

Ongoing mentorship works for retaining minorities in STEM

Improving the academic environment for marginalized groups is aided by a holistic approach and dedicated resources.

There are a million summer internships around, but they haven't had much impact in retaining underrepresented students in the natural sciences," says Richard Anthes, former president of the University Corporation for Atmospheric Research, which oversees the National Center for Atmospheric Research (NCAR) for NSF. Twenty-five years ago he conceived of the Significant Opportunities in Atmospheric Research and Science (SOARS) program to tackle the problem.

"SOARS had a huge impact on my career trajectory," says Dereka Carroll-Smith, who participated for three summers early this decade; her comments about the program are typical among the more than 200 alumni. "I credit the program with preparing me for graduate school, and building a network that I still use today," she says. A scientist who splits her time between NCAR and Jackson State University in Mississippi, she models tropical cyclone hazards and the effects of severe weather on society.

A signature feature of SOARS is that interns can return. They are eligible to join after their sophomore year in college and can participate for up to four summers. About 80% of them go on to graduate school or pursue a career in STEM (science, technology, engineering, and mathematics) after earning their bachelor's degree. Given the program's success, it's surprising how little it has been emulated. Recently, though, SOARS has begun seeding satellite programs. In a different field altogether, the Stewart Blusson Quantum Matter Institute (QMI) at the University of British Columbia in Canada has launched a program modeled on SOARS. And related activities at various institutions are gaining traction.

Not a summer vacation

SOARS was born of the question "What more can you do?" posed by Neal Lane,

then NSF director, during a visit to NCAR in the 1990s. He wanted to attract more minority students to STEM. "The stuff they were doing was so interesting—storms, weather, clouds," he says. "I thought it was the kind of thing that could get kids excited regardless of their educational or home background." In response, Anthes realized that NCAR's existing internships weren't long enough. Students would come to Boulder, Colorado, for two months and then go back to their home universities. "I interpreted their experience as a nice summer vacation," he says. So he sketched out a model that he hoped would "actually influence these young people's lives."

SOARS covers the travel and living expenses of up to two dozen participants a year. The program pays for students to present their work at national conferences and provides financial assistance for college or graduate school. "It's important that they don't have to decide between working at McDonald's or coming to Boulder," says Thomas Windham, the inaugural director and now a senior adviser to the program. SOARS is the rare internship program that hires full-time staff and provides year-round mentoring. NSF funds the program; the current five-year grant is a bit more than \$3 million.

Any undergraduate who is a US citizen can apply; the focus on underrepresented groups is addressed through the recruitment and selection processes. As a member of the steering committee, SOARS alumnus Matthew Paulus reviews applications. "I'm a Hispanic male," he says. "Graduate school was dominated by 'pale, stale, male.' I try to look beyond the numbers by looking at personal statements. I try to find people who are passionate about diversity and who want to give back to the community." Among the categories NSF considers underrepresented are African Americans, Native Americans, Hispanics,



LEADERSHIP TRAINING EXERCISES at the Significant Opportunities in Atmospheric Research and Science mentoring program in Boulder, Colorado, are a way for participants to get to know each other. This group activity took place on 22 May 2018.

women (for many fields), veterans, first-generation college students, people with disabilities, and sexual and gender minorities.

The 11-week summer program kicks off with activities intended to promote bonding through group physical and mental challenges. In the second week students join their research groups, which are usually at NCAR, NOAA, and the University of Colorado Boulder. But for returning students, research can involve fieldwork anywhere from Juneau to the Galápagos Islands. Fridays are reserved for workshops in communications, computation, and professional development. SOARS participants present their work in poster and talk formats.

Each SOARS participant has up to five volunteer mentors: for research, communication, computation, and community, plus a peer mentor. The program is set up to be holistic, says NCAR director for



education and outreach Rebecca Haacker, who was SOARS director in 2011–17. “Students have the opportunity to see who they click with most.” She regards the teacher-apprentice model as flawed because success depends completely on one person. “Across SOARS and the geo-

science community, we are trying to break down this old model.”

