EXHIBITS AND LEARNING IN THE SCIENCE CENTER: ANOTHER VIEW

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In "Invention, Revelation, and Learning in the Science Center," reprinted in the Sept.-Oct. Informal Science Review, Bradburne and Wake[1] address perhaps the most basic question for science centers: "What kind of exhibits we are building, and what effects they are having on visitors?" They identify two kinds of current exhibits, which they label "invention" and "revelation," and find that each has shortcomings in terms of its effects. To develop more effective exhibits, they propose a combination of the two approaches, and yet their new approach presents its own problems. I suggest here a different solution, one which depends primarily on setting more appropriate learning goals for exhibits--goals that derive from the primary experience at the exhibit.

How and What: Two Dimensions of Exhibits

Bradburne and Wake see the revelation and invention exhibits as representing "two opposing philosophies about how people learn about science." Revelation exhibits *present* science as a finished product; invention exhibits encourage people to *explore* and have their own experiences and ideas.

This appears to be another example of the division identified some sixty years ago by John Dewey: "The history of educational theory is marked by opposition between the idea that education is development from within and that it is formation from without."[2] The invention exhibits would belong mostly to the "within" school and the revelation exhibits to the "without."

It helps the discussion, however, to note that the two kinds of exhibit differ not only in *how* they expect people to learn, but also in *what* they expect them to learn. The "what" of revelation exhibits is mostly the *knowledge* of science; the "what" of invention exhibits is more the *process* of science. These two dimensions of exhibits are shown in the following table.[3]

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		WHAT people learn	
		Knowledge	**Process**
HOW people learn	from **Within**		INVENTION
	from **Without**	REVELATION	

Bradburne and Wake criticize the invention exhibits for not dealing better with knowledge and the revelation exhibits for not dealing better with process. In combination, they propose, the two would complement each other and result in a more satisfying exhibit. Since knowledge and process are not in opposition, but are two parts of the greater whole of science, this seems like a reasonable proposal.

Combining the two kinds of exhibit, however, also means combining the two different "hows" of learning, and this poses a problem. These, indeed, may be opposing positions, as identified by Dewey, and be incompatible within the same exhibit. The result of combining "revelation" and "invention" approaches could be to negate, rather than reinforce, one another with an effect exactly opposite of that intended. In fact, this often seems to be the case. A self-motivated exploration can be ruined by a didactic label that does not relate to the visitor's experience; and an informative label can actually discourage people from doing any exploration of their own.

Revelation: Oppenheimer Misunderstood

Not only may revelation-type exhibits be incompatible with exploration exhibits, their existence in science centers at all may reflect a basic misunderstanding--namely, that exhibits can function as didactic teachers.

Bradburne and Wake seem to lay the "blame" for revelation exhibits on the Exploratorium. Their article begins with the statement that Frank Oppenheimer and the Exploratorium "began to explore ways of translating scientific principles into three-dimensional form," and imply that they created the original exhibits of revelation, "designed to illustrate a single, specific scientific principle to visitors ... every time, without fail." This does indeed seem to be the intent of many museums which have adopted the Exploratorium's exhibits and style, but I believe they have misinterpreted Oppenheimer and are using Exploratorium-type exhibits in a way they were not intended.

Oppenheimer wrote several excellent papers about his museum and its exhibits, and in none of them is there any mention of translating or transmitting the principles of science as a goal. Instead, he talked about phenomena and their exploration. For example:

> Many people who talk about the discovery method of teaching are really talking about arranging a lesson or an experiment so that students discover what they are supposed to discover. That is not exploration.[4]
>
> By presenting a multiplicity of examples ... the museum can build up the visitor's *intuitive familiarity* with such concepts.[5] (Emphasis added)
>
> The Exploratorium is not designed to glorify anything.... Nor do we tell people what they are supposed to get out of a particular exhibit....[6]

In addition, museum studies going back as far as 1952[7] confirm that the exhibit *alone* does not work well as a didactic teacher, and there is good reason for this. You *cannot* exhibit a principle; the best you can do is exhibit a phenomenon and then tell, through interpretive techniques, how the principle applies. The principle itself is abstract and invisible, and connecting it to the particular case at hand requires, at a minimum, reading the label and applying intellectual effort--something relatively few visitors seem inclined to do. Despite all of this, the opinion widely persists that conveying the "knowledge" of science, largely through revelation-type exhibits, is the real goal of science centers.

Oppenheimer also knew, however, that the exhibits could be used as excellent "props" for teaching. In this assisted mode, the exhibit takes on a different function--not so much an exploration as a demonstration or concrete example. In skillful hands, this does not mean didactic teaching, however, but an effective complement to the exploratory mode, without negating it.

