C&EN TALKS WITH

AN UNDERGRADUATE CHAMPION

University of Arizona’s Mike Doyle wants more undergraduates to do chemistry research

REBECCA L. RAWLS, C&EN WASHINGTON

Michael P. Doyle, professor of chemistry at the University of Arizona and president of Research Corporation, has another title among his colleagues. They know him as the guru of undergraduate chemical research.

It’s a title Doyle has earned in two ways. First, he’s very good at directing undergraduate research in chemistry. Since he began his academic career in 1968, he’s published more than 200 research papers in peer-reviewed journals that have been coauthored by some 130 undergraduate students. Indeed, his skill at directing undergraduates in performing quality chemistry research is almost legendary in some quarters. In recognition of his work with undergraduates, Doyle is this year’s recipient of the American Chemical Society’s George C. Pimentel Award in Chemical Education.

But he’s the guru of the field for another reason as well. Doyle is one of undergraduate research’s most outspoken supporters. Whenever he’s given the opportunity, he’s quick to promote the value of engaging undergraduates in research that makes genuine discoveries and advances the frontiers of scientific knowledge.

As is perhaps common with gurus, Doyle’s views are controversial. He has a clear vision of what undergraduate research in chemistry and other sciences ought to look like, a vision that some chemical educators think is too narrow and others see as unrealistic for many institutions.

But whether his audience agrees with him or not, Doyle is not shy about sharing his view of what undergraduate research in chemistry and other sciences can and should be. And he believes it benefits professors as well as students.

Like all academic research, Doyle says, research involving undergraduate students begins with faculty members who are passionately committed to discovering new knowledge. Such people “begin their careers with an understanding that the advancement of science is a priority,” he explains. Self-confidence is key, he says. “You have to really want your point of view and expertise to have an impact on the future development of the science in which you were educated and trained.”

Given that attitude, Doyle suggests, the where and how of doing research become secondary—though important—considerations. “One can advance science in a variety of environments,” he explains. “It can be with graduate students, with undergraduates, or in industry.”

The Choice of setting for a researcher’s career is likely to be shaped by the opportunities that arise. Doyle says. In his own case, when he completed his Ph.D. in organic chemistry at Iowa State University in 1968, his first thought was to pursue a research career at a graduate institution. But such jobs were scarce in the late 1960s, so Doyle accepted an assistant professorship at Hope College, an exclusively undergraduate school in Holland, Mich.

Doyle knew of the work of Hope College chemistry professor Douglas C. Neckers, now a research professor at Bowling Green State University in Kentucky. In the 1960s, Neckers was already doing quality research with the help of Hope College chemistry students. “He had shown that you could do something in an undergraduate environment,” Doyle recalls. “So I thought, why not try it?”

He continues: “It was with that sense, that I loved research and the advancement of science, and that I wanted to make a difference, that undergraduate students became the workforce—and a delightful workforce—with which I was engaged.”

Doyle spent 16 years at Hope College conducting research with undergraduates before moving in 1984 to another undergraduate institution, Trinity University in San Antonio. He moved from there to Research Corporation and the University of Arizona, which has a graduate program, in 1997.

Doyle continues to be surprised that many research scientists don’t expect undergraduates to be able to do quality research. Throughout his career, he says, he has received comments from reviewers of papers he and his students have coauthored pointing out that the work is particularly noteworthy because it was done by undergraduates. It shouldn’t seem remarkable that undergraduates do quality work, Doyle says. “Those reviewers are really saying that not much good can come out of undergraduate students and their involvement in research. Yet it’s been my firm belief for an awfully long time that undergraduate students can succeed in research.”

For Doyle, conducting research means advancing the frontiers of knowledge. That’s not what everyone means when they speak of undergraduate research, he has
found. Too often, Doyle thinks, undergraduates perform experiments and work on problems whose results are either already known or easily predicted. Such projects can be very educational for students and can give them a feel for what research is like, he says, but they are not really research. And for Doyle, they are not enough.

HE CONTENDS that the research experience isn't complete without public acknowledgment from other scientists. This acknowledgment can come in the form of grants from funding agencies that use peer review to evaluate grant proposals. It can also come through publication of research results in peer-reviewed journals.

Undergraduate research needs to lead to publication for several reasons, he believes. Both faculty and undergraduates themselves need to experience the thrill of making an impact on their chosen field of science. "Publication in a peer-reviewed journal is the source of renewal that allows a person to continue," Doyle explains.

