

CAREERS

Q&A NIH director lays out workforce initiatives for early-career scientists **p.443**

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EDUCATION

Free-range learning

The budding field of informal science education offers varied research paths but uncertain funding.

BY VIRGINIA GEWIN

Zombies are on the attack. Victims' organs must be replenished to save humanity from the undead. But only players with an understanding of cells, tissues and organs — even the latest techniques to induce pluripotent stem cells — can regenerate the lost body parts.

This is the challenge set forth in *Progenitor X*, a problem-solving video game in which players learn how to reprogram more than 200 human cell types. "People play *Progenitor X* because it is fun to learn some things about science as they play," says game developer Kurt Squire, who works at the University of Wisconsin-Madison.

Squire is one of a growing number of informal-science-education (ISE) researchers, who focus on providing learning experiences outside of the formal classroom environment. The field encompasses a diverse group of talents, including video-game developers, as well as people who design, develop and evaluate science-education experiences for museums, television shows, after-school programmes, science festivals and national parks. "The learning that takes place in museums and science centres is the same learning as in school — brains generally work the same no matter the location," says Justin Dillon, an ISE researcher at Kings College London, which is launching a bachelor's degree in science engagement and communication in

September. "But those experiences can reinforce or deepen the learning."

ISE is increasingly gaining traction: both government and non-profit funders are supporting activities; some museums are hiring more research staff; and the number of training opportunities is increasing. Attempting to organize the field is the Washington DC-based Center for Advancement of Informal Science Education (CAISE), which was formed in 2007 with support from the US National Science Foundation (NSF). CAISE aims to raise the field's profile by bringing together diverse sectors under the ISE umbrella to garner more funding, formalize training opportunities and establish methods to assess the success of various outreach projects.

However, in the face of strained science budgets, this budding field has been prone to funding ups and downs. Government agencies might perceive their activities as lower priorities. Practitioners have increasingly forged partnerships with industry or private foundations that are eager to cultivate a science-savvy citizenry and workforce. Although diverse job opportunities exist, seizing them requires connections, flexibility and creativity.

ACADEMIC RESEARCH

The diversity of career tracks may be the field's biggest perk. Science centres, zoos, aquaria, video-game companies, television shows and non-profit organizations are all looking to develop new materials to keep visitors and users engaged. Research-oriented jobs are among the fastest-growing areas of employment. "Funders want people to fundamentally look at the learning question — it's not just about building an exhibit any more to get NSF funding," says Rhiannon Crain, who trained with Dillon and is now leading a citizen-science project called Yard Map. Run from the Cornell Lab of Ornithology in Ithaca, New York, Yard Map asks users to provide data about the effect of landscape changes on wildlife, and teaches them how best to create a bird habitat.

ISE practitioners might quantify, for example, how access to scientific instruments or engaging in hands-on exploration — through laboratory experiments or forensic-investigation simulations — can spark curiosity and strengthen someone's comprehension of science. Kevin Crowley, an education researcher at the University of Pittsburgh in Pennsylvania, has partnered with the Carnegie Museum of Natural History in Pittsburgh to help the ►

► museum to enrich civic debates that involve scientific evidence. For example, to increase climate-change literacy in urban communities, the museum is breaking down the huge, complex topic into small pieces, focusing on how climate change will affect Pittsburgh itself.

Approaches to ISE, and therefore to training options, differ. A group led by Lynn Dierking at Oregon State University in Corvallis focuses on what motivates people to seek learning experiences in daily life, a concept she calls “free-choice learning.” Dierking’s group studies how to create opportunities that pique human curiosity, such as during visits to state parks.

The university offers a six-course certificate programme, an online master’s degree and a formal PhD. Trainees can have a science or social-science background. The online master’s is designed to provide the skills to enhance visitor learning at museums, national parks or nature centres. PhD candidates typically conduct research at an ISE outlet (such as a museum or an after-school programme), and recipients generally go into academia or become evaluators.

