Intel ISEF—Profiles of Success

Getting Help

How Mentors and Teachers Support Student Researchers

"Science research is not just teaching. It's mentoring. As teachers, we should create a culture of mentoring."

—Josette Biyo
Western Visayas, Philippines
Winner, Intel ISEF Excellence in Teaching Award, 2002

Teachers, parents, and other mentors often provide valuable assistance to young researchers. Many students credit teachers with giving them inspiration for projects or encouragement to take their research deeper. Some students work with mentors who share expertise or access to cutting-edge research. Students talk about the importance of knowing when and where to seek help.

Solar Energy Improvements
Aleksey Kornev

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'Finally, It Worked'
Marcel Schmittfull

"Quantum mechanics is a very tough subject that students generally learn only by using mathematics," says Marcel Schmittfull, 16, from a Bavarian village in southern Germany called Geldersheim. "But I thought maybe using pictures would help students see how quantum mechanics works, and they would grasp the beauty of it." Read more.

Discovering a 'Really Good Thing'
Mairead McCloskey

Mention turbulence and most people think of a bumpy airplane ride. But for Mairead McCloskey, 17, turbulence is a fascinating subject worthy of intensive study. Working with university scientists, she has even helped design a sophisticated laboratory device that allows her to observe and study turbulence in action. Her project, "Chaotic Fluids: An Examination of Phase Transitions in Taylor-Couette Flow," won the best-of-category prize in physics at Intel ISEF 2003, and previously won the top prize presented by Intel at the Esat BT Young Scientist and Technology Exhibition in Ireland. Read more.

Learning From Role Models
Emma Smith

Emma Smith, who attends Aberaeron Comprehensive School in Wales, ended the 2003 BA CREST Science Fair in London with top honors: an invitation to take her biochemistry project to Intel ISEF in Cleveland and compete against other young scientists from around the world. But the bigger reward may be the boost in confidence she experienced as a result of digging into research and sharing the results of her investigation with mentors and judges. Read more.

Connecting With Experts
Ayelet Abush

A school program that connects students interested in science with professional mentors brought 18-year-old Ayelet Abush an invitation to work in a cutting-edge microbiology laboratory. The Israeli student has made the most of the opportunity, conducting genetic engineering research that may result in more disease-resistant grape vines. Read more.

Solar Energy Improvements

Aleksey Kornev

Sometimes a good teacher can make all the difference. When 16-year-old Aleksey Kornev demonstrated a gift for chemistry, Pavel Troshin, his teacher at Lyceum #1 in Bryanks, Russia, not only helped him develop the idea for his science research project, but also connected him with a professional laboratory where he could conduct his research. The instructor, who also works for the Institute of Problems in Chemical Physics near Moscow, arranged for Kornev to spend several months in the laboratory there, working on his project, “Synthesis of Fullerene Derivatives for Design of Donor-Acceptor Dyads.”

Access to such a fully equipped research facility made a big difference for Kornev. There, he was able to test his theory about an alternate compound for use in solar energy cells.

“Fullerenes possess unique photophysical properties and are widely used as electron acceptor units in various donor-acceptor systems,” he explains in his project abstract. “The most promising are non-covalently bonded dyads formed from fullerene derivatives bearing chelating groups and metalloporphyrins. Such self-assembled systems mimic natural photosynthetic antenna and are potential materials for solar energy conversion.”

Kornev conducted numerous experiments over the course of about four months to find an appropriate fullerene-based material.

The result was the discovery of a new compound that may be used in the solar cells of solar panels. “It possesses unique properties like flexibility,” says Kornev, which “increases greatly the area of where you can use panels.” The student adds, “And it’s cheap.”

Additionally, the research resulted in “a new type of chemical reaction, [the] first catalytic cycloaddition,” reports Kornev, a remarkable outcome for a budding chemist.

Of course, as with any scientific research, there were setbacks along the way. An initial approach for synthesis did not work, Kornev says. It produced a compound, but when the student analyzed it, he realized it was not a viable option. So he forged ahead.

Inspiration for the project came from Kornev’s passion for the work. “I just like chemistry, that’s all,” he says. “The work itself encouraged me.”

Kornev will complete his course of studies at Lyceum #1 this year and plans to study chemistry at the university level next fall. He hopes his project research and experience at the Intel International Science and Engineering Fair (Intel ISEF) will help him garner a prime spot in a competitive university program.

He also intends to continue with his research in the area of solar energy. “This particular compound is final,” he says, but “other compounds could be found.”

'Finally, It Worked'

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"Quantum mechanics is a very tough subject that students generally learn only by using mathematics," says Marcel Schmittfull, 16, from a Bavarian village in southern Germany called Geldersheim. "But I thought maybe using pictures would help students see how quantum mechanics works, and they would grasp the beauty of it."

