

Fostering diversity in science and public science literacy

The Young Scientist Program at Washington University in St. Louis has a history of changing lives through inspiration and scientific discovery

BY KATHERINE B. CHIAPPINELLI

Bart Bartlett was a junior in 1995 at Metro Academic and Classical High School in St. Louis when his science teacher put him in touch with an M.D./Ph.D. student at Washington University in St. Louis who was interested in bringing high-school students into his thesis laboratory.

The graduate student, James McCarter, was one of the founders of the Young Scientist Program, which brings scientific laboratory experiences directly to underprivileged middle- and high-school students and their teachers. Bartlett was in one of the first cohorts.

While Bartlett had taken science courses, this was his first exposure to research in a laboratory. Over the course of the summer, Bartlett performed an independent research project doing genetic analysis in the model organism *C. elegans*, a small worm. Bartlett says the most important part of the experience was working in the lab as part of a team.

“I learned by experience how the scientific method works to do cutting-edge research,” he says. “Knowing that scientists work together and have a lot of fun doing it reinforced a career in science.”

The experience changed his life. Bartlett went on to study chemistry in college, earn a Ph.D., do postdoctoral research and become an assistant professor at the University of Michigan. He credits much of this success to YSP and is currently initiating a similar one at his institution.

An obvious need

Few would argue that scientific discovery and progress benefit from the diverse perspectives of individuals in the field. Yet, while underrepresented minorities make up 29 percent of the U.S. population, they make up only 5 percent of full professors with science and engineering doctorates, according to the National Science Foundation’s 2011 report on Women, Minorities and Persons with Disabilities in Science and Engineering. While women made up 5 percent of

this group in 1979, that figure had increased to more than 20 percent in 2008. Meanwhile, underrepresented minorities made far fewer gains, with their numbers growing from about 2.5 percent in 1979 to 5 percent in 2008.

With these disparities in mind, the Young Scientist Program seeks to expose underrepresented minority students and those from disadvantaged backgrounds to experimental



Bart Bartlett is an assistant professor of chemistry at the University of Michigan. When Bartlett was in high school in St. Louis, he was one of the first participants in the Young Scientist Program. Today he is initiating a similar program at his institution.



Lesley Rankin scrapes off a colony of cells from a petri dish in the lab of Justin Fay, an associate professor of genetics at Washington University in St. Louis, while Devjane Swain Lenz, a Ph.D. student in molecular genetics and genomics, assists. Rankin was a 2008 participant in the Summer Focus program and continued to volunteer in the lab after finishing the program.

science and thus encourage science literacy and the pursuit of careers in science.

“YSP is unique in the United States, as the program is primarily run by volunteers, comprised of Ph.D. and M.D. students and postdoctoral fellows,” says Thomas Woolsey, the program’s faculty adviser.

Each year, YSP works in partnership with St. Louis public schools to engage more than 1,000 high-school students and teachers through a broad repertoire of programs. Over 20 years, about 500 volunteers have worked with more than 7,000 students. YSP was honored for its contributions to the St. Louis community when it received the 2011 Science Educator Award from the Academy of Science of St. Louis.

With the support of the university and community members, YSP continues to have a major impact by attracting

students from diverse backgrounds to pursue careers in science. In turn, YSP volunteers benefit from these programs, gaining a variety of skills and experiences not formally taught during graduate and post-graduate training.

Bartlett, who serves as a research adviser for graduate students, says he sees “the profound impact that instructing younger students, including high school students, has on their ability to communicate science.”

Summer Focus

YSP uses several unique initiatives to augment middle- and high-school science curricula and attract young people to scientific careers. One of them is the Summer Focus program, in which students from local high schools conduct independent research at Washington University for eight weeks.

Each student summarizes his or her discoveries in a formal research paper and presents his or her findings at a symposium at the summer’s end. He or she participates in a scientific writing course, attends career presentations by professional scientists, takes part in a journal club and is coached in making presentations.

Each student has both a laboratory mentor, who guides the student through an independent research project, and a tutor, who helps reinforce basic biological concepts. Bartlett says he remembers meeting with his tutor to build on what he had learned in freshman biology so that he could understand the genetics research he was doing in the lab.

“Learning a few functional lab skills to get going right away while also filling in the background information as the summer progresses is a pivotal aspect of keeping students productive and encouraged,” he says. “Focus too heavily on skills, and we become mere

technicians. Focus too much on background, and we’d be too overwhelmed to get anything accomplished. YSP has found the right balance.”