But the academic track often offers little job security. “Unfortunately, most of those are not tenure-track positions,” says Crain. Those who do find university-based work are typically adjunct faculty who rely heavily year-to-year on grant money. Squire’s students end up not only in academia but also in the entertainment industry or starting their own companies.

OUTSIDE ACADEMIA

Museums, meanwhile, particularly larger ones, are building up internal research and evaluation teams to track, for example, visitor experiences through surveys. The Science Museum

of Minnesota in St Paul and the Exploratorium in San Francisco, California, have teams of 12 to 14 who use this visitor feedback to hone exhibits. Larger museums have programme or exhibit departments — many of which are staffed by scientists with doctoral degrees — that develop and design exhibits, a process that can take two to three years from conception to completion. Smaller museums often have to hire external evaluators or companies to design and fabricate their exhibits. (Although some museums, notably The Field Museum in Chicago, Illinois, are facing harsh budget realities that have meant cuts affecting researchers and

“We are really interested in understanding what motivates and sustains interest in science.”

other employees (see *Nature* <http://doi.org/j6q>; 2012).) The increasing demand for consultant evaluators is a bright spot that seems poised to continue. “The need for evaluators in ISE is growing even when, and perhaps because of, decreases in funding,” says Kirsten Ellenbogen, senior director of lifelong learning at the Science Museum of Minnesota. It’s more urgent to demonstrate impacts than in past years, she adds. Evaluators collect data about the learning experiences of museum visitors to show whether the programme or exhibit has effectively educated or enlightened. Evaluation is often crucial to satisfying grant requirements. “In the current funding environment, accountability is critical,” agrees Ellen McCallie, programme director with NSF’s division of research on learning in Arlington, Virginia.

As a result, evaluators can find work as project-based consultants or join evaluation

firms that are popping up. The research institute SRI International, headquartered in Menlo Park, California, continues to grow — hiring people with social-science skills and a passion for communicating science. A few universities, notably Boston College in Massachusetts, the University of California, Berkeley, and Claremont Graduate University in California, offer PhD-level training that specializes in designing quantitative-research studies to analyse visitor data.

FUNDING FLUCTUATIONS

Regardless of the track, funding is a challenge. The NSF cut its funding request for the Advancing Informal STEM (Science, Technology, Engineering and Maths) Learning programme for the fiscal year 2013 by 22% from 2012 numbers, to US\$43 million. Funding is equally uncertain outside the United States. It is not yet clear whether ‘Science in Society’ — one of the two main ISE funding schemes under the European Framework Programme — will continue to exist in 2014.

Yet, at the same time, funders such as the NSF broadly encourage the use of ISE outreach and evaluation techniques across other NSF programmes and centres. For example, the NSF’s Centers for Chemical Innovation programme requires a robust effort in informal science communication or ISE. The programme’s director, Katharine Covert, says that there is a supplemental funding opportunity of up to \$150,000 for the centres to develop collaborations with an ISE organization. And a new NSF-funded initiative — Science Education For New Civic Engagements and Responsibilities (SENCER) — will establish partnerships between higher education and ISE organizations to find innovative ways to share research and interact with the public. The next round of SENCER funding, as part of a “Civic Engagement Partnership” programme, will provide six \$50,000 partnership awards (applications are due by 15 March) to ISE–higher-education collaborations.

“These days, informal-science educators have to be flexible and imaginative about how to obtain funding in this research area; ideally, they are able to piggyback onto existing activities,” says Karen Bultitude, director of research in the department of science and technology studies at University College London. She expects that the UK’s new Research Excellence Framework, which requires researchers to demonstrate the impact of their research outside academia, will encourage other groups to collaborate with ISE outreach projects. “Almost all of academia in the UK is desperately interested in demonstrating impacts of their work on wider groups,” says Bultitude.

