The Value of Educators “on the Floor:”
Comparing Three Modes of Presenting Science On a Sphere®

Jeff Hayward & Jolene K. Hart

Abstract
Exhibit experiences at most museums are designed to be self-guided rather than facilitated; and it’s certainly a good goal to make exhibit interpretation clear enough to be understood on one’s own. The primary rationale for not staffing exhibits is the ongoing personnel cost, but that should be weighed against the value of “on the floor” staffing in terms of visitor experience. This study at the Denver Museum of Nature & Science (DMNS) investigated three modes of presenting a Science On a Sphere exhibit: staff-presented “shows” (18-20 minutes at scheduled times, scripted, audience on benches), staff “facilitating” with individual visitor groups, and thirdly, visitors looking at the Sphere on their own, called “auto-run.” The findings of this study underscore the appeal of staffing to visitors as well as the educational benefits; however, each mode had advantages and disadvantages.

Although most exhibit experiences are self-guided, the role of personal interpretation – “on the floor” staffing – is an interesting debate. Is it better to have visitors figuring things out on their own? Does the personnel cost of staffing exhibits (whether by paid staff or volunteers who need to be coordinated, trained, and monitored by paid staff) outweigh consideration of the benefits gained? (are there benefits? what are they?) And as museums realize what educators have known for a long time – that people in their audience have a wide variety of interests and prior familiarity with a topic and may need less or more guidance in understanding concepts presented in exhibits – efforts to customize museum experiences are being pursued more consciously.¹ This article reports a systematic experiment designed to add to the discussion about personal interpretation.

The context for this experiment: Space Odyssey is a permanent exhibition that opened at the Denver Museum of Nature & Science (DMNS) in 2003 and won a Leading Edge award in 2004 from the Association of Science-Technology Centers. It is unusual in many respects. Space Odyssey gives museum visitors hands-on and minds-on ways to explore astronomy and space science; it integrates exhibits, interactives, programs, and media into a dynamic educational experience. Also, in an extraordinary example of institutional commitment, the exhibition is continuously staffed with volunteer Museum Galaxy Guides (MGGs) – some of whom are part of the museum’s large pool of volunteers, and some of whom come from Colorado’s space industry and want to engage with the public about a favorite subject of theirs. MGGs stimulate space science discovery, sharing conversation and information and performing science demonstrations that help visitors understand basic scientific principles and interpret the latest space science information.
With the support of a grant in 2010 from NASA, the National Aeronautics and Space Administration, the museum enhanced *Space Odyssey* by obtaining and incorporating a Science On a Sphere (SOS) global display system directly into the exhibit space.

As background for understanding visitor experiences with this kind of exhibit, it’s important to know that Science On a Sphere (SOS) is a dramatic media exhibit based on a sophisticated technological achievement: four coordinated digital projectors are imperceptibly mounted on the ceiling of an exhibit space, directed toward a 6’ spherical projection screen in the middle. Often, the image produced on the screen shows the Earth from space. There is a “wow factor” for visitors, not only because that realistic image of a planet seems to hang in mid-air, but also because the projection of almost-seamless digital data is often in motion! – clouds moving, hurricanes forming, the Earth spun vertically by a staff facilitator to show the poles, or data overlays of tsunamis, lights from cities at night, temperature changes over time, population density, or all the airplanes that are in the air at the same time are some of the data visualizations. Supported by NOAA (the National Oceanic and Atmospheric Administration) and NASA (National Aeronautics and Space Administration), approximately 100 sites around the world have an SOS installation (about 70 in the U.S., mostly science museums).

Some of the benefits of Science On a Sphere include learning something new about Earth processes or events, helping visitors to visualize specific events, visualizing concepts of time and scale, and being reminded that the Earth is always changing. At the same time, however, there are a variety of challenges in general for making SOS an effective visitor experience: viewing the Earth from only one side, not being prepared for a storyline or able to follow a story as datasets change quickly, the use of different graphic styles in the variety of data visualizations, and although the view of Earth is dramatic it is also familiar (perhaps like a 3D Weather Channel, for some people) so people tend to look at it rather simply (recognizing continents, questioning where’s my home?) instead of grasping global concepts. Possible barriers to learning include lack of cohesive storylines, insufficient explanations, and confusing images (e.g., “rainbow” color scales).

