CAREERS

BARRIERS Bias based on gender and race is pervasive in science **p.561**

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ILLUSTRATION BY ERIC NYQUIST

LAB EDUCATION

Teen spirit in the lab

Offering adolescents work experience can benefit the scientific enterprise and inspire future researchers, but some lab heads question the practice.

BY CHRIS WOOLSTON

Ava VanDommelen stood out at a convention known as Photonics West, held in January by the Society of Photo-optical Instrumentation Engineers. Her poster presentation, which described her work using photon microscopy to track the metabolic effects of lactic acid on immune-system cells, was impressive enough.

But, at 17, she was much younger than most other presenters at the convention, which was held in San Francisco, California, and attended by more than 23,000 researchers, engineers and industry representatives.

Although still in high school, VanDommelen has logged hundreds of hours in a lab headed by biomedical engineer Melissa Skala at the University of Wisconsin–Madison. The experience has sent the teenager down a career path that will probably include many more hours at the bench. "At first, I wasn't sure that research was something that I wanted to do in my future," VanDommelen says. "But after all of the positive experiences that I've had, I definitely want to continue this."

ADOLESCENCE
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In certain parts of the world, teenagers might be more familiar with Snapchat than with spectrometers. But some principal investigators note that adolescents often show a level of drive and curiosity that can counterbalance their lack of formal training — and make for a successful scientist. "I love high-school students," Skala says. "They bring so much energy."

Skala feels that she's doing her part to broaden the science-career pipeline by exposing young people to the possibilities of science, but she also notes that her entire lab benefits from the students' productivity and hard work. "It's tricky because the tasks have to match the ▶

experience of the student," she says. "But a lot of science can be done by students with a little guidance, creating a win–win."

Whether students end up in a lab through a formal programme or on their own initiative, they can thrive with good mentorship and strong support (see 'How to support teenagers in the lab'). Not all researchers think that training adolescents is the best use of their time, but some say that science-minded high-school students are an important resource, and that seeing teenagers' enthusiasm in the lab makes them optimistic about the future of the scientific enterprise. Bringing an adolescent into a lab is most effective, researchers say, when the principal investigator embraces the idea and when the student is eager to learn the fundamentals of science.

VanDommelen and another high-school student, Isabel Jones, landed in Skala's lab through the Wisconsin Youth Apprenticeship programme, a state-wide initiative that gives promising pupils real-world, paid work experience in a variety of fields, including scientific research. VanDommelen started working in Skala's lab at the beginning of year 11, when she was 16; by the time she graduates, in June, she'll have logged at least 900 lab hours. These days, she estimates that she's in the lab for 15–20 hours a week.

"They spend more hours in the lab than some undergraduate students do," Skala says. When it comes to productivity, the number of hours at the bench matters more than the age of the researcher, she says. "If a high-school student wanted to work here but could only commit to a few hours a week, I would offer to buy her a cup of coffee and give her a tour of the lab instead," she adds.

Most teenagers don't understand how to conduct scientific research, at least in the beginning, says Sascha Schmeling, head of teachers and students programmes at CERN, Europe's particle-physics lab near Geneva, Switzerland. At any given time, CERN hosts dozens of teens who are participating in various short-term internship programmes. This type of outreach helps CERN to stay connected with the community while giving young people an important glimpse of science in action.

"High-school students tend to know a lot about physics," Schmeling says. "But what they are missing is the idea of how to do research. In high school, a teacher may present an experiment and write down a table with results. To them, that is research. The step from measurement to research is something that they always learn when they come here."

In 2017, CERN started the High School Students Internship Programme, an initiative spearheaded by Schmeling that brings in up to 24 teenagers each year from one of the 22 CERN member states (in 2017, all of the students were from Hungary); selected students will complete a 2-week internship. The teens can't really contribute much to a lab in such a short time, Schmeling says, but they do get to perform research tasks, such as analysing data from the Large Hadron Collider. "They learn what it means to work in research," he says, and so can find out early on whether they want to pursue academic science.

"It was like walking into Willy Wonka's chocolate factory. Everything was so new to me."