In some cases, private funders have stepped in. The Wellcome Trust in London has spent upwards of £50 million (US\$80 million) over the past decade on schemes that include media fellowships for scientists and, most recently,



The zombie video game *Progenitor X* helps players to learn how cell types are formed.

engagement fellowships to support senior researchers who are developing a programme or projects to share their expertise with the public. One recipient, Roger Kneebone, based at Imperial College London, is a surgeon-turned-public-engagement fellow who plans to use live surgical simulations to engage the public. Clare Matterson, director of medical humanities and engagement at the Wellcome Trust, hopes that two reports published by the trust in November 2012 — *Analysing the UK Science Education Community: the Contribution of Informal Providers* and *Review of Informal Science Learning* — will prompt more grant submissions in the United Kingdom, and for ISE in general, of which there is a dearth at the moment, she says. “What is needed is a greater number of high-quality research-based proposals so we have a better understanding of how children learn through informal science experiences,” she adds. “These don’t have to be education groups; they could be people working in psychology or neuroscience, studying how people respond to different types of learning.”

In the United States, the Gordon and Betty Moore Foundation and the Noyce Foundation, both in Palo Alto, California, are funding ISE efforts ranging from citizen-science engagement to helping teachers in training learn how to develop their own interactive science-lesson plans. “We are really interested in understanding what motivates and sustains interest in science,” says Janet Coffey, a programme officer at the Gordon and Betty Moore Foundation.

Industry is also experimenting with ISE in an effort to reach the public. Novo Nordisk, headquartered in Bagsvaerd, Denmark, for example, finances the Steno Health Promotion Centre in Gentofte, Denmark, which runs a 33-million-krone (US\$5.7 million) project called PULSE at the Experimentarium in Copenhagen, to promote healthy lifestyles for families. The project will engage and track families with children aged 6–12 years old from a variety of socioeconomic backgrounds as they design and develop healthful eating and exercise strategies. The museum is increasingly “looked at as a serious partner instead of simply an institute for kids,” says Sheena Laursen, director of international projects at the Experimentarium.

Many hope that continued research efforts that document how ISE increases scientific literacy or encourages students to pursue STEM careers will help the field to grow. “Anyone who cares about scientific literacy and STEM workforce development,” says Ellenbogen, “should pay attention to ISE.” ■

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Q&A Francis Collins

Changes at the NIH

For years, the US National Institutes of Health has struggled with promoting non-academic career tracks for biomedical scientists, gauging the supply of PhD holders and demand for research jobs, enticing under-represented minorities into science and establishing funding avenues for early-career researchers. Hoping to bring some evidence-based clarity to these issues, NIH director Francis Collins asked two working groups of the NIH Advisory Committee to study the issues and make recommendations. They released their recommendations in two reports in June; Collins responded in December. The NIH has decided to take measures that include raising its postdoc stipend, increasing the number of grants that encourage early-career independence and offering 25 institutional grants, each worth about US\$250,000, to support training programmes that prepare students for a broad range of research-related careers, including non-academic paths.

What did you learn from the advisory reports?

The working groups put in a lot of effort collecting data to figure out what career paths PhDs were ultimately heading down. Only about 23% of US-trained biomedical PhD holders were in academic tenure or tenure-track positions in 2008, they found. Many end up in research-related positions, in industry, government, teaching, science policy, science journalism and other science-related professions. Training programmes have tended to view those tracks as secondary and have even sent messages that they are second-rate. So we need to retool to expose trainees to multiple pathways, rather than simply producing clones of their principal investigators.

What might the \$250,000 institutional grants involve?

We propose to have institutions provide actual exposure to careers outside a university setting, to help them to think more creatively about

the skills and knowledge that PhD holders might need for the job market. For example, students and postdocs may spend time at a pharmaceutical company, develop entrepreneurial skills or learn aspects of science-policy development.

Where will you get the money to support these programmes?

We can do it with the NIH Common Fund, which is dedicated to innovative initiatives, especially for topics that are relevant to multiple NIH institutes or centres. We will have to balance that with the need to continue other programmes through the Common Fund.

Unemployment is low among scientists in the United States, at 4–5%. Is the priority, then, to change expectations among those considering the academic track?

Yes, that is the intention. Unemployment is actually about 2% among biomedical PhD ►