Intel ISEF—Profiles of Success

Matching Students With Experts

Teachers Guide Positive Mentoring Experiences

Students who tackle challenging science research projects tend to share certain habits of mind: curiosity, persistence, and creativity in solving problems. Many also know when to seek help. Working with a mentor can be a powerful strategy for success.

Some students work face-to-face with their mentors while others communicate via email or telephone. Often, mentors open doors for students, giving them access to cutting-edge laboratory equipment or to other research opportunities at their university, organization, or lab. When mentoring takes place in the adult's research setting, students are immersed in the culture of scientific research and discovery. Even from a distance, mentors can provide an expert's ear, offering advice, direction, and encouragement during challenging aspects of the research process.

How do students find mentors willing to share their time and expertise? What role can teachers play in helping students connect with mentors and make the most of the experience? Veteran teachers share some proven strategies, including:

- Nurturing relationships with potential mentors
- Using summer opportunities for learning

'A Perfect Match'

Ryan Patterson, past winner of both Intel International Science and Engineering Fair and Intel Science Talent Search, knows firsthand the value of a mentor. He credits John McConnell, a retired physicist, with giving him a foundation in science. Read more.

Nurturing Relationships With Experts

Dr. Josette Biyo teaches science research at Philippines Science High School Western Visayas. Winner of the 2002 Intel ISEF Excellence in Teaching Award, she recommends building "a culture of mentoring" in both the school and larger community.

To expand mentoring opportunities in her own community, which is geographically distant from research laboratories, Biyo has initiated and nurtured relationships with scientists working at a variety of agencies and laboratories in the Philippines. She takes students on field trips to visit government laboratories and university facilities, and also invites scientists to her community to give presentations and see students present their own research findings.

"It took energy and guts for me to talk to these people about opening their labs and facilities to my students," Biyo admits. The outreach has paid off, however, with some institutions providing funding to help students travel and expand the scope of their investigations.

Biyo, who holds a Ph.D. in biology, has continued to pursue marine research in addition to teaching. She also mentors her own students. During vacations and weekends, when she continues her studies of sea grasses, "my students are my understudies," she says. They learn how to gather data, take core samples, and taxonomize specimens. Through her role modeling, she helps her students "learn the manner in which a researcher works." As students become more competent at research skills, they gain self-esteem and confidence by doing real research while they are still in high school. Many go on to develop their own science research projects involving marine biology or related fields.

Similarly, in the United Kingdom, Simon Pugh-Jones has helped his students take advantage of opportunities to work with prominent researchers at Kew Gardens, the Bristol Zoo, and other settings. "Having the opportunity to do real-world, contextualized research really helps my students' skills," he says.

Pugh-Jones is head of physics at Writhlington School in Bath, England. Through the teacher's sustained efforts, a once-vacant greenhouse has blossomed into a cutting-edge laboratory where students undertake serious research in the field of tropical plant conservation. Pugh-Jones has also taken students on research expeditions to the Brazilian rainforest. Some students have gone on to develop successful projects for the national science fair in London, and many have published original research findings.

Developing contacts in the research community has helped Pugh-Jones "raise the level of research we're doing within the school," he says. "With our expertise and knowledge in tropical orchids, we're in a position to make links that really count. Having contacts with places like Bristol Zoo, which has become very involved in our conservation work, offers fantastic research opportunities. Kew Botanical Gardens is a world leader in plant science and orchids, so that gives us more opportunities. You reach the point where you see research opportunities all around you."

Large cities like London and New York are home to leading researchers—-and potential mentors—-in a wide range of fields. Teachers in less-populous areas may have to be creative to recruit mentors at universities, government agencies, private industries, and other locations.

"Of course, your students cannot do DNA research if there's not a DNA lab nearby," acknowledges Pavlica. "But there's probably a department working on environmental issues in most communities," he says, where students might find experts. He suggests using email or telephone to overcome geographic challenges.

Using Summer Opportunities

Summer vacation opens opportunities for students to work with mentors for more extended periods.