Curtis Walker studies surface transportation meteorology as an NCAR postdoc. Before SOARS, he says, he would have ended his academic career after a bachelor’s degree. “I thought I would be a broadcaster or forecaster. SOARS introduced me to research.” The group of mentors is invaluable, he says. “It’s one thing to have help with science, but you also have help with data analysis and programming if you need it, and with writing.” The peer mentor is important too. “It’s helpful to know that others were in your shoes of feeling uncertain.”

The repeat experiences and focus on the whole person make SOARS feel like a family, say many alumni. They gather at conferences, which helps solidify their connections, especially across years. “It’s like a big SOARS reunion.

I feel very connected to other alumni,” says Paulus, an associate scientist at NCAR. “In graduate school is when I found a need for support,” says Talea Mayo, an assistant professor of civil engineering at the University of Central Florida. “I still lean on the SOARS com-

munity, as a tenure-track faculty member, and I talk to others going up the career ladder.”

This year 105 people applied for eight spots for newcomers; another dozen students returned. “A key part of my vision was that it not be a remedial program,” says Anthes. “We look for students with demonstrated potential, and we challenge them to go on to become leaders in the field.” Many outcomes constitute success, notes Haacker, including when someone realizes they don’t want to do science. Today, nearly 25 years on, SOARS alumni are senior scientists and professors, they hold leadership roles in NOAA and other federal agencies, and they work in the private weather and climate sectors. Two alumni hold elected positions on the council of the American Meteorological Society.

What makes SOARS successful, says Haacker, “is that we adapt and evolve.” As examples she lists the program’s addition of financial support at the undergraduate level, adjustments in its mentoring options, and seminars in time and stress management. “The overarching goals are to broaden participation and improve the quality of science by bringing in diverse perspectives,” she says. It is also critical, says Windham, that the program has had both top-down and bottom-up support and that the research community was prepared and accepting of SOARS from its inception. He describes the program’s attitude as, “We are here to facilitate your success, but it’s on you.”

Long-term commitment

The SOARS model is duplicable, Windham says. At universities successful examples exist that use some of the same features. Given variables such as the size and cohesion of the research community and the availability of equipment and

TALEA MAYO (center), an assistant professor at the University of Central Florida, runs a spinoff of the Significant Opportunities in Atmospheric Research and Science (SOARS) program. Her first recruit was Cindi-Ann Findley (right). In 2018 they presented their computational work on the nonlinearities of tides and hurricane storm surges at an NSF event on Capitol Hill, where they posed with Karen Saxe of the American Mathematical Society.

TALEA MAYO





STUDENTS IN QUANTUM PATHWAYS, a new multiyear internship program at the University of British Columbia's Stewart Blusson Quantum Matter Institute.

funding, the best approach is to adopt the aspects of SOARS that make sense, he says. "You don't need to replicate the exact same model, but you do need to have an environment where the soil is enriched and welcoming."

Perhaps closest to SOARS is Research Experiences in Solid Earth Science for Students (RESESS), a spinoff at UNAVCO in Boulder that became independent more than a decade ago. It hosted eight students this year, two of whom were returning. The program limits participation to two summers to reach more students.

Tight funding makes for a tricky trade-off between the number of students and repeat participation; programs tend

to maximize the number of students. For example, NSF discourages repeat participation in its Research Experience for Undergraduate (REU) programs, a prime vehicle for increasing participation of marginalized groups in STEM.

For their part, SOARS alumni and administrators swear by the continuity of the program. During a broad external review of the QMI in Vancouver a few years ago, Anthes mentioned in passing that committing to students over time is what makes SOARS different and that it has had a huge payoff. The institute's 22 faculty members in physics, chemistry, and electrical engineering grabbed the idea. In 2018 they launched Quantum Pathways, which hosted two stu-

dents its first year. They both returned, and the total jumped to 15 this year.

