Science On a Sphere®
Ocean-Atmosphere Literacy Partnership
Summative Evaluation

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Understanding, fostering, and promoting lifelong learning

About the Institute for Learning Innovation:

Established in 1986 as an independent non-governmental not-for-profit learning research and development organization, the Institute for Learning Innovation is dedicated to changing the world of education and learning by understanding, facilitating, advocating and communicating about free-choice learning across the life span. The Institute provides leadership in this area by collaborating with a variety of free-choice learning institutions such as museums, other cultural institutions, public television stations, libraries, community-based organizations such as scouts, the YWCA, hospitals, scientific societies and humanities councils, as well as schools and universities. These collaborations strive to advance understanding, facilitate and improve the learning potential of these organizations by incorporating free-choice learning principles in their work.

Executive Summary

In 2008, the Ocean-Atmosphere Literacy Partnership was formed. Funded through a NOAA Environmental Literacy grant, the Partnership comprises the American Museum of Natural History (AMNH), the Maryland Science Center (MSC), and the Science Museum of Minnesota (SMM). The Institute for Learning Innovation (ILI) was contracted by the Partnership to conduct a summative evaluation of their four, newly-created Science On a Sphere® (Sphere) programs: (1) an 8-minute auto-run program developed by the AMNH focused on historical understanding and prediction of tropical cyclones, (2) an 8-minute auto-run program created by SMM focused on the discovery through present-day modeling of ocean currents' effects on climate, and (3) two facilitated 15-minute programs with accompanying scripts developed by MSC on tropical cyclones and ocean-climate thermodynamic connections. All programs used innovative spherical display techniques to supplement use of data sets and computer model-generated graphics.

Five overarching questions guided the evaluation of these four programs:

1. Did the visitors enjoy the program?
2. Did visitors recognize the intended message of the program?
3. What science literacy concepts did visitors learn?
4. Which visual images were most useful in conveying science concepts and the message?
5. How did the visitors react to the presentation style?

Data collection occurred over 6 days during July and August 2010 at the Maryland Science Center, where all four programs were implemented. Methods included semi-structured interviews and written questionnaires. In total, 343 visitors participated in the study. Nearly all of the respondents were United States residents with almost half residing in Maryland. The large majority of participants had a very high interest in science, and more than two thirds had college degrees or higher levels of education. For most, this was the first program they had viewed on a Sphere.

Findings Across Programs

Most visitors reported enjoying all four programs, were able to identify the main messages of the programs, and stated that they learned scientific concepts that built on their existing knowledge. Respondents commented on the usefulness of the color-enhanced images for explaining concepts such as temperature-driven ocean currents and air flow, especially those images that depicted warmer water or air as red and cooler water or air as blue. The most common suggestions for program improvement were to consider tailoring the program to a younger audience, ensure that all elements of the programs can be seen by all members of the audience, include additional audience participation, and possibly extend the length of the auto-run programs to accommodate additional content.

Tropical Cyclone Facilitated Program

Visitors clearly felt they enhanced their understanding of tropical cyclones from this program – what conditions are necessary for tropical cyclones to form, where they form, and what they are named in different regions of the globe. Most visitors knew that warm water was an essential component of tropical cyclone formation, but many visitors were challenged to provide complete details on all the components that need to be present.

As far as learning about the impact of tropical cyclones on people, half of the respondents mentioned devastating effects, but it was not clear that this was a new concept for visitors. In fact, nearly half of the respondents said they did not learn anything new about the impacts of tropical cyclones on people. A few people recommended making the visual images more exciting by using animated images rather than

still photos or making the visuals more dynamic. Some suggested using videos of real storms and including the storms' sounds.

Ocean-Climate Facilitated Program
The large majority of respondents said they learned something new from the ocean-climate facilitated program. For many, the concept that the ocean currents affect Earth's climate was a revelation. Nearly as many reported learning that salt and cold water are more dense than fresh and warm water. Many people reportedly learned about the deep ocean currents that are connected to the warmer surface currents and that these currents are circulating in predictable pathways around the Earth.

Reactions to Both Facilitated Programs
The main concern voiced by respondents not sitting directly in front of the presenter was that they could not see the images on the globe that were being pointed out. To improve visibility, the seating might need to be more closely aligned with the center point of the presentation. Another strategy the presenter could adopt is an instructional style that is "on the move," traveling around the Sphere to point out the images on the globe and ensure that all visitors are able to see what is being discussed.

Tropical Cyclone Auto-Run Program
Nearly half of the respondents reported learning more about tropical cyclones and how our understanding of them has changed over time or how models are used to accurate predict tropical cyclones, concepts targeted by the program creators. Over a third of respondents reported learning that tropical cyclones have different names in different regions around the globe. When asked specifically about the use of computer models for understanding and predicting tropical cyclones, almost all of the interviewees were able to describe how the computer models are used to predict tropical cyclones and how the development of modern technology has improved the accuracy of those predictions.

When asked about the visual images, the cutaway image showing how tropical cyclones form was by far the most often mentioned. In addition, visitors found useful the Huracan ancient god image, the satellite images, and the image that compared satellite to predictive model data. Several people made recommendations for the inclusion of additional types of graphics such as photographs or movies of tropical cyclones in action and images of the equipment used to track and study storms.

Ocean-Climate Auto-Run Program
The large majority of respondents reported an increase in their understanding of ocean-climate interactions. Ben Franklin was the star of the show with nearly a third of respondents reporting that they did not know that he had discovered the Gulf Stream. Many people learned that ocean currents affect the climate and reported the example of how Calgary and London have very different climates despite being at the same latitude.

Overall
Data from this study suggest that the four programs created by the SOS Ocean-Atmosphere Literacy Partnership were not only enjoyed by visitors, but were successful in conveying intended messages and content. These innovative program formats show great promise as models for future Sphere presentations.

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Introduction

The Science On a Sphere® Ocean-Atmosphere Literacy Partnership, funded through a NOAA Environmental Literacy Grant and composed of the American Museum of Natural History, the Maryland Science Center, and the Science Museum of Minnesota (Partners), formed in 2008 to create new educational media for spherical display systems. The American Museum of Natural History (AMNH) created an 8-minute auto-run program on our historical understanding and prediction of tropical cyclones, and the Science Museum of Minnesota (SMM) created an 8-minute auto-run program on the discovery through present-day modeling of ocean currents' effects on climate. The Maryland Science Center used NOAA data and model outputs to create two facilitated 15-minute programs with accompanying scripts on tropical cyclones and ocean-climate thermodynamic connections.

The auto-run programs incorporated relatively new spherical display techniques such as overlaid images (e.g., ocean current arrows), three dimensional renderings (e.g., cut-away diagram of tropical cyclone), the use of historical story-telling (e.g., how computer modeling has changed our understanding of cyclones over time), and the inclusion of a historical character to convey a message (e.g., Ben Franklin). These images supplemented traditionally-used data sets, such as satellite imagery.

Because each of the four programs was unique in design, the evaluation considered each program independently. Instruments were developed to address the unique attributes of each program based on five overarching questions:

1. Did the visitors enjoy the program?
2. Did visitors recognize the intended message of the program?
3. What science literacy concepts did visitors learn?
4. Which visual images were most useful in conveying science concepts and the message?
5. How did the visitors react to the presentation style?

Methods

Instruments

The evaluation employed a parallel mixed methods strategy to assess the outcomes. An interview guide and a written questionnaire were developed for each of the four programs guided by the priority questions provided by the Partners and using pre-validated scales and items developed by ILI for past studies (Appendix A). The interview guides consisted of several open-ended questions about the programs' messages and what the visitors had learned. The single closed-ended question in the interview assessed overall satisfaction. The written questionnaire, in contrast, consisted mainly of closed-ended questions regarding learning and satisfaction with a few short, open-ended questions. The questionnaires and interview guides had identical demographic questions at the end.

The interviews and questionnaires were pilot-tested in June 2010. From that experience, we learned several things:

- Visitors needed mini flashlights to see the questionnaires in the darkened sphere area.
- The questionnaires and interviews were too long. They were reduced in length after review and prioritization by the Partners.
- Observing the audience during the Sphere presentation was not informative; a draft observation rubric was abandoned.
- The seating for the facilitated programs needed to be as compact as possible; the seats were moved to be as close to the center as possible.

- People quickly left the area immediately after the program ended and were difficult to intercept. For the final collection, the visitors were approached before the program to get a commitment for them to stay afterward for the interview or questionnaire.

Data Collection Schedule

The auto-run programs each were about eight minutes in length. The facilitated programs were about 15 minutes in length.

Typically, the auto-run programs were shown according to a predetermined schedule on the operating computer. Visitors encounter the show at different points in the program. Although this was the "natural" use of the auto-run programs at MSC, we were interested in the impact of the entire show on the visitors. To maximize the number of visitors who saw the programs from start to finish, the MSC scheduled showings of the auto-run programs and advertised them in the same manner as the facilitated shows.