Schmeling doesn't have trouble finding researchers at CERN who are willing to take in adolescent interns, he says — but some are more enthusiastic than others. "I've heard interesting remarks from time to time," he says. One recurring theme is a concern that high-school students are simply too young for lab work. "Some supervisors speak of them as kids instead of as students," he says. Still, he adds, most CERN researchers find that teens rise to the challenge when given work assignments.

For some, bringing adolescents into the lab is an effective type of public outreach. Thorfinnur Gunnlaugsson, a chemist at Trinity College Dublin, has welcomed dozens of young students into his lab over the years, often as a result of their own initiative. "We get quite a few requests," he says. "We take them in for three or four weeks and let them do some experiments. They can see that scientists are not portrayed correctly on television most of the time. There's a lot going on." Trinity's labs have become such a popular destination that the chemistry department recently launched formal programmes for high-schoolers, including a week-long intensive course that combines lectures with lab work.

The Gunnlaugsson lab made an impression on Niamh Murphy, who was 15 years old when she spent a week working there in November 2015. "It was like walking into Willy Wonka's chocolate factory," Murphy says. "Everything was so new to me." Murphy, who just turned 18, parlayed that week-long introduction into a 7-month stint as a lab assistant. She'll finish that position in May, before starting studies in chemistry at the Dublin Institute of Technology. "I still feel like a puppy running around with a lot of older dogs," she says. "To me, column chromatography is so cool. But the postdocs do it every day."

Gunnlaugsson says that he never expects adolescents to make immediate contributions to his lab, but he adds that his government grants over the years have imbued him with a sense of duty. "That's money from the public, so we're obliged to engage with the public," he says. "We have to let them know what we're doing." Opening the doors to adolescents is an important part of that outreach effort, he says.

Murphy feels lucky to be in a lab where she can contribute to the research itself. Some teens she's talked to, she says, have no chance to run equipment or perform other such tasks. She says that students should talk to lab alumni

THE 'WOW' FACTOR

How to support teenagers in a lab

Bringing someone into the lab is always a gamble: no matter what their accomplishments or references are, you never know how well they'll fit in with the team. If that person is still at school, the process can require some care. Here are things to keep in mind.

- Cultivate the 'wow' factor. The most important thing a teenager will discover in a lab is a sense of wonder, says Thorfinnur Gunnlaugsson, a chemist at Trinity College Dublin. He lets students use sophisticated equipment, such as the nuclear-magnetic-resonance machine and chromatography columns. "They have to be inspired."
- Know the rules. Countries and institutions might have laws and policies regarding young people in the lab. At Harvard University in Cambridge, Massachusetts, for example, all lab interns under age 18 must undergo lab-safety training. Also, minors aren't allowed to be in any lab unless they're accompanied by a supervising adult, even if the minor is simply working on a computer.
- Stay realistic. Even the brightest teenagers aren't going to be independent right out of the gate. Melissa Skala, a biomedical engineer at the University of Wisconsin–Madison, gives students in her lab well-defined projects with a clear objective.
- Be prepared to shift expectations. Because most high-schoolers lack research experience, it's impossible to predict how they'll handle their work, says Peter Tonge, a chemist at Stony Brook University in New York. Principal investigators and other mentors should watch the students' progress closely, so that they can adjust goals and demands accordingly. "Some of them have been fantastic," Tonge notes. "They turn out to be as independent as a well-trained undergraduate student." But those who struggle might need extra attention. "I feel sorry when I sense that someone's under a lot of pressure," he says. C.W.

The CERN High School Students Internship Programme introduces adolescents to particle physics.

JULIEN MARIUS ORDAN/CERN

to determine whether the principal investigator will make teaching them a priority. "If you can find someone who is really invested in young people, like Thorri, you'll be on your way," she says.

UNEQUAL OPPORTUNITIES

But some scientists feel that there are better ways to invest their time and limited resources than in training the typical adolescent applicant. Terry McGlynn, an ecologist at California State University Dominguez Hills in Carson, made his position clear in a 2013 post on his blog Small Pond Science (see go.nature.com/2egm2ph). In the post, McGlynn argues that providing a university lab experience to certain high-school students exacerbates an inherent societal inequality.