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The high school junior's interest in the physics of subatomic particles was initially fired by his science teacher at Celtis Gymnasium, in the nearby city of Schweinfurt. "My teacher recommended some books, and I learned quantum mechanics on my own with lots of books from the library," says Schmittfull.

In one book, Schmittfull saw a three-dimensional illustration of harmonic oscillation, which started him thinking about a computer simulation program to help students visualize the principles and effects of quantum mechanics. His science project was born. A further aim was to make his program interactive, allowing users to input and manipulate data.

Strong Nerves

Using interactive software, Schmittfull got to work. "Writing the code was quite hard and took about five months and strong nerves," Schmittfull recalls. When he got stuck, scientists from other parts of Germany gave him tips, and physicists at the University of Würzburg helped him improve his program. "Finally it worked, and that made me very happy."

Schmittfull took his project, "Simulating and Visualizing Quantum Mechanics," to the regional science fair, where it won first prize. "So I went on to the Bavaria state science fair, and then the national competition near Frankfurt, and I won again," says Schmittfull. "I really enjoyed making contacts with other young people at these fairs who have the same interest in math and physics. And of course,it is a pleasure to discuss quantum mechanics and my project with experts on the field."

The most important thing he learned from his science adventure is this: "You have to have fun and always try to do something unusual." His project won third place, and US$1,000, in the physics category at Intel ISEF.

Discovering a 'Really Good Thing'

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Mention turbulence and most people think of a bumpy airplane ride. But for Mairead McCloskey, 17, turbulence is a fascinating subject worthy of intensive study. Working with university scientists, she has even helped design a sophisticated laboratory device that allows her to observe and study turbulence in action. Her project, "Chaotic Fluids: An Examination of Phase Transitions in Taylor-Couette Flow," won the best-of-category prize in physics at Intel ISEF 2003, and previously won the top prize presented by Intel at the Esat BT Young Scientist and Technology Exhibition in Ireland.

McCloskey attends Loreto College in Coleraine, County Derry, a sparsely populated area in the northwest of Ireland. Her interest in turbulence began when she read a book called *Chaos* by James Gleick. "The book mentions Taylor-Couette flows as a good way of looking at turbulence, and looking at chaos theory in particular," she explains.

She set out to gain a better understanding of flow when fluids become turbulent. Rather than happening as gradual change, turbulence is "actually a series of sharp transitions," she explains. After reading research papers and studying phase diagrams about turbulence, McCloskey found herself asking more questions. She wanted to be able to see turbulence in action in order to study the process.

Building an Apparatus

Working with the physics teacher at her school, she first tried building an apparatus that would allow her to study turbulence in a laboratory setting. The first device didn't offer the precise control she needed, however, so she approached scientists at the nearby university where her father teaches geology.

The apparatus has two independently rotating cylinders.

"I asked them to build something for me," she says, "and it turns out they were enthusiastic about helping me." The geophysics group could see the benefits of what she had in mind. McCloskey worked closely with the technicians who were designing, building, and testing her custom apparatus. "I was telling them exactly what I wanted, and they were giving me feedback to make it better. They took a real interest in what I was doing."

McCloskey's experimental device is called a Taylor-Couette apparatus. It has two independently rotating, coaxial cylinders, with a gap between filled with fluid. Computer-controlled stepper motors allow for precisely controlling the drive speed. By suspending mica crystals in the fluid, a researcher is able to visualize the flow of the fluid and map phase transitions. Changing the speed of the cylinders sets up an instability, McCloskey explains, " so then you get a whole range of different types of behavior, with the transfer of liquid between the two cylinders."

Previous research about phase transitions had predicted rapid onset of chaotic behavior. McCloskey was able to map more gradual transitions, specifically 12 distinct flow

regimes and corresponding phase transitions.

"There's actually a huge complexity in this that you would never predict, which is how this whole thing links with chaos theory," she explains. McCloskey says her research opens questions for further study, and may result in modifying the existing phase diagrams to incorporate the subtle transitions she has observed. "I know it looks like you'd be simplifying the phase diagram by taking out a lot of those boundaries, but you're actually acknowledging an even greater complexity." That greater complexity, as well as an apparatus that allows researchers to analyze complex behavior, "is a really good thing I discovered."

What's next? McCloskey hopes to enter Cambridge in the fall and continue her study of physics.

Learning From Role Models

Emma Smith

Emma Smith, who attends Aberaeron Comprehensive School in Wales, came away from the 2003 BA CREST Science Fair in London with top honors: an invitation to take her biochemistry project to Intel ISEF in Cleveland and compete against other young scientists from around the world. But the bigger reward may be the boost in confidence she has experienced as a result of digging into research and sharing the results of her investigation.