To maximize the number of opportunities to collect data from program participants who watched the complete auto-run or facilitated program, the MSC scheduled programs every half hour and posted the schedule for the visitors at the entrance door and on small announcement sheets at the front desk. The desk staff was asked to mention the special Sphere programs to visitors when they purchased their tickets. Education staff on the floor was asked to prompt visitors to consider going to a Sphere program as part of their visit. A large sign was posted on an easel at the entrance to the Sphere area, so visitors on their way to SpaceLink or the planetarium could see it. The passersby were also told about the program if they stopped in the area. A center-wide announcement was made about 5 minutes before each program started. For the last four of six data collection days, MSC offered a raffle chance for a 3-month membership to visitors who were interviewed or completed written questionnaires.

Data were collected at the Maryland Science Center for six days during July and August with a full ILI-MSC team (typically 4 interviewers and 1 questionnaire manager present for each show), and two additional days (one MSC person) in September.

Analysis

Quantitative Data

On the questionnaires, two items measured self-reported pre-to-post change in knowledge. A paired samples t test was used to determine if there was a statistically significant different in visitors' pre-post program knowledge. Another item asked for visitors' overall impression of the program (questionnaire and interview). The mean was calculated to show the data's central tendency. Visitors were also asked a series of Likert-type, capped (labeled) items related to their experience (e.g., enjoyment of program, personal meaning of program, etc.). The central tendencies of those data were reported as medians. No statistical tests were performed to compare the four programs.

Qualitative Data

The majority of the data collected was qualitative, e.g., oral or written responses to open-ended questions. These data were analyzed through coding of emerging themes and generating frequencies. A sample quote was pulled out to illustrate a typical response for each theme.

Audience and Sample

We collected data almost exclusively from adults (95% adults, 5% minors under 18) (Table 2). The minors were included in the data collection when their parent deferred to them to answer the questions. The overall audience attending the Sphere presentations from which this sample was taken was 61% adults and 39% children under 18 which nearly matches a typical weekend visitor composition of 66% adults and 34% children.[1]

Visitor attendance at the Sphere programs varied greatly. Mornings shows were usually better-attended than afternoon shows, however, there was never a guaranteed pattern to attendance.

Given that scheduled programs were being evaluated, we were unable to use the traditional visitor intercept random selection process such as approaching every fifth visitor who crosses an imagined line. Instead, we used an opportunistic convenience sample, approaching the adult visitors as they sat down for the program. The visitors were asked to either remain after the program for a 5-minute interview, or to complete the two-sided paper questionnaire.

In the end, data were collected from 76-96 visitors per each of the 4 programs (N=343) (Table 1).

Table 1: Interview and questionnaire sample by program

	Climate Facilitated		Cyclone Facilitated		Climate Autorun		Cyclone Autorun		Totals
Date in 2010	**Inter**	**Quest**	**Inter**	**Quest**	**Inter**	**Quest**	**Inter**	**Quest**	
Thursday, July 15	7	4	5	8	6	2	3	0	35
Saturday, July 17	12	10	6	8	8	0	4	5	53
Thursday, August 12	8	8	8	7	6	3	5	7	52
Friday, August 13	11	9	10	23	8	4	9	11	85
Saturday, August 14	8	16	13	8	4	0	3	3	55
Sunday, August 15	n/a	n/a	n/a	n/a	15	1	19	7	42
Monday, Sept 6	n/a	n/a	n/a	n/a	n/a	17	n/a	n/a	17
Thursday, Sept 9	n/a	n/a	n/a	n/a	n/a	4	n/a	n/a	4
Totals	**46**	**47**	**42**	**54**	**47**	**31**	**43**	**33**	
Totals per Program	**93**		**96**		**78**		**76**		**343**

More than half of the respondents were in the 30-49 age range (n=178, 54%) (Table 1)

Table 2: Respondents' age ranges

Age in Years N=330	Frequency n	Percent %
80-89	1	0
70-79	8	2
60-69	43	13
50-59	38	12
40-49	107	32
30-39	71	22
18-29	46	14
17 and under	16	5

[1] Average number of adults and children (ages 3-12) over 3 weekends in September 2010.

Nearly all of the respondents who provided their home location were United States citizens (Table 3). Almost half of the respondents lived in Maryland (n=137, 48%). Most of the other respondents were from nearby east coast states from NY south to VA (n=126, 44%). A handful of visitors were from other countries such as England (n=2), Denmark (n=1), France (n=1), Germany (n=1), and Qatar (n=1).

Table 3: Respondents' state of residence

State N=287	Frequency n	Percent %
Maryland	137	48
Pennsylvania	56	20
Virginia	32	11
New Jersey	18	6
New York	14	5
Delaware	6	2
Michigan	3	1
North Carolina	3	1
Ohio	3	1
South Carolina	3	1
Texas	3	1
Illinois	2	1
Tennessee	2	1
California	1	<1
Florida	1	<1
Georgia	1	<1
Idaho	1	<1
North Dakota	1	<1

There were more women than men in the sample (Table 4).

Table 4: Respondents' gender

Gender N=329	Frequency n	Percent %
Male	140	43
Female	189	57

The respondents scored very high on their interest in science with nearly three-quarters rating themselves as either a 4 or 5 on a 5-point scale, where 1 equaled not at all interested and 5 equaled extremely interested (n=251, 78%) (Table 5).

Table 5: Respondents' interest in science

Science Interest N=324	Frequency n	Percent %
Not at all interested	0	0
2	12	4
3	61	19
4	116	36
Extremely interested	135	42

More than two thirds of the visitors in the sample had college degrees or higher (n=224, 68%), with about a third of the respondents having master's or doctorate degrees (n=110, 34%) (Table 7).

Table 6: Respondents' level of education

Highest Education N=328	Frequency n	Percent %
Some elementary school	5	2
Some secondary school	11	3
High school graduate	22	7
Some college	46	14
Associate's degree	17	5
College degree	96	29
Some graduate school	18	5
Master's degree	84	26
Doctorate	26	8
Other	3	1

A large majority of respondents were viewing the sphere for the first time (Table 7).

Table 7: Respondents' prior experience with Sphere

Sphere Times N=325	Frequency n	Percent %
First time	272	84
Second time	32	10
3 or more times	21	6

Findings

Tropical Cyclone Facilitated Program

Satisfaction

Visitors who completed questionnaires were generally very positive about the tropical cyclone facilitated program. They agreed moderately that they enjoyed the program and agreed strongly that it was easy to understand (medians=5 and 6 respectively on a 6-point agreement scale, N=50).

The average rating by visitors who watched the facilitated programs on tropical cyclones was 7.98 (SD=1.39) on a 10 point scale where 10 represents the highest rating (N=86). Fifteen participants rated the program at the highest level. When the 71 visitors who rated the program as less than a 10 were asked, "What would make the program a 10?," they gave a variety of recommendations (13 did not respond). Making sure everyone can see the presentation was most frequently mentioned (n=10, 17%) (Table 8).

Table 8: Recommended improvements to tropical cyclone facilitated program

(N=58) Response	Frequency n	Percent %	Example Quote
Make sure everyone can see everything	10	17	“Couldn't see images well from where I sat.”
Suggested additional content	8	14	“I'd really be interested in knowing effects of global warming.”
Make it more exciting	8	14	“A little more animation instead of stills.”
More audience interaction	8	14	“More interactive--it's like sitting and listening to a lecture and tuning out.”
Make it child-appropriate	6	10	"Above the grade level of most kids that were here. When I do my lectures, I make sure I am talking to ages that would be there.”
Different types of graphics	6	10	“If possible, closer views of individual storms, or more focus on one storm, e.g. Katrina, any pictures of storm surges or diagrams. Also, comparisons with other parts of the world, e.g. population, damage.”
Reduce the noise in the area	3	5	"Get rid of background noise"
Better quality graphics	2	4	“Better video--video quality looks like something you could see at home on Google Earth”
Other: unique responses	3	5	
I don’t know	4	7	

Learning

Visitors who completed a questionnaire reported a higher degree of knowledge of tropical cyclones after the facilitated presentations than before. The mean increased just over 2 points on a 10-point scale (Table 9).

Table 9: Pre to post change in self-reported knowledge for tropical cyclone facilitated program

Scale: Nothing = 1, A great deal = 10	Pre Mean (standard deviation)	Post Mean (standard deviation)	Paired Sample T-test Significance
How much did/do you know about tropical cyclones? (N=53)	5.62 (2.30)	7.83 (1.77)	p=.000

When asked to rate how much they agreed with several learning statements, the median questionnaire response was that they “agreed strongly” that they learned something new and “agreed moderately” that they learned how tropical cyclones form. The visitors agreed, but not as strongly, that the program was personally meaningful (Table 10).

Table 10: Learning statements for tropical cyclone facilitated program

1=disagree strongly, 2=disagree moderately, 3=disagree, 4=agree, 5=agree moderately, 6=agree strongly	Tropical Cyclones Median N=54
Learned something new	Agree strongly
Learned how tropical cyclones form	Agree moderately
Parts of program were personally meaningful	Agree

When asked to complete this sentence, "I never knew that …," 83% of the respondents (combined interview and questionnaire) gave an example of a concept that was new to them. The most frequently mentioned concepts were the areas where tropical cyclones form and the variety of names for a tropical cyclone (Table 11).