Pavlica recalls one student, for example, who worked hard to create her own summer research opportunity. He explains: "For whatever reason, this girl loved chimpanzees. She found researchers in Washington State who work with primates. She started writing to the researchers. They told her they only work with college students and graduate students. She wrote back and asked if they would recommend something she could read. They did, and she wrote back again with her reactions. Then they told her that their chimps use sign language, so she put herself through sign language school. Finally they asked her, what are you thinking of researching? She suggested a spin-off of their research and convinced them to let her come out for a summer and work with them. She followed her dream."

By staying current about research and grant opportunities, teachers can help steer motivated students toward rewarding summer experiences. In the UK, for example, the Nuffield Foundation funds summer research positions called bursaries in a variety of settings for students interested in doing scientific or technical research.

Pugh-Jones has had several students take advantage of the Nuffield program. "It's a chance for them to get some really good field experience," he explains. Students typically spend four weeks in a research setting gathering data, then continue working on their projects during the following school year. "They usually come back to school in September with lots of data but not a finished project," Pugh-Jones explains. "That's when we use course time to turn their research into a real project. Of course, you have to get them to do supporting research and a lot of reading around their project topic. They may need to do statistical analysis or additional experiments to really pull it together."

In the United States, the Research Science Institute brings together talented high school students from around the world for an intensive summer experience. Held at the Massachusetts Institute of Technology and California Institute of Technology, the institute includes two weeks of rigorous college classes and four weeks of research internships. Students selected through competitive application process conduct research in mathematics and science under the guidance of professional scientists, engineers, and mathematicians. Many student use the summer research projects as a basis for entry to science competitions.

'A Perfect Match'

Ryan Patterson of Grand Junction, Colorado, knows firsthand what a difference a mentor can make. When he was still in elementary school, Patterson was asking questions about electricity that stumped his parents and teachers. A teacher recruited John McConnell, a retired particle physicist from Los Alamos Laboratory, to mentor the inquisitive young student. For the next seven years, the two spent nearly every Saturday working together in the mentor's workshop on projects that involved electronics and other technical fields.

Ryan Patterson

Patterson went on to win top prizes and scholarships at both Intel International Science and Engineering Fair and Intel Science Talent Search for his engineering research project, a glove that converts American Sign Language to written text on a laptop or portable display. At the awards ceremonies McConnell was Patterson's guest of honor, watching his protégé reach the pinnacle of achievement.

Both Patterson and McConnell recognize that their long-term relationship has been an exceptional example of mentoring. But as Patterson points out, "There are a lot of different circumstances where a mentor can help."

How did these two work together? And what did both gain from the experience? Their insights should prove helpful to other students working on research projects with adult mentors.

Benefits for the Student

In hindsight, Patterson can see clearly what he learned from his mentor. "He helped me get a foundation in science," Patterson explains. During their all-day Saturday sessions in McConnell's workshop, they did hands-on activities, such as building robots and electronic circuitry, that helped Patterson understand the basics of electrical engineering. At the same time, McConnell was modeling what it means to be a scientist, engaged in the process of asking questions and seeking answers.

By high school, Patterson was ready to work independently on his own research projects. McConnell's role evolved from teacher to sounding board and friend. "He's become like a grandparent to me," says Patterson, now a student at the University of Colorado. That early foundation has supported the student well. Patterson reflects, "When you know the basics, you can go on and teach yourself more. But without that foundation, you wouldn't know where to start."

To go about programming his glove invention, for example, Patterson had to learn three advanced computer programming languages while he was still in high school. His mentor's expertise was particle physics, not computer science. That meant the student had to teach himself what he needed to know.

One of McConnell's best lessons was how to work through the obstacles that can get in the way of innovation, regardless of the field. As Patterson explains, "In Grand Junction, there are not a lot of technical things and opportunities. But John taught me what a scientist does if he gets stuck: He researches, reads books, and consults experts. John taught me I could email experts, like the people who make chips or circuit boards, and ask them my technical questions. I operated as if I was an independent company, working on an invention. I used the same cycle that a professional engineer would do. And John taught me all that—-how to research, how to get my questions answered."