"In labs all around the country, wealthy high-school students are getting high-quality research training at universities while the majority of the nation's public-school children are now living in poverty," he writes. "I'm not inherently opposed to taking on a high-school student, but I'll be damned if I take an opportunity away from an low-income student who truly needs it and transfer it to one who comes from a position of privilege."

McGlynn tells *Nature* that although some high-school students who want to work in a lab are genuinely interested in science, he has found that many are mainly looking for a chance to bolster their university applications. After talking to a few students who asked to train in his lab, he learnt that none was aiming for a professorship at a small state school such as his. Most were students from private schools who saw themselves gaining positions at top research institutions. He adds that he would consider taking in a local student from a public high school if someone else in his lab were willing to provide the necessary supervision and mentoring.

Peter Tonge, a chemist at Stony Brook University in New York who has hosted scores of young students over the years, has similarly found that some teens have ulterior motives for seeking lab work. Several previous students have gone on to earn top scores in the prestigious Intel Science Talent Search competition (now the Regeneron Science Talent Search), which ramps up expectations. "Some students may arrive thinking this is their yellow-brick road towards an Intel scholarship, and that it's my job to make that work," he says. "But that's not my job."

Still, he says, most students truly want to learn about science. Tonge has a long-standing partnership with a local high-school teacher who brings in small groups of students to work in Tonge's lab for 8–10 weeks over the summer. He also takes in the occasional student who asks for a position in the lab after school hours. Tonge gives the students projects — perhaps using enzyme kinetics to track the effects of a compound — but he counts on his graduate students in the lab to do most of the mentoring.

Tonge says that he understands why some researchers would rather not open their doors to adolescent researchers, but he has no plans to stop. "Nobody pays me to work with high-school students," he says. "And they use reagents in my lab, so there's a cost."

On the upside, he feels that his graduate students can gain valuable mentoring experience and the high-schoolers can get a sense of real-life science while they still have a chance to change course. "Even if you're the best at this and the best at that and get straight As, it doesn't mean that your experiments are going to work," he says. "You have to have the motivation and enthusiasm to get up the next morning and fix it. The earlier you learn that in your career, the better." ■

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WORKPLACE DISCRIMINATION

Barriers in science

A poll run by the Pew Research Center, a think tank in Washington DC, surveyed more than 2,300 US adults working in science, technology, engineering or maths (STEM) jobs. The findings underscore the reality that, for some in the sciences, gender and race are still a barrier to success (see go.nature.com/2esrhz5).

In the report, which is based on surveys conducted in summer 2017, 50% of female and 19% of male respondents in STEM fields said that they had faced discrimination because of their gender. By comparison, 41% of women outside STEM reported gender discrimination. The most common forms reported by women in STEM were earning less than other people in the same position, and being treated as if they weren't competent. Nearly 10% of women in STEM said that they had been passed over for a job or promotion because of their gender.

"For women working in science, technology, engineering or math jobs, the workplace is a different, sometimes more hostile environment than the one their male co-workers experience," the team says. "Discrimination and sexual harassment are seen as more frequent, and gender is perceived as more of an impediment than an advantage to career success."

Harassment continues to be a concern. More than one-third of women in STEM — and nearly as many men — said that sexual harassment was a problem in their workplace. Among women who worked in male-dominated workplaces, 48% said that harassment was a problem. Just under one-quarter of women in STEM said that they had been harassed, which matched the rate reported by women in non-STEM jobs.

The survey also uncovered race-based obstacles, especially for African Americans. Sixty-two per cent of African Americans in STEM said they had encountered discrimination because of their race. Notably, 50% of African Americans in non-STEM fields reported discrimination. For women and minorities, discrimination in the sciences seems to be even more commonplace than in other fields.

Some STEM fields seem to be more problematic than others. Nearly three-quarters of women in computer jobs said that they had experienced gender-based discrimination in the workplace. The report noted that although the proportion of women in the workforce has grown in most science fields since 1990, their presence in the computer field has shrunk.

Gender inequities seem to be most prevalent in workplaces where men outnumber women, the report found.

CORRECTION

The Careers feature 'Teen spirit in the lab' (*Nature* **554,** 559–561; 2018) wrongly stated that CERN has 12 member states. In fact, it has 22.