Table 11: New concepts learned from tropical cyclone facilitated program

N=80	Frequency n	Percent %	Example quote
Where tropical cyclones originate	19	24	"That the tropical storms in the gulf are caused by storms in Africa, then they get pushed to the Atlantic ocean, it travels that way."
The different names for tropical cyclone	18	23	"Hurricanes, cyclones, typhoons are all same type of storm. Rotated different directions in the southern hemisphere."
Warm water is necessary for tropical cyclone formation	6	8	"Hurricanes need warm water to form."
The direction cyclones travel	5	6	"Weather moved east to west near the equator."
How many tropical cyclones have occurred	5	6	"Over 50 years the globe encountered so many tropical cyclones."
The direction that cyclones spin	5	6	"That hurricanes spin different direction based on where they are on the earth"
2005 was a record year	4	5	"2005 was the most active hurricane season on record."
Nothing new	4	5	"I pretty much knew everything."
Other responses below:	15	18	
The Sphere exists (3), How tropical cyclones form, Seasons that tropical cyclones form (3), Seasons that tropical cyclones form (3), Seasons that tropical cyclones form (2), They occur all over the world (2), The more circular-shaped storms are stronger (1), Monsoons are not cyclones (1), How satellites show cyclones (1), Wind directs cyclone movement (1)			

When asked, "Can you describe the conditions that must be present for a tropical cyclone to form?," the majority of respondents mentioned warm water as a necessary condition for tropical cyclone formation (n=73, 84%), however about half of those people only mentioned warm water and no other conditions (n=37, 43%). The remainder of the "warm water" respondents mentioned a variety of combinations of air temperature, wind/storms, air moisture, and Earth's rotation as conditions for tropical cyclones (Table 12).

Table 12: How tropical cyclones form responses for facilitated program

(N=86) Response	Frequency n	Percent %	Example Quote
Warm water	37	43	"Warm water 80 degrees Fahrenheit or above"
Warm water + wind/storms	16	19	"Wind. Temperature of water. There was a third but I don't remember."
Warm water + air moisture	7	8	"Hot dry weather and moist air going up causes conditions on carrying rain, then picks up moisture at ocean, then moves heat and moisture."
Warm water + air temperature	7	8	"Warm water, cold air forming above the warm water."
Warm water + air temperature + air moisture	2	2	"Warm water, hot moist air, combined with cold air."
Warm water + air temperature + wind/storms	2	2	"Warm water, convergence of fronts--warm air and cold air. Wind patterns."
Warm water + earth rotation	2	2	"Needs to have rotation of Earth, warm water and moisture."
Cannot answer	2	2	
Other	11	13	

When asked, "What did you learn from this program about the impacts of tropical cyclones on people?," half of the interviewees described the devastating effects of tropical cyclones, such as from Hurricane Katrina (n=19, 50%), but it's not certain that all of these examples were new information from the program. Many people said they didn't learn anything new about this topic (n=16, 42%) (Table 13).

Table 13: Human impacts from tropical cyclones facilitated program

(N=38) Response	Frequency n	Percent %	Example Quote
Tropical cyclones are devastating	19	50	"Katrina was devastating due to water damage--devastating to structures, too."
Didn't learn anything new about impacts on people	16	42	"Not that much. Know about it as anyone who watched Katrina."
Other: unique responses	3	8	

Main Message

When asked for the main message of the tropical cyclones facilitated program, half of visitors who responded mentioned the process by which tropical cyclones are formed (50%, n=40). A smaller number thought the program was a general overview about tropical cyclones (16%, n=13) and the remaining respondents pointed out specific topics such as the fact that cyclones occur all over the world (9%, n=7) (Table 14).

Table 14: Main message of tropical cyclone facilitated program

(N=80) Response	Frequency n	Percent %	Example Quote
How tropical cyclones are formed	40	50	"How hurricanes begin, what causes a hurricane to form; weather patterns that initiate storms."
General information about tropical cyclones	13	16	“To educate people on hurricanes; it’s a nice overview for those who don't know much about them.”
Tropical cyclones occur all over the world	7	9	“Cyclones occur all over the globe.”
How cyclones are predicted	6	8	“About how modern technology captures weather from space and gives us warming ahead of time and can predict accurately."
Cyclones have different names in different parts of world	3	4	“Hurricanes are called different names in other parts of the world.”
Tropical cyclones cause damage	3	4	“There is a continuous threat from tropical cyclones.”
Warm water fuels cyclones	2	3	“Hurricanes start because of warm air and dry air mixing and accelerate over warm areas.”
Cyclones are seasonal	2	3	“Hurricanes come in season June-November”
Other: unique responses	4	5	

Visual Images

Visitors who completed questionnaires agreed strongly that they liked the visual images on the sphere (median=6 on a 1-6 agreement scale, N=50). When respondents (combined interview and questionnaire) were asked, “Which visual image on the sphere was most useful in explaining tropical cyclones?,” more than a third of respondents described the multi-colored sea surface temperatures (n=30, 40%) (Table 15).

Table 15: Visual image usefulness in tropical cyclone facilitated program

(N=75) Response	Frequency n	Percent %	Example Quote
Multi-colored sea surface temperatures	30	40	"The one with the infrared that showed seasonal changes and what parts of the world are most affected because of warm water."
The hurricane tracks over time	13	17	“My favorite though was the one with all the lines--the tracks. I haven't realized there's so many more in Asia.”
Images from Katrina	7	9	“Rotation of the storms--Katrina was most intense for the size.”
The sphere	4	5	“Large globe in center of room.”
Other: 1 or 2 responses	21	28	

Ocean-Climate Facilitated Program

Satisfaction

Visitors who completed questionnaires were generally very positive about the ocean-climate facilitated program. They agreed moderately that they enjoyed the program and thought it was easy to understand (medians=5 on 6-point agreement scale, N=45).

The average rating by visitors who watched the facilitated programs on ocean currents and climate was 7.94 (SD=1.37) on a 10-point scale, where 10 represents the highest rating (N=84). Twenty four visitors rated the program at the highest level. The remaining 60 visitors who rated the program as less than a 10 were asked, "What would make the program a 10?," about a fifth of the respondents said they had a hard time seeing the presentation (n=13, 22%) and another fifth reported a desire for the program to be more interactive with the audience (n=12, 20%) (13 did not respond). Several people also commented on wanting the presentation to be more appropriate for children (n=9, 15%) (Table 16).

Table 16: Recommended improvements to ocean-climate facilitated program

(N=47) Response	Frequency n	Percent %	Example Quote
Make sure everyone can see everything	13	22	"Better seat placement. Difficult to show the same image to both sides of the audience." "She was talking to other side of the room and sometimes I couldn't see what she was showing." "Can't see demonstrations very well--maybe project them so all can see. Make sure the kids can see--gather them around."
Make it more interactive	12	20	"More hands on with demonstrations so can go up and do things."
Make it child-appropriate	9	15	"Excellent information for adults but over kids' heads"
The content was too complex	3	5	"To make it a 10, a lot of terms were thrown around. Don't know if audience would know them. She could ask questions to see if people understand."
Make it more exciting	3	5	"More exciting; liked the cart; sphere didn't do much for me; cool as concept but not really doing much"
Reduce the noise in the area	3	5	"Too much noise in area of presentation"
Slow down the pace	3	5	"Too much information too fast."
More relaxed presenter style	3	5	"Speaking slower, presenter should be walking around, not staying in one place."
More comfortable setting	2	3	"More comfortable seating or chairs."
Other: unique responses	9	15	

Learning

Visitors who completed questionnaires reported a higher degree of knowledge of ocean-climate interactions after the facilitated presentations than before. The mean increased about 2.5 points on a 10-point scale (Table 17).

Table 17: Pre to post change in self-reported knowledge for ocean-climate facilitated program

Scale: Nothing = 1, A great deal = 10	Pre Mean (standard deviation)	Post Mean (standard deviation)	Paired Sample T-test Significance
How much did/do you know about ocean-climate interactions? (N=44)	4.91 (2.08)	7.64 (1.70)	p=.000

When asked to rate how much they agreed with several learning statements, the median questionnaire response was that they "agreed strongly" that they learned something new and "agreed moderately" that they learned about ocean-atmosphere interactions. The visitors agreed, but not as strongly, that the program was personally meaningful (Table 18).

Table 18: Learning statements for ocean-climate facilitated program

1=disagree strongly, 2=disagree moderately, 3=disagree, 4=agree, 5=agree moderately, 6=agree strongly	Ocean-Climate Connection Median N=47
Learned something new	Agree strongly
Learned about ocean-atmosphere interactions	Agree moderately
Cart demonstration was an important part of the program	Agree moderately
Part s of program were personally meaningful	Agree

When asked to complete this sentence, "I never knew that …," 79% of the respondents (interview and questionnaire combined) said they learned something new. What they reported learning varied a great deal and included the general concept that the ocean has a big impact on climate, that cold water is denser than warm water and it sinks below the warm water, and new understanding of how the ocean is made up of interconnected currents that circulate around the globe (Table 19).

