the heart of an exploding star? Simple, says an international team of physicists: Go almost a kilometer deep into the earth and wait. These researchers hope to convert deep salt deposits into a pair of underground observatories that would capture thousands of the elusive particles called neutrinos, which spray from the very core of a supernova—carrying clues to its workings.

Led by researchers at four different institutions in the United States and the United Kingdom, the project, called Observatory for Multiflavor Neutrinos from Supernovae (OMNIS), has already settled on a general design and preferred locations; now it faces the struggle of raising tens of millions of dollars from funding agencies. If OMNIS gets up and running, the waiting will begin—years or decades—until a 10-second burst of neutrinos announces a supernova in our galaxy.

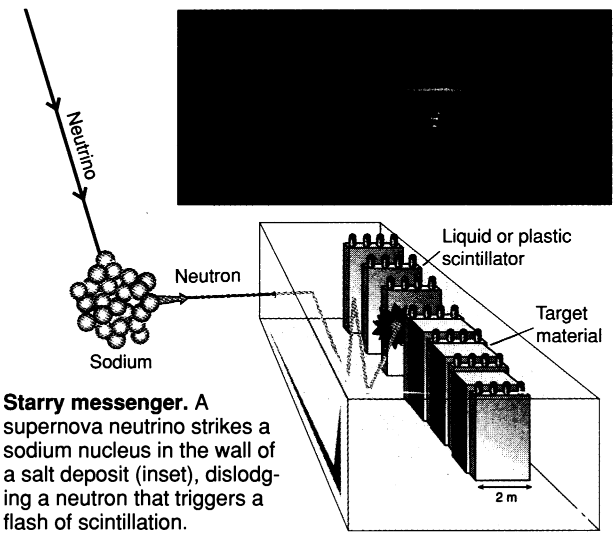
The project's roughly 20 collaborators say it promises more than just a view into exploding stars. The observatories, one in a salt deposit already excavated for a nuclear waste dump in Carlsbad, New Mexico, and the other in the Boulby Salt Mine in the United Kingdom, could also help settle the vexing question of whether the neutrino has mass.

Unlike existing neutrino observatories, OMNIS could readily detect all three "flavors" of neutrinos, which would differ subtly in behavior if the particles do have mass—a finding that would open up new theories in physics and cosmology. "No question about it: I would love to see [OMNIS] go forward," says Mark Vagins of the University of California (UC), Irvine, and a collaborator on Japan's SuperKamiokande (Super-K), now the world's largest neutrino detector.

Existing neutrino observatories, including an earlier version of Super-K, have already demonstrated the principle of OMNIS by detecting a handful of neutrinos—19 ± 1, to be exact—from a 1987 supernova. But Super-K and its peers specialize in drawing the maximum possible information from the low-energy electron neutrinos—one of the three flavors—that stream from the sun (see *Science*, 10 January, p. 159). They are unlikely candidates for a decades-long watch for the pulse of high-energy neutrinos from a type II supernova.

Type IIs are thought to explode when a massive star's core runs out of fusion fuel, cools, and collapses. It then rebounds, generating a ferocious shock wave. The shock slows as it plows into the outer layers of the star, but theorists believe that a blast of neutrinos released from the core revives the shock, which blows the outer part of the star into space, says Adam Burrows, a theorist at the University of Arizona in Tucson.

OMNIS, which germinated around 1990 in discussions between David Cline of UC, Los Angeles, George Fuller of UC, San Diego, and others, "should be a world-beater in many respects" for unraveling the details of this story, says Burrows. Super-K detects faint trails of light when electron neutrinos interact with a huge tank of water, but the high energies of supernova neutrinos would allow OMNIS to use a simpler scheme: detecting the neutrons thrown off when a tiny fraction of the neutrinos crashes into atomic nuclei deep underground. Muon and tau neutrinos—the two other neutrino flavors—would hit either sodium and chlorine nuclei in the salt walls of the mine or iron nuclei in slabs near the detectors. Electron neutrinos, which are expected to shed some of their energy reviving the supernova shock, wouldn't pack enough punch to break up those nuclei. Instead, slabs of lead, which has more fragile nuclei, might be added to generate some of those events.



DOE

ILLUSTRATION: LIZ CARROLL SOURCE: P. F. SMITH/OMNIS

Starry messenger. A supernova neutrino strikes a sodium nucleus in the wall of a salt deposit (inset), dislodging a neutron that triggers a flash of scintillation.

The neutrons released by the nuclei would rattle around the tunnel and strike scintillation detectors. "The whole flood of 2000 events lasts only 10 seconds, with 60% in the first 2 seconds," says Peter F. Smith, a collaborator at the Rutherford Appleton Laboratory in the United Kingdom. Collaborators hope the OMNIS design