DMNS staff and the Museum Galaxy Guides added the SOS to the ever-changing repertoire of facilitated and unfacilitated experiences in the exhibition. The Space Odyssey team decided to use the dynamic Sphere to tackle the challenge of climate literacy education, and developed two specific programs: “See the Seas,” which is focused on Earth’s climate systems, and “A Tale of Three Planets,” which uses a comparative planetology approach to understanding more about Earth’s climate.
Rationale for evaluating DMNS’ presentation of SOS

As part of its responsibility to NASA, DMNS wanted to evaluate visitors’ understanding and experience of its two newly developed programs. Secondly—and most germane to this article—the Space Odyssey team who work on content and volunteer MGG training wanted to better understand the interactions between volunteers and visitors, particularly in terms of the different ways in which its programs are presented to visitors. So we proposed an experiment: test two different modes of how the Guides work as on-the-floor educators (as a full-on scripted “show” with the audience on benches, and as customized “facilitation” with individual visitor groups) compared with “auto-run” situations. Ultimately, the availability of an extensive and trained cadre of volunteers made it possible for the museum to offer several modes of experience with SOS, making this experiment relevant and possible.

The three modes of visitor experience are illustrated in the accompanying photos, Figures 2-4. In addition to the visual presentation of datasets on the spherical screen, there were two flat screens on adjacent walls that added explanatory graphics and text.

Figure 2: A formal presentation = “show mode”

Figure 3: Facilitated mode; more informal

Figure 4: “Auto-run mode”: visitors look at the Sphere on their own.
Previous studies of Science On a Sphere with some of these modes of presentation (“show,” “facilitated” or “auto-run”) suggest mixed results: Goldman and her colleagues found more visitor learning with facilitated SOS presentations compared to auto-run, but no differences in ratings of enjoyment; 4 RK&A found that one-third of visitors were confused about what was shown in an autoplay situation; 5 and The Lawrence Hall of Science’s Center for Research, Evaluation & Assessment, 6 studying a program about sea level rise, found no difference between facilitated and auto-run in terms of visitors’ ratings of enjoyment or in assessments of getting the main message, from samples of visitors specifically invited for the study. Interest in different modes of presentation has also been investigated in other settings, such as Perdue, Stoinski & Maple’s study of educating zoo visitors about conservation using a live presenter, a video of a presenter, or signs only, with results indicating that visitors stayed longer and learned more with a live presenter. 7 The Monterey Bay Aquarium’s interest in guide-visitor interactions was assessed by RK&A in a climate change exhibit (“Hot Pink Flamingos: Stories of Hope in a Changing Sea”). 8 Their staff and volunteers were trained to engage visitors in discussions on climate change—an unstructured facilitated experience—and found that 32% of visitor groups engaged with that topic. Such studies have addressed the issue of “on the floor” interpretation and/or different modes of experience for SOS/media programs, but rarely had the advantage of direct comparisons of different modes and outcomes of visitor experience.

Evaluation Strategy

The evaluation strategy at DMNS was developed as an experimental design, a 2 x 3 study: 2 different programs, with 3 modes of presentation. The research method was a post-experience interview with no cueing. Random samples of visitors were interviewed at a mobile cart at a distance from the Sphere (to avoid the potential bias of looking at the Sphere to answer questions), with selected visual images of or related to the program displayed on the cart. 9 It was a minimum requirement that visitors had seen at least three data sets (usually more) from one of the programs (the “See the Seas” program and “Tale of Three Planets” program were run on alternate weeks), in one mode of presentation (which were operated on separate days).

The sample consisted of at least 50 visitor groups in each of the six cells of the experimental design, yielding a total sample of 378 visitor groups. The composition of the visitor groups paralleled the museum’s normal profile of visitor characteristics (i.e., in terms of first-time vs. repeat visitors, the proportion of family vs. adult visitor groups, local vs. out-of-area visitors, etc.). 10

Although two programs were evaluated, both presenting information regarding climate change, for brevity sake this discussion focuses primarily on the evaluation of one of the programs, “See the Seas.” That program uses eight data sets linked together in a sequence to offer a logical presentation about Earth science (seafloor spreading, continental drift, ocean currents, sea surface temperature, ocean biomass, and acidification) to show that Earth is continually changing and that understanding the ocean is important in understanding the planet.
Findings