Table 19: New concepts learned from ocean-climate facilitated program

N=75	Frequency n	Percent %	Example Quote
The ocean currents affect climate	15	20	"How the climate and land and ocean are linked."
Cold water more dense than warm and salt water more dense than fresh	12	16	"Different weights of water based on salinity and temperature."
It takes the global current hundreds of years to circulate	9	12	"Oceans water travel way around globe, really surprised it takes 100 of years to do so."
The ocean currents are interconnected	8	11	"How the water currents are all connected--uninterrupted. It's all one big flow--not 2 different ones."
The ocean has deep water currents	6	8	"Never knew about the deep ocean currents, where they went."
Other responses below:	25	33	
US coastal currents move different directions (3), Current directions (3), There is a global current (3), It take 4 times energy to heat water than air (2), There is one ocean with multiple basins (2), Ocean temperatures change with seasons (2), The ocean size (2), Global warming (1), The Sphere exists (1), Why a pool stays cool (1), The existence of trade winds (1), The wind moves ocean currents (1), Wind affects water temperature, (1), Nothing new (2)			

When asked, “Can you describe an example of how heat is transferred around the Earth?” almost all of the interviewees mentioned that ocean currents transfer heat around the Earth (n=41, 90%) (Table 20).

Table 20: Examples of how heat is transferred around the Earth

(N=46) Response	Frequency n	Percent %	Example Quote
Ocean currents	26	57	“Heat is transferred through currents. Currents take the hot water from Equator to North and some currents bring colder water south.”
Ocean currents and wind	15	33	"Water heating at equator, currents/wind move, as it moves north or south it is cooled up by poles and it sinks then it moves up to surface and moves back down."
Wind	3	7	“Winds move heat, if it's warmer, then changes direction of wind, east to west winds over equator and moves heat.”
Other	2	4	

When asked, “Can you give an example from the program of how ocean temperature and currents affect climate?,” about a third of respondents gave an example of how warm water ocean currents increase the temperature on land (n=24, 31%). About a quarter of respondents mentioned the example given during the program of Calgary (land-locked) and London (ocean-influenced) and how although they are on the same latitude, London is much warmer due to the Gulf Stream (n=19, 25%). Another quarter of respondents talked generally about how ocean currents affect weather and climate (n=19, 25%) (Table 21).

Table 21: Examples of how ocean temperature and currents affect climate

(N=77) Response	Frequency n	Percent %	Example Quote
Warm water currents warm the climate	24	31	“Ocean currents carry water to the US east coast and heat up the air on the way.”
Comparison of land-locked vs. ocean-influenced cities	19	25	“Moderate temperature of the ocean around England creates milder winter temperature than Calgary in a land locked area.”
General descriptions	19	25	“Different currents in the water that interact with the sun--when water heats or cools, has direct effect on climate in conjunction with revolution of Earth.”
Cold water currents cool the climate	7	9	“California stream is cool and keeps San Francisco weather moderate. “
Could not give example	7	9	
Other	1	1	

Main Message

When asked for the main message of the ocean-climate facilitated program, the majority of visitors who responded mentioned a connection between the ocean and other Earth systems such as the climate, weather, air, or land (82%, n=71) (Table 22).

Table 22: Main message of ocean-climate facilitated program

(N=86) Response	Frequency n	Percent %	Example Quote
Ocean affects climate	27	31	"How water, land, and atmosphere interact and influence the climate."
Ocean affects weather	10	12	"Water currents of different temperatures impact weather."
Ocean affects land	10	12	"If you change the ocean, you affect the land."
Everything is connected	9	10	"The atmosphere and temperature of Earth all interact with each other so if change climate, then changes and impacts the world."
Ocean affects temperature	8	9	"How the wind and currents affect temperatures around the world."
Ocean affects air	3	3	"How water temperature affects air temperature."
Ocean currents	4	5	"Teaching about ocean currents."
I don't know	2	2	
Other: unique responses	14	15	

Visual Images

Visitors who completed questionnaires agreed strongly that they liked the visual images on the sphere (median=6 on a 1-6 agreement scale, N=45). When respondents (interview and questionnaire combined) were asked, "Which visual image on the sphere was most useful in explaining how the ocean and atmosphere interact?," the two images that stood out were the red (warm) and blue (cold) ocean currents (n=23, 32%) and the multi-colored sea surface temperature images (n=19, 26%) (Table 23).

Table 23: Visual image usefulness in ocean-climate facilitated program

(N=73) Response	Frequency n	Percent %	Example Quote
Red and blue colored currents	23	32	"The picture of the warm surface currents in red with the wind and the blue deep currents below."
Multi-colored sea surface temperatures	19	26	"The red in the middle and moving and the yellows and green on the globe."
Arrows showing wind currents	9	12	"With all the arrows pointing the direction of winds, where they go and how they change."
The sphere	8	11	"The sphere was a very interesting visual."
All	3	4	"Everything"
Demonstration cart	2	3	"The saltwater sinking in the beaker and how cold water keeps sinking in arctic and get ice forming in arctic."
Cities at same latitude	2	3	"Different climates in London and Calgary."
Other: unique responses	7	9	

Tropical Cyclone Auto-Run Program

Satisfaction

Visitors who completed questionnaires were generally very positive about the tropical cyclone auto-run program. They agreed moderately that they enjoyed the program and thought it was easy to understand (medians=5 on 6-point agreement scale, N=32).

The average rating by visitors who watched the auto-run program on tropical cyclones was 7.80 (SD=1.49) on a 10-point scale, where 10 represents the highest rating (N=76). Nine visitors rated the program at the highest level. When the 67 visitors who rated the program as less than a 10 were asked, "What would make the program a 10?," the most often mentioned improvements were to include different types of graphics such as photographs (n=13, 24%) and to gear the show to children rather than adults (n=11, 20%) (Table 24).

Table 24: Recommended improvements to tropical cyclone auto-run program

(N=54) Response	Frequency n	Percent %	Example Quote
Different types of graphics	13	24	"I liked the illustrations and graphics if there was less looking at the map of the globe and more photos and illustrations of tropical cyclones it would be better."
Make it child-appropriate	11	20	"Make it more geared towards younger kids; explain things on child's level."
Suggested additional content	8	15	"I learned a lot, informational, it was pretty, good pictures; put more of a history story to the program; 1943 first airplane, would like to hear more about why have plane for storm tracking back then"
Make sure everyone can see everything	5	9	"I sometimes missed part of it, because I could only see half of show from here"
Suggestions for presentation style	4	7	"Make words on screen last longer and all around"
More audience interaction	3	6	"More real interaction"
Other: 1 or 2 responses	10	19	

Learning

Visitors reported a higher degree of knowledge of tropical cyclones after the auto-run program than before. The mean increased about 2.5 points on a 10-point scale (Table 25).

Table 25: Pre to post change in self-reported knowledge for tropical cyclone auto-run program

Scale: Nothing = 1, A great deal = 10	Pre Mean (standard deviation)	Post Mean (standard deviation)	Paired Sample T-test Significance
How much did/do you know about tropical cyclones? (N=33)	4.88 (2.90)	7.48 (2.14)	p=.000

When asked to rate how much they agreed with written statements on the questionnaire, the median response was that they "agreed moderately" that they learned something new and "agreed strongly" that they learned how people study and predict tropical cyclones (medians=5 and 6 respectively on a 6-point scale, N=32).

When asked to complete this sentence, "I never knew that …," 87% of the respondents gave an example of a concept that was new to them. The most frequently mentioned concepts were the variety of names for tropical cyclones, the long history of understanding tropical cyclones, and how computer models are used to predict tropical cyclone formation and paths (Table 26).

Table 26: New concepts learned from auto-run tropical cyclone program

N=66	Frequency n	Percent %	Example quotes
Tropical cyclones have many names	25	38	"Didn't realize that tropical cyclones are called different things in different areas."
The history of understanding tropical cyclones	17	26	"That they sent ships out to track storms so early, in the 1800s."
How models are used to accurately predict tropical cyclones	13	20	"They can overlay computer models with actual data to see if model accurately predicts storms."
Other topics below:	11	17	
How tropical cyclones are formed (3), The directions cyclones move (2), The Sphere exists (2), Warm water is necessary for tropical cyclones to form (2), How complicated tropical cyclones are (1), How much prediction has improved over time (1)			

When asked, "Tell me something you remember hearing or seeing about how computer models are used to understand and predict tropical cyclones," many of the interviewees stated how the models are used to help predict future cyclones, but didn't describe more about how they are used (n=11, 27%). About the same number of people reported more technical understanding of how computer models are created (e.g., using grids and math) and used (e.g., compared to real data to determine accuracy) (n=13, 32%) (Table 27).

Table 27: Learned information about how computer models are used to understand and predict tropical cyclones

(N=41) Response	Frequency n	Percent %	Example Quote
Models help predict the future	11	27	"Set up so can compare past and once reliable, could use to predict future, even years in future."
How models are created	7	17	"When they broke earth into 3D grid--there are complex formulas."
Comparing satellite data to real data	6	15	"They're based on satellite imagery and we use them to compare with computer models"
Models make it easier to understand cyclones	6	15	"They use super computers and the models get better every time."
Other: unique responses	7	17	
Don't know	4	9	

When asked, “How does the modern understanding of tropical cyclones differ from the past?,” almost half of the respondents said that our tools are more sophisticated due to advancing technology (n=32, 47%). Others reported that our understanding of tropical cyclones has grown over time (n=19, 28%) and others said that we are better able to predict when or where tropical cyclones will occur (n=11, 16%) (Table 28).