So far, more than 230 high-school students have participated in the Summer Focus program. Most have attended college, and many have majored in science, often with scholarship support, and have gone on to pursue advanced degrees in science and medicine.

Lesley Rankin, a 2008 Summer Focus student who attended Gateway High School, says she obtained laboratory, writing, reading and career skills from the experience.

“All of the sessions and lab research incorporated into the entire summer were the building blocks for my decision to continue a career in science,” she says. Rankin explains that before participating, she was deciding between a career in music or

science, and the program helped her decide on science.

Bartlett adds, “Kids who love science are viewed as nerds, and Summer Focus shows that nerds who work really hard get degrees and ultimately get very good jobs. I don’t think I even appreciated that as much at the time, but given today’s economy, it’s big.”

Teaching Teams

During the school year, teams of YSP volunteers develop and lead inquiry-based, hands-on science modules to increase science literacy in nine different fields: anatomy, chemistry, ecology, evolution, forensics, genetics and genomics, microbiology, neuroscience, and physics. The volunteers present interactive activities in classrooms, after-school programs and community organizations.

One such example is a genetics demonstration of DNA extraction in which students use household items, including shampoo, rubbing alcohol, salt and cheesecloth, to isolate DNA from fruit. The students are excited to find that DNA, the “blueprint” they have read about in textbooks, is a tangible substance that they can purify from living things.

St. Louis-area teaching team visits have expanded from 15 per year in 2001 (reaching about 350 students) to more than 60 per year in 2011 (reaching more than 1,000 students).

Rankin was first exposed to the Young Scientist Program at a genetics teaching team demo at her high school.

“The team leaders kept us engaged by asking many constructive questions related to the material,” she recalls. “The teaching teams allowed me to critically think through the logistics of any experiment.” The experience prompted her to apply for the Summer Focus program, in which she performed an independent research project on hybrid sterility in yeast.

Rankin is now a junior at Webster University majoring in biology with an emphasis on biotechnology. She plans to obtain a Ph.D. and start her own biotechnology company.

In addition to working with local schools, YSP volunteers bring teaching team demos to national scientific meetings to interact with fellow graduate students and engage high-school students in other areas of the country. The effectiveness of such activities in achieving scientific-concept learning is



Abby Buchwalter (second from left), then a Ph.D. student in cell biology and physiology, works with students at Vashon High School on an experiment about reduction-oxidation reactions. The students used heat and the sulfur in hardboiled eggs to tarnish pieces of silver and copper and then used hot water, baking soda and aluminum foil to remove the tarnish. The Vashon students visited the Washington University School of Medicine for Women in Science Day, sponsored by the Young Scientist Program and the Association for Women in Science.



Students at Central Visual and Performing Arts High School participate in an exercise in natural selection during a visit to the Washington University School of Medicine. The students used forks, chopsticks and spoons to pick up different sizes of beans to simulate trait variation and differential survival within a population of birds. Students competed against one another for food over multiple rounds (generations) and observed how natural selection can alter the frequency of different traits over time within a population. The activities were organized by the Young Scientist Program’s evolution/genetics/genomics teaching team.



Jennifer Lynch Yttri (center), a Ph.D. student in immunology, instructs Summer Focus participants Paris Guerin (left) and Cherise Gilmore in the proper use of a pipette. Guerin and Gilmore were participating in the Research Boot Camp, a two-day course in lab techniques and safety that Summer Focus students must complete before beginning work in their research labs.

evaluated using pre- and post-surveys of participating students.

The Teaching Teams initiative also gives high school students a chance to interact with experts in scientific fields who are young, bright, engaging and enthusiastic about science.

Lowenstein teaching kits

In 2010, thanks to financial support from the Leon Lowenstein Foundation, teaching kits were developed to expand YSP's reach. The stand-alone kits, some based on teaching team demos, can be checked out freely by St. Louis teachers.

Each kit focuses on a specific topic. It contains protocols, supplies and equipment for classes to perform experiments; an instructional video with background material on the topic; handouts and teaching points; and materials for evaluation and assessment of what was learned.

To date, teaching kits for DNA extraction

YSP components

Summer Focus: The initiative promotes science literacy and attracts underrepresented students and those with limited school resources into scientific careers through hands-on research and one-on-one interactions with scientists. Rising high-school seniors perform independent research and develop skills in critical thinking, practice scientific writing, evaluate research articles and conduct peer review. Students receive stipends for their work.