Visitors’ experiences were different in the three modes of presentation (shows, facilitated interactions, auto-run). To understand the different patterns, we have grouped the results into three types of outcomes: affective experience, grasp of interpretive messages, and understanding data visualizations. But first, there is an important piece of context that influences the results: in the “show” mode (the 18-20 minute presentation to visitors seated on benches, with the presenter occasionally engaging the audience with basic questions such as what percent of the planet is covered in water?), visitors see more visual data sets and get more explanations. Their experience of the Sphere is longer, and they see an entire program of data sets created or assembled on that particular theme, from “beginning” to “end.” In the “facilitated” mode, visitors may or may not see any specific data set and they may or may not begin with the “first” data set of each program (because the visitor group might be drawn to the Sphere while an educator is showing any other data set to another group, for example). In the “auto-run” mode, visitors might arrive at the Sphere at any point in the sequence of data sets in a program (in this experiment, “auto-run” used the same sequence of data sets as in the show, but with no presenter), and visitors don’t tend to stay for the whole program (visitors’ estimates of the number of different topics/images they saw were 7.2 in show mode, 4.7 in facilitator mode, and 5.5 in auto-run mode). This difference in exposure to the number of data sets and coherence of the material displayed on the sphere makes the “show” mode substantively different from the other two modes.

Affective experience: Visitors definitely liked the personal attention and interaction that they got from the “on the floor” educator-facilitators, 79% giving high ratings to the “Facilitator” mode for this program. The “Show” mode was also appreciated although not quite as appealing, but it received more high ratings than the “Auto-run” mode did (66% vs. 57%). Probably like other situations where there are volunteer docents, reactions to individual presenters may vary, but at 79% high ratings it is undeniable that personal interpretation to small groups of visitors makes for a very satisfying experience.
Grasp of interpretive messages: Do visitors understand something better by seeing the 3-D visualization of Earth on this Sphere? Yes, definitely, in all three modes, but the messages were different.

<table>
<thead>
<tr>
<th>Auto</th>
<th>Facilitated</th>
<th>Show</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>17%</td>
<td>36%</td>
<td>30%</td>
<td>continental drift, plate tectonics</td>
</tr>
<tr>
<td>17%</td>
<td>15%</td>
<td>19%</td>
<td>ocean temperatures and currents, how climate is affected</td>
</tr>
<tr>
<td>14%</td>
<td>3%</td>
<td>9%</td>
<td>what’s underneath the ocean, draining the ocean</td>
</tr>
<tr>
<td>3%</td>
<td>3%</td>
<td>19%</td>
<td>seafloor spread, Mid-Atlantic ridge</td>
</tr>
<tr>
<td>7%</td>
<td>6%</td>
<td>2%</td>
<td>how the Earth works, global connections</td>
</tr>
<tr>
<td>…</td>
<td>…</td>
<td>…</td>
<td>(more categories, smaller percentages)</td>
</tr>
<tr>
<td>85%</td>
<td>88%</td>
<td>85%</td>
<td>TOTAL</td>
</tr>
</tbody>
</table>
One way of investigating visitors’ grasp of messages is to ask whether they “understand something better” having seen this Sphere, or not, and if so to give a specific example of what they understand better. A huge proportion of visitors, 85%, said they did understand something better. Asked for an example, the top five content categories from the “See The Seas” program are shown in Table 1 (these were coded from visitors’ own words answering an open-ended question).

Because this was an open-ended question, the results only show people’s top-of-mind answers (usually one answer per person). But clearly, the presence of an educator helped visitors understand plate tectonics more often than they did on their own (36% and 30% vs. 17% who perceived this message in the Auto-run mode), and educators presenting a “Show” were effective in helping visitors to understand the process of seafloor spreading that emanates from the Mid-Atlantic ridge (19% vs. 3% and 3%), shown in Figure 6 (image ‘B’ in the interview materials).

A “test question” was developed specifically to investigate visitors’ awareness of global relationships, which is a primary purpose and capability of Science On a Sphere. For the Earth-focused “See the Seas” program the test question was: “Can you give an example of how ocean currents affect climate on parts of the globe?” The results indicate that the educator-conducted “Show” was quite effective in communicating such global relationships, as indicated in Table 2.

Many visitors made a reasonable attempt at thinking of relationships, although some responded with an answer from their prior knowledge, such as El Nino which was not presented in any of these data sets.