Table 28: How modern understanding of tropical cyclones differs from the past

(N=68) Response	Frequency n	Percent %	Example Quote
Technology is more advanced	32	47	"The past relied on physical observable factors and conditions and now rely on computer models as predictor, as well as satellite images"
Better understanding of tropical cyclones	19	28	“In the past they thought it was a god, now we know it’s a phenomenon based on weather and atmospheric conditions”
Predictions are more accurate	11	16	“We can develop models weeks and months out, not just when the sky darkens and winds blow that we know a storm is coming”
Don’t know	6	9	

Main Message

When asked, “What would you say is the main message of this program?,” the most common response was that it described how tropical cyclones are predicted (n=21, 29%). The other two most popular main messages were that predictions have improved over time (n=15, 21%) and a description of how tropical cyclones form (n=12, 17%) (Table 29).

Table 29: Main message of auto-run tropical cyclones program

(N=72) Response	Frequency n	Percent %	Example Quote
How tropical cyclones are predicted	21	29	“Hurricanes and how we know they are coming and the origin of them and how we have explored hurricanes.”
Improved knowledge and prediction over time	15	21	“To inform people that we can now predict hurricanes more accurately than the past.”
Learned how tropical cyclones are formed	12	17	“Teaching about the weather and how storms form”
Prediction can save lives	7	10	"Computers to predict so can save lives or at least warn people"
The role of computer models	7	10	“Role of computer modeling systems predicting what storms are going to hit and when”
General information	5	7	“General education about hurricanes”
We are still learning about tropical cyclones	3	4	“Still trying to understand nature even with lots of technology”
Nothing	2	3	

Visual Images

Visitors who completed questionnaires agreed moderately that they liked the visual images on the sphere (median=5 on a 1-6 agreement scale, N=32).

When asked, “Which visual image on the sphere was most useful in explaining tropical cyclones?,” over a third of the visitors who responded described the cutaway image of the tropical cyclone (n=23, 38%). The next most useful image was that of Huracan, the ancient god (n=7, 11%) (Table 30).

Table 30: Visual image usefulness in tropical cyclones auto-run program

(N=61) Response	Frequency n	Percent %	Example Quote
The cutaway image of how tropical cyclones form	23	38	“The one that shows the movement of air to form cyclones; the hot air and cold air”
The Huracan image	7	11	“Native people using head with two arms image to describe hurricanes.”
The image comparing satellite and real data	5	8	"Split screen between predictive and real; showed how accurate computer models are."
Satellite images	5	8	“The live footage of the storms from the satellites.”
The maps	4	7	“The maps”
The sphere itself	3	5	“Seeing the whole globe at once”
Swaying palm trees	2	3	“Drawing with palm trees and water”
Other: unique responses	12	20	

Ocean-Climate Auto-Run Program

Satisfaction

Visitors who completed questionnaires were generally very positive about the ocean-climate auto-run program. They agreed strongly that they enjoyed the program and agreed moderately that it was easy to understand (medians=6 and 5 respectively on 6-point agreement scale, N=30).

The average rating by visitors who watched the auto-run program on ocean-climate connections was 8.08 (SD=1.45) on a 10-point scale, where10 represents the highest rating (N=75). Thirteen visitors rated the program at the highest level. When the 62 visitors who rated the program as less than a 10 were asked, “What would make the program a 10?,” the most often cited suggestions were to add additional content (n=11, 25%) and to make the program targeted to children (n=8, 18%) (Table 31).

Table 31: Recommended improvements to ocean-climate auto-run program

(N=44) Response	Frequency n	Percent %	Example Quote
Suggested additional content	11	25	“Maybe get a bit more specific about regions, county, the El Nino for example.”
Make it child-appropriate	8	18	“More geared towards kids. This was adult version.”
Make sure everyone can see everything	4	9	“I think this is basically visual, but it didn't work when the screen was split in 2, I couldn't see parts of it”
Slow down the pace	3	7	“Went by a bit fast--didn't absorb everything,”
Better flow of concepts	3	7	“Some topics seemed to jump from one to another. Need to do it gradually.”
Reduce noise in the area	2	5	“Trouble hearing parts due to families running through with kids.”
Other: unique responses	13	30	

Learning

Visitors reported a higher degree of knowledge of ocean-climate interactions after the auto-run program than before. The mean increased almost 2 points on a 10-point scale (Table 32).

Table 32: Pre to post change in self-reported knowledge for ocean-climate auto-run program

Scale: Nothing = 1, A great deal = 10	Pre Mean (standard deviation)	Post Mean (standard deviation)	Paired Sample T-test Significance
How much did/do you know about ocean-climate interactions? (N=31)	**5.48 (2.19)**	**7.32 (1.85)**	**p=.000**

When asked to rate how much they agreed with written statements on the questionnaire, the median response was that they "agreed strongly" that they learned something new, "agreed moderately" that they learned about ocean-atmosphere interactions, and "agreed moderately" that they learned how scientists use computers models to understand how the ocean affects climate (medians=6, 5, and 5 respectively on a 6-point scale, N=30). Visitors agreed, but not as strongly, that the program was personally meaningful (median=4, N=30 (Table 33).

Table 33: Learning statements for ocean-climate auto-run program

1=disagree strongly, 2=disagree moderately, 3=disagree, 4=agree, 5=agree moderately, 6=agree strongly	Ocean-Climate Connection Median N=30
Learned something new	Agree strongly
Learned about ocean-atmosphere interactions	Agree moderately
Learned how scientists use computer models to understand how the ocean affects climate	Agree moderately
Part s of program were personally meaningful	Agree

When asked to complete this sentence, "I never knew that …," 85% of the respondents gave an example of a concept that was new to them. The most frequently mentioned concept was learning that Ben Franklin was the first to discover the Gulf Stream (Table 34).

Table 34: New concepts learned from auto-run ocean-climate program

N=58	Frequency n	Percent %	Example quotes
Ben Franklin studied and discovered the Gulf Stream	20	29	"Benjamin Franklin responsible for detecting the current--I only thought about him as the guy with the lightening."
The ocean has deep water currents	9	13	"Cooler water sank to the ocean floor to form rivers"
Nothing new	9	13	"Everything on there was familiar with, have technical background, so didn't learn anything new."
The presence of the Gulf Stream	5	7	"That the Gulf Stream was basically a river in and of itself."
Warm water at surface, cold water below	5	7	"The ocean had different temperatures at different levels."
The surface layer of ocean	5	7	"Currents formed river and that the top 3 feet of the

retains heat			ocean has the same heat capacity as the entire atmosphere."
Cities at same latitude have different climates	4	6	"The temperature in Perm in Russia is so much colder than in London"
Other concepts below:	11	16	
The ocean circulates heat (3), The ocean affects climate (3), It takes 100s of years for ocean currents to circulate (1), Ben Franklin was assistant post master (1), Different temperature water has different density (1), That the Sphere exists (1), The ocean has current rivers (1)			

When asked, "What did you learn about how ocean currents affect climate?," the most commonly repeated responses were about how the ocean's surface currents transport heat around the world (n=11, 17%), the global circulation of ocean currents from the surface to the depths and back up again (n=8, 13%), and how climates can be different at the same latitude due to the transport of heat by ocean currents (n=8, 13%) (Table 35).

Table 35: Concepts learned about how ocean currents affect climate

(N=63) Response	Frequency n	Percent %	Example Quote
Surface currents circulate warmer water	11	17	"That the different temperatures circulate and bring warmer water to different areas of land."
Surface/warm and deep/cold currents circulate around Earth	8	13	"Surface absorbs heat from traffic and sunlight and gets circulated and the bottom water is cold, then surfaces, it's a cycle."
Same latitude, different climates due to ocean currents	8	13	"Ocean currents can make places at same latitude different temperatures, for example, Alaska is warm."
Nothing new	6	10	"I'm not sure. I already knew about the Gulf Stream."
Deep currents circulate colder water	5	8	"That there are under ocean rivers that rise again"
Information about the Gulf Stream	3	5	"Gulf Stream bringing warm water north"
Nothing specific	5	8	
Don't know	5	8	
Other: unique responses	12	18	

When asked, "Why do we use computer models to study how the ocean affects climate?," the interviewees' most common responses were that computer models facilitate data processing (n=19, 44%) and they help us predict what is likely to happen in the future (n=16, 37%) (Table 36).