Additionally, publication gives the student and the faculty member a chance to build a national—or even international—reputation. Such a reputation can be critical for students who want to enter highly competitive graduate school programs, Doyle says.

"If a research experience is only that, an experience, then the faculty member becomes known at the institution as an excellent teacher, and the student is known to have undergone a significant experience," Doyle explains. "But the experience can't assist the student in his or her future career development. The student doesn't have a record beyond their experience that says they accomplished something. That's what publication provides."

Such a record is particularly important for students at primarily undergraduate institutions, Doyle thinks, because these institutions aren't generally known for the quality of their research. Therefore, either the student or the faculty member the student works with has to establish his or her own reputation. Peer reviewed publications or research grants are the best way to do this, he says.

Doyle bases his views, in part, on a survey of science faculty and administrators at primarily undergraduate institutions in the U.S. It was conducted in 2000 by Research Corporation and four other foundations. Many of its findings were published last year in a document called "Academic Excellence: The SourceBook" (C&EN, Oct. 22, 2001, page 39).

The survey found, for example, that although faculty in the natural sciences at these schools publish, on average, about one paper every other year, only about 25% of these papers include an undergraduate student as a coauthor. "That was a surprise," Doyle says. "Here are institutions where the primary resource for conducting research is their undergraduate students, and only a quarter of the publications list undergraduates as coauthors."

The survey also looked at the grants awarded to support faculty research at undergraduate institutions from 1986 to 2000 by four of the principal supporters of this type of research: the National Science Foundation, the National Institutes of Health, the Petroleum Research Fund (administered by ACS), and Research Corporation. Very few schools consistently received support over the 15-year period. In fact, 41% of the schools that received awards received only one or two of them over the period. That means there's not a whole lot of research going on that meets the standards for programs that require peer review for funding to be granted," Doyle says.

THE SURVEY ALSO found growiing frustration among faculty at undergraduate institutions, who believe that too many conflicting demands are made on their time, Doyle says. Balancing responsibilities for teaching, service to the institution and the wider community, and research has always been challenging at these schools, he points out. "But there's a greater intensity to the situation now: I think many administrators have not paid attention to what their additional expectations of their faculty have meant. The frustration level among faculty is very high."

Doyle worries that undergraduate institutions are coming to be viewed as teaching institutions only and not places where research discoveries are made. "I'm concerned that we are building a two-tiered system," he says, in which research takes place only at the graduate level. It's not clear that the efforts made during the 1980s and 1990s to increase research at undergraduate institutions have changed this pattern, he says.

He's convinced that, despite other pressures on their time, all science faculty need to be conducting research with their students. "Faculty often say they want careers at an undergraduate institution because they want to teach and not do research," he says. "That's the wrong reason."

If Doyle has reservations about undergraduate research opportunities at some undergraduate institutions, he finds these opportunities to be rich at Ph.D.-granting institutions. Having spent most of his career at undergraduate schools, he knows firsthand that faculty at these institutions sometimes think that undergraduates involved in research at universities "don't get to do anything interesting, that all they do is wash dishes," he notes. "I never really believed that," he says, but his appreciation of undergraduate research opportunities at Ph.D.-granting schools has grown in the five years he's been at Arizona.

In fact, he now thinks Ph.D.-granting institutions may be doing a better job of providing research opportunities to undergraduates than most predominately undergraduate institutions are. The attitude of faculty members at Ph.D.-granting schools has changed in recent years, Doyle believes, so that they are now much more interested in having undergraduates involved in their research programs.

Undergraduates at these universities "have quality research opportunities in active, important research areas, and they have top laboratories and instrumentation to do it with," Doyle says. In some cases, the students begin by doing things that are fairly routine, he notes, but as they develop experience, their opportunities grow. "In many cases, they can contribute significantly to the development of an idea or the solution of a problem," Doyle says. "Research universities offer this experience at least as well as the best groups at predominantly undergraduate institutions."

I think we make a mistake by trying to put the two into conflict, as some organizations have done in the past," Doyle says. Doyle remains a champion of all the faculty members who are directing undergraduate research, no matter where they work. "There are awful lot of people who are trying to do their very best," he says, "trying to be successful in this environment. Any attention that is given to them enhances their opportunity to justify what they are doing—to the department chairman, to the president of their institution, to their spouse. All of it helps."