Quantum Pathways accepts applications from across Canada and beyond. Mentoring students for multiple years is a "win-win," says QMI physicist Douglas Bonn, "because once they have experience they can contribute more effectively to research. It's a better investment than a one-off." And having them come from elsewhere widens the potential source of future graduate students, he adds.

Quantum Pathways offers training in science communications, career panels, and career advice, but not as intensively as SOARS. The program is tailored to QMI needs: Students take a machine-shop course and participate in boot camps to learn specific skills, such as materials synthesis; working in ultrahigh

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A few years ago, SOARS was awarded a grant to form satellites as a way to increase its reach. So far two alumni, Mayo in Florida and Deanna Hence at the University of Illinois at Urbana-Champaign, have established small programs; additional satellites are in the works. Mayo recruits individual students to work with her during the school year. Her first student modeled hurricane storm surges and then got into the main SOARS program. Her current student is focusing on machine learning for storm surge data. "I'm trying to be all the mentors for them," she says.

With her satellite program, Hence is targeting transfer students from a nearby community college, which is a large source of diversity. She wants to develop and formalize existing activities to "mimic the mentorship that SOARS is known for." SOARS was "life-changing for me," Hence says. "But not everyone can go to NCAR for 10 weeks. We want to create something similar at home institutions."

The big picture

Broadening participation of people from underrepresented groups in STEM has been a goal of US funding agencies, universities, and professional societies for decades, but the urgency with which it is pursued fluctuates. In physics, for example, the number of women earning physics PhDs each year has more than doubled in the past two decades, although in terms of percentage the increase is smaller: from 13% to 20% of all PhDs awarded in the field, according to the Statistical Research Center of the American Institute of Physics (which publishes PHYSICS TODAY). Over that period, the number of African Americans earning physics PhDs each year has hovered around 12 (with a peak of 22 in 2012), while the number of Hispanic Americans earning physics PhDs has more than quadrupled to about 40.

Dedicated master's programs and the American Physical Society's bridge program are routes for underserved students to pursue higher degrees in physics. (See the articles by Alexander L. Rudolph on page 50 of this issue and by Ted Hodapp and Kathryn Woodle in PHYSICS TODAY, February 2017, page 50, and the news story from April 2019, page 22.)

One new approach seems to be making a difference: a student-initiated club, Physics Undergraduate Women and Gender Minorities at Stanford or PUWMAS. Now in its third year, it's branching out to include other underrepresented groups. "Our goals are to promote diversity by creating community, create a space to discuss issues related to physics and STEM, and provide help with career and academic development," says club co-president Kathlynn Simotas, a first-generation college student with a dual major in music and physics.

Risa Wechsler, a Stanford University physics professor and chair of the department's equity and inclusion committee, says that PUWMAS is having a positive effect. "Now, even before students have a chance to get discouraged, someone has already reached out to them. A few years ago, we had zero Black, Latinx, or Native American women students in the major; there are now several."

Wechsler notes that students tried to set up a similar group some years back, but it didn't take. The difference may in part reflect greater societal awareness of sexual harassment, racism, and other inequity issues both in academia and more broadly, she notes. "And we now have a critical mass of supportive faculty. Many institutions are doing things, with various degrees of success, budget, and enthusiasm."

The challenge of diversifying STEM fields "is so big, it's beyond what anyone can do at a single institution," says SOARS alumnus Chris Castro, a professor at the University of Arizona who focuses on regional climate modeling. He favors a decentralized approach with hubs around the country. In the Southwest, for example, "you could then do deeper outreach to colleges and educational entities that otherwise do not have access to atmospheric and other STEM research—that could be community colleges and tribal colleges."

Castro asserts that to increase diversity in STEM, "you have to create a safe place within your home institution." In part that means that faculty need dedicated time for such activities. "Nothing happens without resources," he says. And a significant hindrance is that "the incentives and professional metrics are at odds with the purpose of broadening participation of underrepresented groups."

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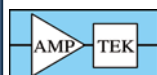
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