Table 36: Concepts learned about how computer models are used to study how the ocean affects climate (N=43)

Response	Frequency n	Percent %	Example Quote
Models make it easier for us to understand ocean interactions with climate	19	44	"It's a lot easier to use computer programs than going through papers to handle blocks of data about a region."
Models can help predict what will happen in the future	16	37	"So we can better understand why the climate is as it is and predict to some degree what might happen in the future from patterns that have been."
Models provide accurate information	3	7	"Give more accuracy, can tell weather so much better than even 10 yrs ago."
Other: unique responses	5	12	

Main Message

When asked, "What would you say is the main message of this program?," about a quarter of the respondents described how the ocean and its currents affect Earth's climate (n=19, 26%). The next most frequently mentioned message was the role that people play in affecting climate change (n=12, 17%) (Table 37).

Table 37: Main message of the ocean-climate auto-run program (N=72)

Response	Frequency n	Percent %	Example Quote
The ocean affects climate	19	26	"Sea currents and water temperature have dramatic effects on the climate"
Humans are affecting climate change	12	17	"That the earth is changing and we are contributing towards that change."
How currents work	9	13	"About the current and what drives them and how discovered them."
Information about global warming	8	11	"Informative of global warming and how things are to be in the future."
Different climates at same latitudes	6	8	"Comparing one area with another even though on the same latitude had different climates."
The ocean affects weather	5	7	"How the ocean affects weather, how currents affect weather."
Increase awareness of ocean-climate connection	4	6	"That there are changes going on in our climate and raising awareness of that."
The ocean affects the atmosphere	3	4	"Significance of oceans, interactions of oceans and atmosphere."
Other: unique responses	6	8	

Visual Images

Visitors who completed questionnaires agreed strongly that they liked the visual images on the sphere (median=6 on a 1-6 agreement scale, N=30). When respondents (interview and questionnaire combined) were asked, "Which visual image on the sphere was most useful in explaining how the ocean and atmosphere interact?," the two most frequently mentioned images were of the hot and cold water currents (surface and deep) (n=17, 29%) and the multi-colored sea surface temperatures (n=12, 21%) Table 38).

Table 38: Visual images usefulness in ocean-climate auto-run program

(N=58) Response	Frequency n	Percent %	Example Quote
The hot (red) and cold (blue) water at different depths	17	29	"The images that show the warm water on top and the cold water on the bottom"
Sea surface temperatures around the globe	12	21	"The one where color--the whole world the different colors of ocean--where we are the ocean was yellow -- down by Africa was a deep red--showed temperature."
The ocean currents	8	14	"The circulation of currents and directions of winds and currents."
Cities at same latitude have different climates	6	10	"Map showing different cities on the same longitude, but having different climate, then the drawing depicting latitude"
The sphere	5	9	"Liked the round sphere. I've never seen a movie on a globe before and that you could see the west and east on sphere at same time."
The Gulf Stream	5	9	"The Gulf Stream image and how currents traveled and explained differences between time ships took to get to Europe and back"
Ben Franklin	3	5	"Benjamin Franklin showing the Gulf Stream currents."
Other: unique responses	2	3	

When asked, "What did you learn from the Ben Franklin character?," over half of the interviewees who replied said they learned that he had discovered the Gulf Stream (n=25, 56%) (Table 39).

Table 39: Concepts learned from Ben Franklin in ocean-climate auto-run program

(N=45) Response	Frequency n	Percent %	Example Quote
He discovered the Gulf Stream	25	56	"He was very interesting, the thought like a scientists and made the first map of the Gulf Stream."
He questioned why ships traveled faster going east than west over Atlantic	9	20	"He questioned how traveling one way on ocean faster than the other way."
The types of experiments he did to figure out ocean currents	6	13	"Dropping the barrels and testing the temperature of the water."
I don't know	3	7	
Other: unique responses	2	4	

Discussion

All Programs

Although comparing the four programs was not the intention of this evaluation, there were a few themes that emerged when reviewing the data. Visitors were consistently pleased overall with the presentations, rating each about 8 out of 10 overall, and showing agreement with the statement "the

presentation was enjoyable." Visitors also reported agreement that they "learned something new" with each presentation and gave on-target examples of science literacy concepts learned. Across all programs, respondents commented on the usefulness of the color-enhanced images for explaining concepts such as temperature-driven ocean currents and air flow, especially those images that depicted warmer water or air as red and cooler water or air as blue.

A challenge of studying the programs at the Maryland Science Center was the placement of the Sphere in a periodically high-traffic area. The hallway adjacent to the Sphere is a thoroughfare to the popular planetarium shows. Visitors frequently mentioned the distraction of the noisy visitors as they passed by during the programs. Program satisfaction ratings may have been higher without these distractions.

A common recommendation from the visitors was to make the presentations more appropriate for a child audience, or for the MSC to post the appropriate audience level and the length of the show so that adults could make the choice about whether to watch the programs with their children.

Tropical Cyclone Facilitated Program

Science Literacy Concepts

Visitors clearly felt they learned from the tropical cyclone facilitated program. They learned what conditions are necessary for tropical cyclones to form, where they form, and what they are named in different regions of the globe. The great majority of visitors knew that warm water was an essential component of tropical cyclone formation, but many visitors were challenged to provide complete details on all the components that need to be present.

As far as learning about the impact of tropical cyclones on people, half of the respondents mentioned devastating effects, but it wasn't completely clear that this was a new concept for visitors. In fact, nearly half of the respondents said they didn't learn anything they didn't already know about the impacts tropical cyclones on people. It seems that the hurricane damage photos and talk about hurricanes' destructive properties were not strong teaching tools in this case.

Main Message

The tropical cyclones facilitated program was designed to convey the factors that must be present for tropical cyclones to form, they happen all around the world, they are seasonal and originate in specific places, and they are studied to save lives. About two thirds of the respondents thought the message was about how tropical cyclones form or a general overview about tropical cyclones. Some people talked about where cyclones occur and how technology is used to predict them. Fewer people mentioned specific concepts such as their seasonal nature or that they cause damage. Overall, most visitors were able to recall at least one of the main messages conveyed in the program.

Visual Images

The visitors reacted positively to the multi-colored sea surface temperatures; that image helped them understand the warm water conditions at the equator that fuel tropical cyclone formation. They specifically mentioned how the red color showed warmer water. They mentioned the hurricane path markings around the globe to be informative. Despite the fact that Hurricane Katrina was familiar to many people, the images of that hurricane's destruction were useful images to some visitors. As with the other three programs, a few people marveled at the Sphere itself.

A few people recommended making the visual images "more exciting" by using animated images rather than still photos or making the visuals more dynamic and quick. Some suggested using videos of real storms and including the storms' sounds. They also suggested reducing the Katrina story and substituting more animated visuals of actual tropical cyclones.

Ocean-Climate Facilitated Program

Science Literacy Concepts

The large majority of respondents said they learned something new from the ocean-climate facilitated program. For many, the concept that the ocean currents affect Earth's climate was a revelation. Nearly as many reported learning that salt and cold water are more dense than fresh and warm water. Many people learned about the deep ocean currents that are connected to the warmer surface currents and that these currents are circulating in predictable pathways around the Earth. Given that one key concept illustrated by the demonstration cart was the water density properties, it is important to ensure that all visitors can see the cart demonstration. Visitors recommended either making the object on the cart larger (e.g., bigger beakers) or to project the cart demonstration up onto the Sphere (not technically possible).

When asked to provide an example of how heat is transferred around the Earth, almost everyone was able to provide an example such as via ocean currents, wind, or a combination of the two. Also, when asked for an example of how ocean temperature and currents affect climate, nearly everyone was able to either give a general description such as how warm currents warm the climate, or they provided a specific example of this effect such as Calgary and London have different climates despite being on the same latitude. Clearly, visitors picked up several science literacy concepts from this presentation.

Main Message

The program was designed to convey that there is one global ocean with different basins, that the ocean transfers heat around the globe, and therefore the ocean affects climate. When asked for the presentation's main message, the great majority of visitors described, in their own words, some interaction between the ocean and the air/weather/climate/land. None of the respondents specifically mentioned the concept of a single global ocean, or the interconnectedness of the oceans.

Visual Images

The visitors seemed to favor images that showed water temperature differences using red for warm and blue for cold. This color coding was effective in showing the warm and cold global ocean currents and highlighted the distribution of sea surface temperatures for many participants. Some respondents commented on seeing the red, warm water at the equator and the gradient of colors radiating out towards the poles. Some visitors noted that this color strategy helped them understand the heat transfer capacity of the ocean currents.

Both Facilitated Programs

Presentation Style

As stated previously, the majority of visitors enjoyed and learned from the facilitated presentations. The main complaint voiced by respondents not sitting directly in front of the presenter was that they could not see the images on the Sphere that were being pointed out. To improve visibility, the seating might need to be more closely aligned with the center point of the presentation. Another strategy the

presenter could adopt is an instructional style that is "on the move," traveling around the Sphere to point out the images and ensure that all visitors are able to see what is being discussed.

Several of the respondents also suggested making the presentation more interactive by including audience participation. Some stated the desire for more question and answer interaction. Although the presenter said she would take questions at the end, the researcher noted that very few people engaged the presenter in a discussion. The presenter could build time into the presentation for the Q&A and encourage a discussion by asking "What questions do you have?" to stimulate audience participation. This presenter-visitor exchange could also increase visitors' perception that the content has personal meaning. In addition, some respondents recommended that the presenter invite children up to the cart for a better view or to participate in a hands-on way.