<table>
<thead>
<tr>
<th>Auto Facilitated</th>
<th>Show</th>
<th>the Gulf Stream keeps Europe warmer</th>
</tr>
</thead>
<tbody>
<tr>
<td>7%</td>
<td>16%</td>
<td>45%</td>
</tr>
<tr>
<td>27%</td>
<td>7%</td>
<td>25%</td>
</tr>
<tr>
<td>21%</td>
<td>6%</td>
<td>0%</td>
</tr>
<tr>
<td>…</td>
<td>…</td>
<td>(other categories of answers)</td>
</tr>
<tr>
<td>71%</td>
<td>69%</td>
<td>96%</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>TOTAL</td>
</tr>
</tbody>
</table>

Data visualizations: Museum visitors seeing 3-D visualizations projected onto Science On a Sphere tend to recognize the familiar image–Earth–which is animated with a novel variety of
content. However, their powers of interpreting the images as data seem to be relatively limited: they can recognize continents, and to some extent they can attach their awareness of plate tectonics to the planet, and they can make guesses about temperature maps depending on the color scales, but otherwise they are quite dependent on either written labels or a presenter’s explanation. Researchers have been experimenting with color scales, labels and legends to understand more about how styles of visualizations are perceived by visitors.

Seeking a measure of familiarity with Earth-science content, image ‘H’ (Figure 7) was not seen on the Sphere by any of the visitors interviewed, but 74% of them recognized that it was about tectonic plates (indicated by yellow and red dots at plate boundaries). This extent of familiarity is helpful in being generally oriented to the meaning of data visualizations being presented relatively rapidly on the sphere, but with 26% of the visitors not understanding it (10% thought it showed underwater mountains or ridges, 5% thought it illustrated ocean depth, etc.), how would we expect people to understand more than their initial (often general) guesses? This is the role of an “on the floor” educator.

Several other visualizations of data were investigated. In the two images shown in Figures 8 and 9 (E & D), neither of which had written labels, visitors interviewed after their SOS experience were pretty good at recognizing the familiar. In ‘E’ the continents are shown askew from their current positions, leading many people (70%) to say this visualization was about continental drift /Pangaea, but some people primarily paid attention to the different color shadings of the ocean and said this image was about water depth or topography (18%). With image ‘D’ the subject of nutrients in the ocean was not as familiar to most visitors, and the color shading seemed to be distracting (colors on the land as well as on the water, and perhaps people’s attention was drawn to the darker and lighter blue on most of the water whereas the green, yellow and red edges of the continents were a mystery), which is probably why only 29% of the people who had seen this image on the Sphere just minutes earlier were able to correctly identify it as a plot of chlorophyll or nutrients, and almost all of those people had experienced the Sphere with a staff presenter (the other intuitive guesses that people made were that this visualization was about ocean depth, 33%, or temperature, 21%).
Like many examples of visitor experience, the findings from this experiment are not simply “good” or “bad.” Rather, the summative evaluation provided a great deal of information that is interesting to and useful for museum staff and volunteers. They said it was great to see that “See the Seas” and “A Tale of Three Planets” were highly rated by visitors and had broad appeal, but even more important were nuances and details that are now being incorporated into current DMNS practices:

- People who sit down with an audience to watch a show stay longer, so they see more datasets and get more-complete content.
- Visitors better grasp intended messages and better understand what they are seeing when content is presented in a planned, coherent way.
- Audience participation makes show content more memorable.
- Shows attract more families with children because they seem more lively and engaging.
- Adults tend to avoid shows because they think they are “just for kids” or to leave seating for families.
- 18 to 20 minutes is a long time commitment; many people prefer to explore on their own.
- People appreciate the opportunity for personal interaction with staff and volunteer MGGs, which can address visitors’ prior knowledge and interests.
- Visitor-directed facilitation does not lend itself to visitors’ getting all of the intended messages—though it does increase visitor engagement.
• Auto-run programming works best for people with special knowledge or background in the subjects presented.
• Auto-run is less engaging and accessible for people without such knowledge and background.
• Visitors without prior knowledge and background are less likely to get the point in auto-run mode.
• People are pretty good at using legends or labels to help them understand visualizations if the unit of measurement is familiar (e.g., temperature, depth) but not so good with unfamiliar units (e.g., wave amplitude) or with representations of anomalies/degrees of change or other such scientific methods of conveying data.
• It’s important to be aware of visitors’ likely meanings attached to colors, such as red for heat, so that visualizations do not mislead.
• Visualizations based on an Earth globe, with its oceans and continents, feel familiar to visitors and are better understood.