"Probably instinctively, I taught him the way you go after a problem, the way you work and look at things," McConnell says. "I'm not sure I did that knowingly, but a young person will watch and pick up on your habits. For example, everything doesn't come easily. Some of the circuits we put together didn't always work. But I'm from that old school—-I'm gonna fix this thing. I think Ryan picked up on that, too. He has the tenacity to dig and dig

and dig."

Running into a technical challenge "can feel like hitting a concrete wall," Patterson admits, "but once you get past it, your confidence grows." It was that drive that first impressed his mentor. "John saw that drive in me the first time we met," Patterson says. "Of course, he didn't tell me that until much later."

Appeal for Mentors

McConnell admits he was initially skeptical about spending his retirement hours as a mentor. During his career as a physicist, he had never been involved with youth education programs. "Kids were the farthest thing from my mind," he says. "I had just built a new house in Grand Junction and was going to spend my retirement working on wood turning."

Then a new neighbor recruited McConnell to help coach a school competition called Odyssey of the Mind. McConnell discovered, almost by chance, that he had a talent for teaching. The local school district was only too happy to keep him busy giving science demonstrations. He started filling up his car trunk with magnets, wires, and batteries that he would haul into classrooms around town. One day, the volunteer coordinator for the schools asked him to spend some time with a third-grader whose high-powered questions about electricity were stumping the teacher.

From their first meeting, McConnell understood that Patterson was special. "I said to myself, 'Wow! This kid is extraordinary.' You could see he had that focus, that intensity. I realized I had to do something to encourage this kid."

They began spending Saturdays together working in McConnell's shop. "Most kids will get tired after an hour on something, but Ryan would go from 9 in the morning until 5 at night, and never turn sideways."

McConnell didn't have a deliberate plan for how to help his protégé develop. They just started working on projects that interested the student. Patterson's favorite boyhood toys were electrical cords and screwdrivers, so it wasn't hard to identify his interests. Explains McConnell, "I started him with transistors. By seventh grade, he was doing a better job, technically, of putting stuff together than my technicians at Los Alamos."

As Patterson's skills matured, McConnell encouraged him to enter competitions to keep challenged. The goal wasn't winning, says the mentor, who often came along as a chaperone. "I'd just pat him on the back and say, 'Do your best, Ryan.'"

Traveling to events opened more opportunities for Patterson to expand his horizons. McConnell remembers one car trip. "We stopped for lunch, and Ryan noticed a glass elevator. He had me riding up and down in that elevator while he stood below and watched how the mechanism worked. That was sort of the way it went with us. We just clicked," McConnell adds. "It was a perfect match. My wife would join us for dinner and say, 'You two finish each other's sentences.'"

More than luck goes into making such a good match. In mentoring, McConnell says, "one of the secrets is to find both a mentor and a student who share the same interest. Then there's a transfer between them, a connection. As the mentor, you get the thrill of watching a kid grow. You're trying to give a kid wings, and all of a sudden you find out that he flies."

McConnell's positive experiences as a mentor have inspired him to launch a K-12 math and science education center in Grand Junction. The Western Colorado Math and Science Center is housed in a 5,000-square-foot space made available by the local school district. More than 1,000 students per month come from more than 100 miles around to work alongside retired adult volunteers on 160 hands-on science displays.

McConnell also is becoming a mentor to educators in the community He has created science inquiry kits for teachers to check out and offers professional development workshops "to help teachers feel more comfortable with science." The target age of his outreach is from elementary to middle school. "We've got to interest kids in

science early," McConnell says. "If you don't get that fire started under them by elementary school, it may be too late."

His retirement project has turned into a 70-hour weekly commitment, but he couldn't be happier with the results. "Some people say they can't work with kids, or they don't have time." His own experience, he says, should motivate others to give mentoring a try. "You give of your time, but you get so much in return."