Tropical Cyclones Auto-run Program

Science Literacy Concepts

A large majority of respondents said they learned something new from the tropical cyclone auto-run program. Over a third of the respondents reported learning that tropical cyclones have different names in different regions around the globe. Nearly half of the respondents reported learning a science literacy concept targeted by the program creators: how our understanding of tropical cyclones has changed over time or how models are used to accurate predict tropical cyclones. It may be that those who reported learning about the naming also learned the other science concepts, but they were not probed for additional concepts.

When asked specifically about the use of computer models for understanding and predicting tropical cyclones, almost all of the interviewees were able to describe how the computer models are used with some visitors giving more detail about how the models actually work, such as by analyzing data in a 3-D grid.

Main Message

The designers intended the program to convey that people's observations and understanding of tropical cyclones has broadened over time and that the more we learn about tropical cyclones, the better we can predict them in the future. When asked about the main message, about two thirds of the respondents talked about our ability to accurately predict storms and how that has changed over time. Some people said the program was about how tropical cyclones form. For these visitors, the science behind tropical cyclone formation eclipsed the intended message about how we have come to have such detailed knowledge about storm development and the direction that discovery is taking us in the future.

Visual Images

When asked about the visual images, the cutaway image showing how tropical cyclones form was by far the most often mentioned. In addition, visitors found useful the Huracan ancient god image, the satellite images, and the image that compared satellite to predictive model data. One person who reported that that last image was confusing recommended showing the same time period "wedges" for satellite and computer model data side by side so that they could be visually compared – how well did the computer model predict the actual storms when viewed side by side?

Several people made recommendations for the inclusion of additional types of graphics such as photographs or movies of tropical cyclones in action and images of the equipment used to track and study storms.

Presentation Style

To a lesser degree than with the facilitated programs, some visitors reported that they couldn't adequately see what was being presented. As far as depicting the historical story of tropical cyclone knowledge and prediction, it appeared to be an effective strategy. Half of the respondents reported these concepts as the main message of the program. And almost all visitors in the sample were able to describe how the modern understanding of tropical cyclones differs from the past, that is, how the development of modern technology has improved the accuracy of our ability to predict tropical cyclones.

Ocean-Climate Auto-run Program

Science Literacy Concepts

The large majority of respondents reported learning something new about ocean-climate interactions. Ben Franklin was the star of the show with nearly a third of respondents reporting that they didn't know that he had discovered the Gulf Stream. Beyond that concept, there was a real diversity of science literacy concepts learned by the visitors, from the presence of deep water ocean currents to the understanding that warm ocean water and currents are above the colder water and currents.

When asked what they learned about ocean currents and climate, most visitors reported learning something about the ocean currents, their temperatures and how they circulate around the globe. Several people learned that ocean currents affect the climate and reported the example of how Calgary and London have very different climates despite being at the same latitude.

Whether people learned new information about how computer models are used for explaining ocean-climate interactions is unclear. The respondents were asked "why" rather than "how" the models are used and the most number of responses were a general understanding that computer models enable us to handle large, complex data sets, something they may have known prior to viewing the presentation. Over a third of the respondents did give examples that were specific to modeling ocean-climate interactions that were addressed in the program.

Some of the visitors suggested additional content to add to the program, such as more information about the relationship between the ocean and global climate change and what future scenarios might look like.

Main Message

The program designers intended to convey that ocean currents are an essential part of our global climate, and we are only just now beginning to fully understand how they work and how they might change. When asked for their perception of the main message, the visitors were mainly on target. Most of them stated the ocean-climate connection and how humans are contributing to changes in the climate. As with the tropical cyclones auto-run, several people described "how it works" messages about ocean currents rather than the overarching theme of the development of our understanding of the ocean-climate connection over time and the need for additional understanding as people have increasing impact on the climate and the ocean.

Visual Images

People seemed to respond the most to the images that showed with color the contrasting water temperatures. Both the red/blue contrast of the deep and shallow water currents and the red/yellow/green/blue gradient of the sea surface temperatures were mentioned most frequently. People also responded to the maps with the latitudes shown with the discussion of different climates at similar latitudes. No one specifically mentioned the people who talked about their local climates, but it may be that the visitors didn't consider them to be "visual images." We didn't probe for their opinion of the videos of the people from the different regions.

Presentation Style

Generally, people enjoyed the auto-run ocean-climate program. A few people reported having difficulty seeing all of the images on the Sphere. A few thought it was too fast-paced. Nearly all of the respondents gave an example of something they learned from the Ben Franklin character. He seemed to grab people's attention and effectively illustrate the key concepts intended by the program designers.

Conclusion

Overall, the four programs created by the Ocean-Atmosphere Literacy Partnership were well-received by visitors and were successful in conveying intended messages and content. It appears that the innovative techniques used in the auto-run and in the facilitated programs were effective presentation strategies that reinforced the learning goals. Visitors made several recommendations for improving the programs further, such as ensuring all members of the audience can see all parts of the programs, creating programs targeted at children, adjusting the presentation style to be more interactive, and extending the length of the auto-run programs to include more content. These adaptations may support greater outcome attainment. These innovative program formats show great promise as models for future Sphere presentations.

Acknowledgements

ILI appreciates the assistance from the Maryland Science Center staff and volunteers during the evaluation data collection. Amy Wood at MSC was the solo presenter of all facilitated programs, presenting up to six programs per day. Manjit Goldberg and Jim O'Leary assisted with evaluation logistics and data collection. The following staff/volunteers also helped with data collection: Diane Bellomo, Peter Garretson-Butt, Katherine Kidwell, Miriam Krause, Joe Miko, Jason Silva, Maureen "Mo" Sullivan, and Paul Yurko.

Date: _____ Time _____ Interviewer name: _____

AUTO-RUN OCEAN-CLIMATE INTERVIEW

How would you rate the program overall on a scale from 1 to 10, with 1 being the lowest rating and 10 being the highest? (circle one)

Lowest 1 2 3 4 5 6 7 8 9 10 **Highest**

What would make it a 10 for you?

Please complete this sentence: "I never knew that …."

What would you say was the main message of this program?

Was anything in the program confusing? Yes _____ No _____
If so, tell me about it.

What did you learn about how ocean currents affect climate?

Why do we use computer models to study how the ocean affects climate?

Which visual image on the sphere was most useful in explaining how the ocean affects climate around the world?

What did you learn from the Ben Franklin character?

I have just a few more questions. These are about you.

What year were you born? _____ (e.g., 1975)

Where do you live? State _____ Country _____

The interviewee is Male Female (circle one)

On a scale from 1 to 5, how interested are you in science? (circle one)

Not at all interested 1 2 3 4 5 **Extremely interested**

What is your highest level of education? (mark their response)

_____Some elementary school
_____Some secondary school
_____High school graduate
_____Some college
_____Associate's degree
_____College degree
_____Some graduate school
_____Master's degree
_____Doctorate
_____Other

About how many times, including this one, have you watched a *Science on a Sphere* presentation (here or elsewhere)? _____ times (if this is the first time, enter a 1)

Is there anything else you'd like to say about the program?

THANK YOU FOR YOUR COMMENTS!

AUTO-RUN OCEAN-CLIMATE QUESTIONNAIRE

THANK YOU for providing feedback about the *Science on a Sphere* presentation. Your anonymous comments will help the Maryland Science Center staff improve their programs.

Date _____ **Time** _____

How would you rate the program overall on a scale from 1 to 10, with 1 being the lowest rating and 10 being the highest? (circle one)

Lowest 1 2 3 4 5 6 7 8 9 10 **Highest**

What would make it a 10 for you?

Please indicate how much you agree or disagree with these statements. (circle your responses)

	Disagree strongly	Disagree moderately	Disagree somewhat	Agree somewhat	Agree moderately	Agree strongly
The presentation was enjoyable.	1	2	3	4	5	6
I learned something new from the presentation.	1	2	3	4	5	6
I learned how the ocean and the atmosphere interact.	1	2	3	4	5	6
I learned how scientists use computer models to understand how the ocean affects climate.	1	2	3	4	5	6
There were parts of the presentation that were personally meaningful.	1	2	3	4	5	6
I thought the program was easy to understand.	1	2	3	4	5	6
I liked the visual images on the sphere.	1	2	3	4	5	6

How much did you know about ocean-climate interactions BEFORE seeing the presentation?
Please indicate on a scale from 1 to 10 with 1=nothing and 10=a great deal. (circle one)

Nothing 1 2 3 4 5 6 7 8 9 10 **A great deal**

How much do you know NOW about ocean-climate interactions? (circle one)

Nothing 1 2 3 4 5 6 7 8 9 10 **A great deal**

PLEASE COMPLETE THE OTHER SIDE

AUTO-RUN OCEAN-CLIMATE QUESTIONNAIRE

Please complete this sentence: "I never knew that ...."

What was the main message of this program?

What did you learn about how ocean currents affect climate?

Please describe a visual image that helped you understand the impact of the ocean on climate around the world.