And although the Space Odyssey exhibition at DMNS is one of the strongest examples of institution support for “on the floor” interpretation, many of these points could have potential relevance to other museums and science centers with more limited opportunities for extensive personal interpretation.

Conclusion
Since it is commonly believed that people are more engaged with informal educational experiences if they are enjoying themselves, it is not a small point that visitors like interacting with an “on the floor” educator or education volunteer at this unusual media exhibit. Indeed, ~80% high ratings for the “Facilitated” mode are about as good as it gets in terms of visitors’ ratings. Visitors even stayed engaged with a relatively long “Show” presentation and rated that experience well (66% high ratings) even though they were not told when it started that it would be an 18-20 minute commitment (they could have left mid-show). Obviously, Science On a Sphere is a novel and engaging experience on its own (57% high ratings even in Auto-run mode), but interpretation by educators adds value for visitors.

DMNS is not alone in investigating and using “on the floor” staffing for Science On a Sphere: the Science Museum of Minnesota conducted numerous studies of visitors in the space dedicated to SOS then changed from an installation that was frequently on “auto run” mode to now emphasize a staff-facilitated experience in Planet Earth Decision Theater – essentially using staff to better engage visitors and communicate key messages about climate change.14

Ultimately, a museum’s decision about whether, where, and when to make a commitment to personal interpretation with “on the floor” staffing will depend on several factors, including availability and cost of staffing and volunteers, the use of new media to present complex topics, and visitors’ interests. Adding to those factors are the findings from this study and others like it, that there are benefits to visitor experiences in terms of affective experience and enhanced learning. Especially for unfamiliar and integrative subjects (e.g., global understanding, concepts beyond basic facts), explanation by an educator—in this case anyway—is more effective than people trying to figure out the subject on their own.
About the authors

Jeff Hayward is Director of People, Places & Design Research in Northampton Massachusetts; Jolene Hart is Senior Research Analyst with the firm. They have conducted over 650 studies of audiences for 180 cultural or interpretive organizations, including visitor analysis, exhibit or program evaluations, and visitor experience studies. They are especially interested in visitor studies involving environmental science or social justice.

These benefits were summarized in an evaluation of almost 20 SOS installations by Kate Haley Goldman, Cheryl Kessler and Elizabeth Danter, “Science On a Sphere: Cross-site Summative Evaluation,” (Unpublished research report, Institute for Learning Innovation, 2010).


Kate Haley Goldman et al., 2010.


Center for Research, Evaluation & Assessment. “Ocean Science Center Remedial Evaluation for Aquarium of the Pacific” (Unpublished manuscript, Lawrence Hall of Science at the University of California, Berkeley, 2011).


Sampling of visitors was somewhat different depending on the mode of presentation. For “facilitated” and “auto-run” modes, interviewers observed the Sphere from a distance and when a visitor group had watched the Sphere as three or more datasets were shown, that visitor group was approached and asked for an interview to help plan future shows; they were offered free tickets to the adjacent planetarium show. For the “show” mode, since all visitors would be done at once, interviewers distributed paper card invitations (one per visitor group) that visitors could turn in at the cart for free planetarium tickets; this system allowed visitors to wander in the exhibit until they could see that the cart was available, instead of having to wait in line to be interviewed.


“Special knowledge” was self-defined by visitors based on this question: Do you have any special knowledge or background in planetary or earth science? Types of answers included college classes, graduate work, or job related (there is a substantial presence of the aeronautical industry in the Denver area, who are attracted to the Space Odyssey exhibition).

This technique of assessing self-reported understanding with a broad open-ended question followed by asking for a specific example has been a reliable indicator of measuring learning in an individual unstructured way, as documented by Jeff Hayward, “Is Self-reported Learning Reliable?” Informal Learning Review, 122: September-October (2013): 12-15.

See, for example: C. A. Brewer, “Color Use Guidelines for Mapping and Visualization.” In Visualization in Modern Cartography, ed. Alan M. MacEachren and Fraser Taylor (Tarrytown

14 Tranby and colleagues analyzed the transition to a facilitated and interactive “Decision Theater” using iClickers, as reported in Zdanna Tranby, Alice Anderson, and Joseph Schantz, “Planet Earth Decision Theater: Summative Evaluation” (Unpublished research report, Science Museum of Minnesota, 2014).