Teacher-Researcher Partnership: The initiative provides teachers with laboratory experience and researchers with classroom teaching experience. St. Louis teachers perform eight-week independent summer research projects with volunteers in a Washington University laboratory. The teacher-researcher pairs develop science activities to bring their research into classrooms. Volunteers continue to work with teachers during the school year to develop science curricula and also work with students. Several teachers who have participated subsequently pursued advanced degrees in science or education.

Teaching Teams: The initiative brings interactive scientific demonstrations into classrooms. Current teams focus on anatomy, chemistry, ecology, evolution, forensics, genetics and genomics, microbiology, neuroscience and physics. Stand-alone teaching kits are being developed to provide teachers with more classroom tools and reach the community more broadly through nonschool-related activities. Additionally, middle- and high-school students may take fieldtrips to Washington University School of Medicine to participate in demos and take tours of the Genome Center and anatomy laboratory.

Laboratory Equipment Recycling: The initiative provides lab

materials and equipment to St. Louis Public School teachers to incorporate hands-on science teaching as part of their curriculum.

Science Educator Colloquium: These short courses and seminars are available to YSP volunteers and are aimed at enhancing their mentoring, tutoring and teaching skills. The sessions also provide perspective on the profession of and challenges faced in science education.

Community Partnerships: YSP cooperates with both local and national organizations. These partnerships include a series of lectures for students and their families on medical topics, teaching at the St. Louis Science Center, projects with other universities in St. Louis, and presentations and demonstrations at national conferences. YSP also partners with St. Louis organizations UrbanFUTURE and the Youth Learning Center to expose middle-school students to laboratory science. YSP holds a special series of events for the annual Women in Science Day at Washington University in St. Louis.

Family Science Experience: This science camp for middle-school students and their families was started in July. Volunteers guide students through inquiry-based, hands-on activities for two days. Family members of students attend the evening of the second day, learning with and from the students. In the future, this will become a monthly science experience and dinner at which students and their families explore science together while learning basic science concepts in a fun, interactive atmosphere.

To learn more about the Young Scientist Program, please visit <http://ysp.wustl.edu/>.

Knowledge before and after neuroscience Teaching Team outings

Facts (N=34):

1. A stimulant excites the brain.
2. Withdrawal is the symptoms felt after stopping the use of a drug.
3. The hippocampus is the brain area representing touch.
4. The more sensitivity to touch, the more representation of that area in the brain.

At the 2007 Spring Brain Conference in Sedona, Ariz., the Young Scientist Program's neuroscience teaching team visited the Flagstaff Bordertown Dormitory, an educational residence for Native American high-school students. The evaluation showed a significant increase in students' knowledge of specific facts about the brain before and after the teaching team activities.

In addition, students showed statistically significant improvement in positive attitudes toward science. When asked to evaluate the usefulness of the demos and the extent to which they felt they had an opportunity to participate actively, students gave an average ranking of 3.5 on a scale of 1 (worst) to 5 (best) in response to both questions.

	Before	After
1. A stimulant excites the brain.	5.88%	10.71%
2. Withdrawal is the symptoms felt after stopping the use of a drug.	51.52%	82.76%
3. The hippocampus is the brain area representing touch.	50.00%	74.29%
4. The more sensitivity to touch, the more representation of that area in the brain.	75.76%	93.10%
mean (all)	45.79%	65.22%
SD	29.10%	37.14%
t-test		NS
mean (2-4)	59.09%	83.38%
SD	14.45%	9.42%
t-test		p < 0.05



At Research Bootcamp, Derecka Travis, left, plates bacteria on petri dishes that contain the antibiotic ampicillin with Ph.D. student Zac Cusumano and Kenneth Stockard, right.

from fruit, surface tension and generation of a citrus battery have been created. YSP is working with a community organization, the Youth Learning Center, as well as St. Louis public school science teachers to get feedback to improve the kits. Graduate and medical students at other institutions can now take advantage of online teaching team demos and teacher kits by accessing the

online resources at <http://yosp.wustl.edu>.

Both participants and organizers agree that YSP is a proven and flexible model for a volunteer-based approach to improve science understanding and inspire future generations of science professionals, especially among under-represented groups.

"Summer Focus was one of the best things I have been a part of in my life,"

Rankin emphasizes. "Completing the program and, most importantly, walking away with a deeper passion for science was amazing. One day, I want to give a similar experience to young adults so they can explore their strengths and develop career goals. I want them to have that same life-changing experience that will make them strong and effective leaders."

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