Measuring Learning with the Knowledge Hierarchy

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The measurement of learning has challenged funders, developers and evaluators of museum exhibits for many years. We are educational institutions and yet we have difficulty demonstrating our educational effectiveness. We have tried a variety of approaches to get visitors to learn in a way that will show up on traditional achievement tests, including paying visitors (Screven, 1974), setting up structured and controlled environments (Nedzel, 1952), and using innovative technologies (Callison, 1983). Currently, a popular approach to dealing with the fact that museum learning is difficult to measure is to proclaim that learning isn't important—we really are not about learning, but about affect...although we have yet to come to a consensus about what we mean by affect.

In this paper, I am proposing a different solution. Learning is important at museum exhibits. So are enjoyment, interest, and developing positive attitudes, in addition to a whole range of other affective responses such as curiosity, feelings of comfort and empowerment, playfulness, and awe.

Ultimately, in order to determine exhibit effectiveness, we need to assess a large number of important criteria that determine the quality of an exhibit. However, this does not mean that we should neglect the measurement of learning. What we need to change is how we think of learning and how we think of assessing learning at exhibits.

This paper suggests the use of the knowledge hierarchy as a technique for measuring learning at a museum exhibit. It presents the concept and some examples. Due to space limitations, it does not give specific how-to information. That will be the focus of another paper at another time.

The knowledge hierarchy assessment technique is based on the assumption that inherent in each exhibit is an internal knowledge structure. This knowledge structure is at the intersection of the exhibit developer's, and the visitor's, organization and understanding of the topic. A knowledge hierarchy is simply a description of this range of understandings. It is not the range of knowledge visitors have about a topic, but the range of knowledge within the context of the exhibit.

For example, from the summative evaluation of an exhibition about nuclear particle physics, the following knowledge hierarchy emerged (Perry,

1993a). It is based on a careful examination of the exhibit, discussions with the exhibit developers, and in-depth interviews with visitors to the institution.

0 - The visitor may have heard of atoms, molecules, electrons, protons, and neutrons from previous exposure, but knows very little and has no interest in finding out more. Typical interview responses to the question, "What did you find out?," might include, "I don't know. I never thought about it," or "Who cares?"
1 - The visitor has heard of atoms, molecules, electrons, protons, and neutrons, and is interested in finding out more, but (for whatever reason) did not. Typical interview responses might include, "I don't know. I was trying to figure it out," or, "I didn't take the time."
2 - The visitor has a superficial understanding that atoms, molecules, electrons, protons, and neutrons are small. They can say something vague, which may or may not be correct, about these particles. They may recognize the words *quark*, *baryon*, *isotope*, and *half-life*, but can't explain what they are.
3 - The visitor has a basic understanding of the relationships between the words mentioned above. They can explain that electrons, protons, and neutrons are in atoms, and atoms combine to make molecules, and that these are the building blocks of everything around us. The visitor may be able to explain that neutrons and protons are made up of quarks. They may be able to state that there are six types of quarks.
4 - The visitor has a more sophisticated understanding of atoms, molecules, electrons, protons, and neutrons. They have an accurate, though basic, understanding of isotope and half-life, and can explain the relationship between quarks and baryons, and the different types of them.
5 - The visitor has an in-depth and sophisticated understanding of nuclear particle physics.

Another knowledge hierarchy emerged from a front-end analysis of visitors' understanding of AIDS (Perry, 1993b).

0 - no awareness of AIDS
1 - an awareness and perhaps an interest, but no information
2 - basic information about what to do, and what not to do, to protect themselves from AIDS
3 - an understanding of the whys—e.g. why a condom works
4 - an understanding about what happens at the cellular level

5 - detailed, in-depth understanding of the disease and its epidemiology.

From a formative evaluation and a summative evaluation on a stand-alone exhibit unit on the subject of mixing colored lights came the following knowledge hierarchy (Perry, 1989).

0 - no awareness or interest in where the colored lights shining on the table came from
1 - an interest, but no knowledge
2 - an explanation, but incorrect
3 - a correct explanation that the colors come from the lights hanging above the table
4 - an understanding that red, blue, and green lights combine to form white light
5 - an understanding that the red and green lights mix to make yellow, red and blue make magenta, and blue and green make cyan
6 - an understanding that when you take a primary color away from white light the two remaining primary colors mix to make a secondary color.

Once a knowledge hierarchy for a particular exhibit unit or exhibition has been established, it can be used in numerous ways. As described above, these hierarchies were used for summative, front-end, and formative evaluation, respectively. For this process, a series of carefully worded interview questions was used to determine where a particular visitor placed on a given ladder. The percentages of visitors at each level was then calculated.

In using the knowledge hierarchy for the formative evaluation about mixing colored lights, we were surprised at how few visitors could say that the colors on the table came from the colored lights shining down from above. We approached visitors and asked the first question on our list, "Where do you think the colors on the table come from?" Fully 50% did not make the connection. Responses ranged from, "I don't know. I didn't think about it," to, "They come from inside the table," or "They are reflecting off my clothes."

Our first goal in increasing the learning that occurred at this exhibit was to change the exhibit so that most visitors at least made this connection. We added labels that directed visitors to "Look up!," and a computer program that told parents to point out the lights to their children (although it wasn't necessarily the children who didn't notice the lights.) The number of visitors who did not make the connection dropped dramatically to 25%.

The next line of questioning was to determine how many visitors had a more thorough understanding of the exhibit concepts. Those visitors who

correctly made the connection between the lights and the colors on the table were asked, "Where does the white light come from?" If they answered that it was a combination of the red, green, and blue, they were asked, "Where does the yellow come from?" (There was no yellow light shining onto the table). If they correctly answered that it was a combination of the red and green, then they were asked to explain how the colored shadows were made.

The last question a visitor answered correctly determined their position on the learning hierarchy. Percentages of visitors in each category were determined, and again the data were used to change the exhibit so that visitors could achieve higher positions on the hierarchy.

The hierarchy was used repeatedly to engage in a cycle of questioning visitors, making changes to the exhibit, questioning visitors, etc. The final exhibit resulted in more visitor learning than the original prototype.

Determining learning by conducting open-ended interviews with visitors allows the visitor to tell us in their own words the many things they learned. Using a well-articulated knowledge hierarchy to guide the interview allows us to simultaneously find out the degree to which the visitor understands the main and secondary points of the exhibition. It also enables us to measure the progression of knowledge that typically occurs at a museum exhibit.

Assessing learning is an important component of determining the success of an exhibit. It should not be done at the expense of measuring the other important aspects of a successful exhibit, such as the ways visitor physically and socially interact, or the amount of enjoyment they derive. When measuring museum learning, it is essential that it be done carefully, rigorously, and in a way that is appropriate to the unique characteristics of the museum environment.

References

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