Invention: the Source of "Physical Knowledge"

What, then, is the value of exploratory exhibits if not to directly develop the "knowledge" of science? Bradburne and Wake contend that, "All too often these open-ended exhibits consist of a play experience that does not leave the visitor with a greater understanding of science or of technology," and they criticize "enthusiasts" of this form of science learning who believe that the "process ... *alone* will enable visitors to derive the theory...."

Critics of invention exhibits ask, in other words, what is the point of exploring a phenomenon if not to learn the underlying principles. I think the answer lies in turning that question around: what is the point of learning science principles if not to understand phenomena? Without prior exploration of the phenomena, teaching principles becomes giving the answers to

questions that were never asked. So one value of the invention exhibits is that they lead to curiosity and genuine questions; in short, they can be the start of inquiry.

A second value is that through first-hand experience people develop what may be called "physical knowledge."[8] This means an intuitive feeling for the way the world works, not necessarily verbalized, that forms the *foundation* for scientific knowledge. For example: swinging develops physical knowledge of simple harmonic motion; using tools develops physical knowledge of simple machines; playing with electric trains develops physical knowledge of electric circuits.

A good invention exhibit can be distinguished from one that is "just playing" by the extent of physical knowledge that can be derived from it, and this can be judged from the degree that the elements of the experience are the same as the elements of learning. Here Bradburne and Wake inadvertently furnish a good example. They take the activity of building arch bridges (some science centers use wooden blocks on table tops, others use large styrofoam blocks on the floor) to show the shortcomings of invention exhibits, and quote from another critic that "in the bridge-building example, ... the visitor may not learn anything at all about bridges...." Quite the contrary, the arch bridge is an example of an excellent invention exhibit and shows exactly what they *can* accomplish. People building these bridges experience that tapered-shaped blocks can be put together in a certain way to form an arch, that the blocks will stay together without any glue or cement, that the arch is strong enough to walk over, etc. All of these are elements of the experience *and* also elements of learning. Even if the ideas are not consciously formed, there is nevertheless a great deal being learned about bridges and, perhaps most important, it is a kind of learning that most people would *never* otherwise have. And, at some later point, it is likely to lead to other connections, further experiences, and additional learning.

Experience-Based Learning: the Highest Goal for Museums

Bradburne and Wake's proposal is to develop science exhibitions that both "incorporate scientific fact and encourage a reasoned process of exploration" I suggest a different direction for science centers at this point.l

The key is in developing a more comprehensive picture of science education and, within that, a more modest and realistic--but absolutely essential--role for museums. This will lead us, I believe, to focus on the exhibit as the provider of *experience*, and to direct our efforts toward making that experience rich, meaningful, and memorable. In this approach, the primary goals for exhibits are piquing curiosity and developing physical knowledge. In may ways, this is going "back to the future," yet it needs to break new ground in developing ever better ways to reach these goals.

At the same time, along with this, we need to look for ways to ensure that the exhibit experience does not remain isolated but becomes part of a larger process of learning. This need not happen at the exhibit, however. It can be handled by the museum through other forms of programming, in cooperation with other institutions, such as schools, or by the visitors continuing on their own path of inquiry.

The best term I know for this overall process is "experience-based learning,"[9] and its distinguishing characteristic is to give recognition to the exhibit experience as a legitimate goal *in itself*, and not just as a means to the end of learning factual knowledge.

Museums, with their real objects and phenomena, are natural homes for experience-based learning. Extending and refining this practice, and demonstrating the joy and satisfaction inherent in this way of learning, is, I believe, the highest mission for science centers.

Footnotes

1. James D. Bradburne and Drew Ann Wake,"Invention, Revelation, and Learning in the Science Center," The Informal Science Review, Sept-Oct, 1995, 11-13
2. John Dewey, *Experience and Education* (Collier Books, New York, 1963) Originally published, 1938
3. The idea for this table developed out of discussions with George Hein
4. Frank Oppenheimer, "Exploration and Culture," Museum News, Nov-Dec, 1982, 39-45
5. Frank Oppenheimer, "The Exploratorium: A Playful Museum Combines Perception and Art in Science Education," Am. J. Phys, vol. 40, 1970
6. Ibid.
7. Lucy Nedzel, "The Motivation and Education of the General Public through Museum Experiences," Unpublished doctoral thesis, University of Chicago, 1952
8. The term "physical knowledge" comes from Constance Kamii and Rheta DeVries, *Physical Knowledge in Preschool Education: Implications of Piaget's Theory* (Prentice-Hall, Englewood Cliffs, NJ, 1978)
9. Unfortunately, much of what goes on under the name of "hands-on" science is <u>not</u> truly experience-based learning. A good presentation of what experience-based learning can be is found in Eleanor Duckworth, Jack Easley, David Hawkins, and Androula Henriques, *Science Education: A Minds-On Approach for the Elementary Years* (Lawrence Elbaum, Hillsdale, NJ, 1990)