

# The value of discovery

Informal learning offers important counterpoint to formal education.

BY GARY BOAS, CONTRIBUTING EDITOR

More than 40 years ago, Frank Oppenheimer, a physics professor at the University of Colorado and the younger brother of American physicist J. Robert Oppenheimer, proposed a science museum to be housed in the vacant Palace of Fine Arts in the Marina district of San Francisco. The museum – which, as the Exploratorium, opened its doors in 1969 – would be a sort of “Library of Experiments,” a teaching laboratory where visitors could discover the principles of mechanics, heat and electricity, for example, by directly engaging the myriad interactive exhibits in the museum in an informal, even playful way.

The mission of the Exploratorium was, in short, to democratize science learning. “All of those scientists came out of the Manhattan Project,” said Dennis Bartels, the current executive director of the museum, referring to Oppenheimer and his contemporaries, “and many had fled fascist Europe. They believed that science and technology were far too important to leave only to politicians and scientists, that their future direction belonged to all of us.” And they felt that a certain literacy in the sciences was essential to making informed choices in society.

This latter view is still relevant today, perhaps even more so. In the 1950s and '60s, scientific concerns were, for many people, limited to the threat of the atomic bomb. Now, as just one example, we are faced with almost daily discoveries in the world of genetics, which raise “fundamental questions about morality and ethics, about who we are as human beings,” Bartels said. Science is also tied up in important quality-of-life decisions – involving health care, for instance – and in broader societal issues such as food production and the environment. At the very least, we need tools to disentangle the many, often contradictory claims made in these arenas.

Science museums and other “informal learning” institutions provide these tools, not just by educating people – young and old alike – about the many fields of study



The Exploratorium in San Francisco is an informal learning institution that seeks to educate people about science through interactive exhibits. The museum employs a team of scientists to develop the imaging exhibit and to offer demonstrations of what the microscopes can do. Photo credit: Lily Rodriguez, ©Exploratorium, [www.exploratorium.edu](http://www.exploratorium.edu).

that fall under the rubric of “science,” but by encouraging them to ask questions and inspiring them to learn more. Today there are more than 15,000 such institutions in the US, encompassing everything from science museums and aquariums to local astronomy clubs. By fueling people’s sense of wonder – and helping them comprehend the world around them – they have become an important part of the social fabric.

## Taking it to school

Informal learning differs significantly from the formal education provided in public and private schools. It offers a unique type of learning environment – open-ended as opposed to goal-oriented/assessment-based – and engages and motivates children in different ways. Thus, it can be viewed, indeed it usually is, as complementary to the education children receive in schools.

Still, schools could benefit by heeding the underlying ethos of informal learning institutions: that the process of discovery can be an end in itself. Few people are likely to excel in the workplace because they remember the general equation for photosynthesis. But if they exhibit a keen sense of curiosity, which once led them to ask, for example, how photosynthesis might have contributed to the evolution of complex life on the planet, they become more valuable employees – and better informed citizens. It is this spirit of inquiry, this type of creative thinking, that should be cultivated in students.

Science museums such as the Exploratorium and the California Science Center in Los Angeles seek to do just this (to read about my visit to the California Science Center, see my blog on [photonics.com](http://photonics.com)). By directly engaging children with open-ended investigations, they encourage them to ask questions, to want to

know why. At the same time, they hope to expand their reach by helping teachers implement these strategies in the classroom.

The Exploratorium has been educating teachers since its inception – through a teachers’ institute as well as a successful mentoring program. Instructors use the museum’s exhibits to demonstrate how complex scientific principles can be illustrated simply and creatively. In this way, they are changing the teachers’ relationship to the subject matter. “We’re moving the teacher from a third-person relationship, where they’re passing on someone else’s knowledge, to a first-person relationship, where they’re figuring things out for themselves,” Bartels said.

How does this play out in the classroom? When faced with a question they don’t know the answer to, instead of bluffing their way through it, or dismissing the question, teachers trained at the Exploratorium will respond with, “That’s a fantastic question. How would we figure out the answer?” They might even go off script for two or three days to explore ways in which they might do so.

“That’s a remarkable teaching moment,” he added. “It’s those kinds of rich educational experiences that students never really forget.”

#### Aiding standardized learning

Of course, public education is assessment-based. Stringent standards have been established as to what is to be taught and when; whether or not teachers and schools are adhering to these standards is determined by how well students perform on tests. Teachers, therefore, cannot give themselves over entirely to a discovery-based approach. The museums and their outreach coordinators recognize this and have accounted for it in their various programs.

The Amgen Center for Science Learning at the California Science Center also serves as the Los Angeles County GEMS (Great Exploration in Math and Science) Center, offering workshops and activity-based learning materials to schools and other educators throughout the community. The materials are designed to motivate and engage children through experimentation and direct experience, but always with an eye toward the standards associated with the particular grade.

For example, in the primary grades, the physical science standards are related to states of matter: solids, liquids and gases.

The center offers two GEMS guides that help support those concepts. The first of these, “Liquid Explorations,” looks at the properties of liquids (plain water, bubbly water and saltwater). Here, children observe what happens when a drop of food coloring is placed in each of these, and, later, are asked to classify and sort liquid samples according to their characteristics.

All of these activities support the California State Science Standards, said Anna Gaiter, director of professional development at the California Science Center. At the same time, they are designed to educate children by involving them in the discovery process. Thus, they encourage them to ask questions, to want to know more – a trait that, hopefully, will stay with them always.

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