"Friends and family will tell you that I'm not the most talkative and extroverted person you'll find," she admits. "However, I love talking about my project, something I have created from start to finish. I especially enjoy talking to adults or students who have a genuine interest or even experience in the field of research. The best thing about participating," she says, "is the confidence you gain."

Immersed in Real Science

Smith conducted her research during a summer holiday spent in the company of scientists at the Institute of Grassland and Environment Research. She received a Nuffield Bursary award, which funded her four-week internship at the institute.

Her supervisor, Dr. Danny Thorogood, began by explaining to her his ongoing research in the field of plant genetics. Smith then set out to design a research project that would generate data useful to Thorogood and his colleagues. Her project focused on finding clusters of plant genes in ryegrass that control senescence, the process that leads to chlorophyll breakdown (resulting in leaf yellowing), and eventually plant death. Smith saw potential benefits to the study: "By maintaining leaf greenness, we are looking at producing healthier and more productive grasses, which is important for both forage and livestock systems," she explains.

Once Smith set out her aims, objects, and experimental design, she began gathering her data. "To an onlooker, it may have looked rather tedious. Some days were spent wholly in the greenhouse, working through well over a hundred plants, taking the same readings from each. In addition, one had to type all the data collected into a text file at the end of the day. But I enjoyed every minute of it," she says.

Thorogood was impressed to see the high school student settling into the research environment, mixing with professional botanists and gene researchers, using technical equipment, and asking questions when she needed direction. For Smith, the experience gave her an insider's view of the life of a scientist—a life she has come to love.

"A career in science is not well-documented," she says. "We all like to think we know what it is like to be a police officer, paramedic, teacher, or high-flying barrister from all the dramas and soaps on television. However, science isn't given such a glamorous image. To a pupil, a career in science seems overwhelming. So I needed to experience research, and the experience I gained was invaluable. I learned so much in a month: the process of conducting research, the need for huge data samples, and more importantly, how to communicate my findings to a wide circle of different people."

A Mentor's Help

Working closely with her mentor was also valuable. "He allowed me plenty of freedom to approach the experiments and results as I saw fit, even if he didn't entirely agree," she says. "In the latter stages, particularly, he was interested in my conclusions. We often had little five-minute discussions where he listened to me relaying my findings." Eventually, Thorogood hopes to have Smith's findings published in a peer-reviewed journal.

As for Smith, she plans to pursue university studies that will lead to a career in scientific research. Although she's long been interested in the field of genetics, she now has a deeper appreciation for plant genetics. "My project has taught me to keep an open mind," she says. "Plant genetics is just as important as human genetics."

Connecting With Experts

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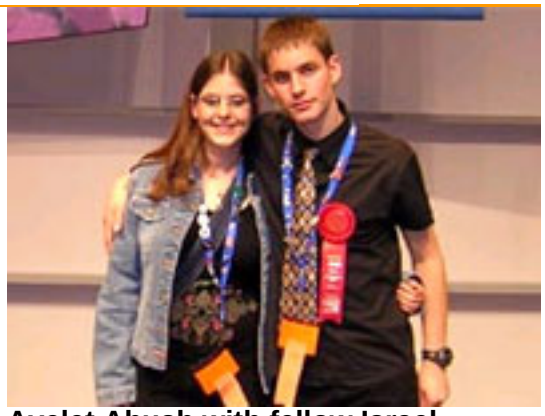

Ayelet Abush with fellow Israel student and Intel ISEF finalist Ron Neuman

Abush, who attends Reali High School in Rishon Lezion, presented her research at the Intel-Israel Young Scientists Competition in March, and came away with an invitation to take her project on to international competition at Intel ISEF in the United States.

Real-World Lab Work

She conducted her research at the Vulcan Institute Virology Department in Beit Dagan. Dr. Munir Mawassi, an expert in microbiology, enlisted her to participate in his research that involves engineering a virus to act as a gene carrier.

Abush's research project involved comparing two vine plants, one of which had been infused with the gene carrier. She observed that within two weeks, the plant into which the genes had been inserted was speckled with blue spots, just as she had expected. Her research shows that the viral carrier is indeed capable of importing a gene. In the future, scientists could use this approach to create vines that are more resistant to fungi and other pests, or which produce grapes of different colors or sweetness levels.

Learning From Competing

Abush says that preparing her project and presentation poster for the Young Scientist Competition "helped me understand the concepts and the entire research process." She admits that she was at first hesitant to enter the competition. "I didn't think I had a chance to win. I also knew it involved dealing with an enormous amount of paperwork."

She persisted, however, and wound up "incredibly surprised and excited" to hear her name called during the awards ceremony at the President's Residence, with her teacher, mother, and brother present to share in the moment.

Since attending Intel ISEF, she plans to continue her studies of biology at the university level.