BioEYES: 2018 Elizabeth W. Jones Award for Excellence in Education

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The Genetics Society of America's Elizabeth W. Jones Award for Excellence in Education honors individuals who have made a significant and sustained impact on genetics education. The 2018 recipients are geneticist Steven Farber of the Carnegie Institution for Science and education expert Jamie Shuda of the University of Pennsylvania. Farber and Shuda were awarded the prize in recognition of their outreach program BioEYES, which provides students in grades 2–12 with hands-on biology experience using live zebrafish. The flagship program brings fish—and the tools to study them—into the classroom for an entire week, during which time students observe much of the fish's life cycle, from mating to the development of larvae.

In classrooms from Philadelphia to Melbourne, kids huddle around a common interest: live zebrafish. The fish are not class pets—they are part of a hands-on educational experience provided by BioEYES, a program that earned its creators, geneticist Steven Farber and education expert Jamie Shuda, the Genetics Society of America's 2018 Elizabeth W. Jones Award for Excellence in Education. BioEYES has come a long way since its creation in 2002. "We've been around for 15 years and reached over 120,000 kids," says Shuda. "But it literally started with me driving around Philadelphia with fish in my backseat."

Before BioEYES, Shuda says she didn't enjoy giving science lessons to her third graders—in large part because she did not fully know how. Her graduate training in early education had left her feeling at ease with core subjects like reading and math, but she had far less knowledge of how to best teach science. "The experience was frustrating," Shuda says. "But I knew my kids loved it." That drove her to improve.

Meanwhile, at Thomas Jefferson University, Farber was thinking about how to bring real, hands-on science to Philadelphia schools. A take-your-child-to-work event had led a gaggle of kids to his laboratory—the most popular stop on the day's tour—where they marveled at the zebrafish. After seeing how excited the children were by their encounter with the fish, Farber began seeking someone who could work with him to recapitulate that enthusiasm in the classroom in a practical, educational way.

For Farber, working with Shuda was a clear choice. With her background in education and understanding of the school system, she knew how to take the idea and make it work in a classroom setting. They also agreed on the importance of making sure their program would reach students of all backgrounds, not just those in affluent school districts or those who specifically applied to advanced science programs, and Shuda's experience with under-resourced schools was a major asset in the pursuit of that goal.

Combining their knowledge, Farber and Shuda put together the core plan for the BioEYES program: working directly with teachers, they would bring zebrafish and the science equipment needed to observe them into classrooms (Figure 1). The rapid development of zebrafish means students can cross the fish on Monday, collect embryos on Tuesday, and observe the translucent fish's beating hearts by Friday. The learning expectations would be adjusted based on the students' grade level, with the youngest kids learning about topics like anatomy and older students learning about genetics and development.

As teachers, parents, and school administrators saw the positive effects of the program, their endorsements fueled its growth. When Farber moved to Baltimore to become a faculty member at the Carnegie Institution for Science, he started a BioEYES branch there, and over time the program began to spread to other cities around the world.

To get a sense of the program's impact, Shuda, Farber, and two others on the BioEYES team (Valerie Butler and Robert Vary) tested how participation affected 19,000 students ranging in level from elementary through high school (Shuda *et al.* 2016). They found that knowledge of the content taught in BioEYES increased over the week-long experience. Students' attitudes toward science shifted, too; after going through BioEYES, they were more likely to say they understood what it was like to be a scientist and that they'd be interested to learn more about careers in the sciences.

The team is now conducting a longitudinal study to determine whether the BioEYES program has long-lasting

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Figure 1 Two students at Beechfield Elementary Middle School in Baltimore making observations on their embryos during a week-long genetics experiment with Project BioEYES. Photo courtesy Project BioEYES.

benefits. Research on this topic has limitations; for example, it can be difficult to develop control groups for such studies, and there are many confounding variables, such as the differing skills of each teacher. Still, Farber says, it is important to try to get quantitative information on the program's effects.

Many seem to be convinced of BioEYES' value. Since the team published their results, they have received requests to bring the program to over 80 sites around the world, and Shuda says there is a 1-year waitlist to be involved in the program in Philadelphia. According to science curriculum specialist Emily McGady, a former BioEYES teacher and one of Shuda's close colleagues, experiences like the one the program provides are not the norm in Philadelphia's public schools. "Very few partners come into the classroom to provide state-of-the-art laboratory experiences with cutting-edge technology," McGady says. "My students profoundly enjoyed the experience. They often told me that it was one of the most exciting things they did in the school year and their first real opportunity to feel like a research scientist."

The team continues to develop new activities for the students, too, including experiments on how temperature affects zebrafish embryo growth. The project involves key topics featured on state standardized tests, such as graphing and data analysis. Shuda says learning these concepts through BioEYES is fundamentally different from textbook-based learning. "They're actually graphing their own results. They're actually using their own data and finding a conclusion based on their own investigation," she says. "Isn't that a lot cooler to graph than some made-up dataset?"

Marnie Halpern, an investigator at the Carnegie Institution for Science on the BioEYES advisory board (and Farber's mentor during his postdoctoral research), has seen how the experience continues to affect some young people long after the program is complete. Halpern is involved in outreach endeavors of her own, and one of her projects—a speaker series called Women Serious about Science—brings her to high schools. When she talks to the teens about her research, many say they know about zebrafish and recall learning about them through BioEYES. "They even remember from doing this in primary and middle school. It makes a big impression on these kids," Halpern says.

With so much interest in BioEYES, the only thing slowing its spread is the need to build funding. The program is unique in that it involves coteaching for 3 years with each teacher rather than just shipping them prefabricated materials and having them fend for themselves, and that contributes to the need for dedicated staff. Shuda and Farber started BioEYES with no experience in obtaining funding for projects of its kind, but they have grown the program over the past 15 years through resourcefulness and the generosity of supporters, including the University of Pennsylvania and the Carnegie Institution for Science, their home institutions.

The excitement about BioEYES is apparently contagious, as many of the team's colleagues have become involved, including graduate students, postdoctoral researchers, and professors. Participating in outreach is about more than filling out a "community engagement" section on a grant application, although it is certainly looked upon favorably by funding agencies. For scientists who find it fulfilling to put their scientific expertise to work helping their communities, that satisfaction can feed into their productivity as researchers. According to Farber, working on BioEYES has not hindered his research; in fact, he says he's now working on some of the most exciting science he's ever done.

Scientists are well-suited to working on social causes such as increasing access to science and improving science education. "I think in science we're trained to take really intractable problems and pick a place to make a marginal impact," Farber says, drawing a parallel to social problems. Finding out where to make a difference in big, complicated issues is one area in which scientists excel. Whether we're chipping away at genetic mysteries or working with educators to improve young people's experiences with science, we can put that skill to use.

Literature Cited

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