What year were you born? _____ (e.g., 1975)

Are you (circle one) Male Female

Where do you live? State _____ Country _____

On a scale from 1 to 5, how interested are you in science? (circle one)

Not at all interested 1 2 3 4 5 **Extremely interested**

Highest level of education (check one)

_____Some elementary school
_____Some secondary school
_____High school graduate
_____Some college
_____Associate's degree
_____College degree
_____Some graduate school
_____Master's degree
_____Doctorate
_____Other

About how many times, including this one, have you watched a *Science on a Sphere* presentation (here or elsewhere)? _____ times (if this is the first time, enter a 1)

PLEASE PUT THIS QUESTIONNAIRE AND CLIP BOARD IN THE BIN MARKED "SOS QUESTIONNAIRES."

Date: _____ Time _____ Interviewer name: _____

AUTO-RUN TROPICAL CYCLONES INTERVIEW

How would you rate the program overall on a scale from 1 to 10, with 1 being the lowest rating and 10 being the highest? (circle one)

Lowest 1 2 3 4 5 6 7 8 9 10 **Highest**

What would make it a 10 for you?

Please complete this sentence: "I never knew that …."

What would you say is the main message of this program?

Was anything in the program confusing? Yes _____ No _____
If so, tell me about it.

Which <u>visual image</u> on the sphere was most useful in explaining tropical cyclones?

Tell me something you remember hearing or seeing about how <u>computer models</u> are used to understand and predict tropical cyclones.

How does the modern understanding of tropical cyclones differ from the past?

I have just a few more questions. These are about you.

What year were you born? _____ (e.g., 1975)

Where do you live? State _____ Country _____

The interviewee is *Male Female (circle one)*

On a scale from 1 to 5, how interested are you in science? (circle one)

Not at all interested 1 2 3 4 5 **Extremely interested**

What is your highest level of education? (mark their response)

_____Some elementary school
_____Some secondary school
_____High school graduate
_____Some college
_____Associate's degree
_____College degree
_____Some graduate school
_____Master's degree
_____Doctorate
_____Other

About how many times, including this one, have you watched a *Science on a Sphere* presentation (here or elsewhere)? _____ times (if this is the first time, enter a 1)

Is there anything else you'd like to say about the program?

THANK YOU FOR YOUR COMMENTS!

AUTO-RUN TROPICAL CYCLONES
QUESTIONNAIRE

THANK YOU for providing feedback about the *Science on a Sphere* presentation. Your anonymous comments will help the Maryland Science Center staff improve their programs.

Date _____ **Time** _____

How would you rate the program overall on a scale from 1 to 10, with 1 being the lowest rating and 10 being the highest? (circle one)

Lowest 1 2 3 4 5 6 7 8 9 10 **Highest**

What would make it a 10 for you?

Please indicate how much you agree or disagree with these statements. (circle your responses)

	Disagree strongly	Disagree moderately	Disagree somewhat	Agree somewhat	Agree moderately	Agree strongly
The presentation was enjoyable.	1	2	3	4	5	6
I learned something new from the presentation.	1	2	3	4	5	6
I learned how people study and predict tropical cyclones.	1	2	3	4	5	6
I thought the program was easy to understand.	1	2	3	4	5	6
I liked the visual images on the sphere.	1	2	3	4	5	6

How much did you know about tropical cyclones BEFORE seeing the presentation?
Please indicate on a scale from 1 to 10 with 1=nothing and 10=a great deal. (circle one)

Nothing 1 2 3 4 5 6 7 8 9 10 **A great deal**

How much do you know NOW about tropical cyclones? (circle one)

Nothing 1 2 3 4 5 6 7 8 9 10 **A great deal**

PLEASE COMPLETE THE OTHER SIDE

AUTO-RUN TROPICAL CYCLONES
QUESTIONNAIRE

Please complete this sentence: "I never knew that ...."

What was the main message of this program?

Which visual image on the sphere was most useful in explaining tropical cyclones?

How does the modern understanding of tropical cyclones differ from the past?

What year were you born? _____ (e.g., 1975)

Are you (circle one) Male Female

Where do you live? State _____ Country _____

On a scale from 1 to 5, how interested are you in science? (circle one)

Not at all interested 1 2 3 4 5 **Extremely interested**

Highest level of education (check one)

_____Some elementary school
_____Some secondary school
_____High school graduate
_____Some college
_____Associate's degree
_____College degree
_____Some graduate school
_____Master's degree
_____Doctorate
_____Other

About how many times, including this one, have you watched a *Science on a Sphere* presentation (here or elsewhere)? _____ times (if this is the first time, enter a 1)

PLEASE PUT THIS QUESTIONNAIRE AND CLIP BOARD IN THE BIN MARKED "SOS QUESTIONNAIRES."

Date: _____ Time _____ Interviewer name: _____

FACILITATED OCEAN-CLIMATE INTERVIEW

How would you rate the program overall on a scale from 1 to 10, with 1 being the lowest rating and 10 being the highest? (circle one)

Lowest 1 2 3 4 5 6 7 8 9 10 **Highest**

What would make it a 10 for you?

Please complete this sentence: "I never knew that …."

Did you learn that from the cart demonstration _____or the sphere _____? (check one)

What would you say was the main message of this program?

Was anything in the program confusing? Yes _____ No _____

If so, tell me about it.

Can you describe an example of how heat is transferred around the Earth?

Can you give an example from the program of how ocean temperature and currents affect climate?

Which visual image on the sphere was most useful in explaining how the ocean and atmosphere interact?

I have just a few more questions. These are about you.

What year were you born? _____ (e.g., 1975)

Where do you live? State _____ Country _____

The interviewee is *Male* *Female* *(circle one)*

On a scale from 1 to 5, how interested are you in science? (circle one)

Not at all interested 1 2 3 4 5 **Extremely interested**

What is your highest level of education? (mark their response)

_____Some elementary school
_____Some secondary school
_____High school graduate
_____Some college
_____Associate's degree
_____College degree
_____Some graduate school
_____Master's degree
_____Doctorate
_____Other

About how many times, including this one, have you watched a *Science on a Sphere* presentation (here or elsewhere)? _____ times (if this is the first time, enter a 1)

Is there anything else you'd like to say about the program?

THANK YOU FOR YOUR COMMENTS!

FACILITATED OCEAN-CLIMATE QUESTIONNAIRE

THANK YOU for providing feedback about the *Science on a Sphere* presentation. Your anonymous comments will help the Maryland Science Center staff improve their programs.

Date _____ **Time** _____

How would you rate the program overall on a scale from 1 to 10, with 1 being the lowest rating and 10 being the highest? (circle one)

Lowest 1 2 3 4 5 6 7 8 9 10 **Highest**

What would make it a 10 for you?

Please indicate how much you agree or disagree with these statements. (circle your responses)

	Disagree strongly	Disagree moderately	Disagree somewhat	Agree somewhat	Agree moderately	Agree strongly
The presentation was enjoyable.	1	2	3	4	5	6
I learned something new from the presentation.	1	2	3	4	5	6
I learned how the ocean and the atmosphere interact.	1	2	3	4	5	6
There were parts of the presentation that were personally meaningful.	1	2	3	4	5	6
I thought the program was easy to understand.	1	2	3	4	5	6
I liked the visual images on the sphere.	1	2	3	4	5	6
I thought the cart demonstration was an important part of the program.	1	2	3	4	5	6

How much did you know about ocean-climate interactions BEFORE seeing the presentation?
Please indicate on a scale from 1 to 10 with 1=nothing and 10=a great deal. (circle one)

Nothing 1 2 3 4 5 6 7 8 9 10 **A great deal**

How much do you know NOW about ocean-climate interactions? (circle one)

Nothing 1 2 3 4 5 6 7 8 9 10 **A great deal**

PLEASE COMPLETE THE OTHER SIDE

FACILITATED OCEAN-CLIMATE QUESTIONNAIRE

Please complete this sentence: "I never knew that …."

What was the main message of this program?

Please describe an example of how ocean temperature and currents affect climate.

Please describe a visual image that helped you understand the impact of the ocean on climate around the world.

What year were you born? _____ (e.g., 1975)

Are you (circle one) Male Female

Where do you live? State _____ Country _____

On a scale from 1 to 5, how interested are you in science? (circle one)

Not at all interested 1 2 3 4 5 **Extremely interested**

Highest level of education (check one)

_____Some elementary school
_____Some secondary school
_____High school graduate
_____Some college
_____Associate's degree
_____College degree
_____Some graduate school
_____Master's degree
_____Doctorate
_____Other

About how many times, including this one, have you watched a *Science on a Sphere* presentation (here or elsewhere)? _____ times (if this is the first time, enter a 1)

PLEASE PUT THIS QUESTIONNAIRE AND CLIP BOARD IN THE BIN MARKED "SOS QUESTIONNAIRES."

Date: _____ Time _____ Interviewer name: _____

FACILITATED TROPICAL CYCLONES INTERVIEW

How would you rate the program overall on a scale from 1 to 10, with 1 being the lowest rating and 10 being the highest? (circle one)

Lowest 1 2 3 4 5 6 7 8 9 10 **Highest**

What would make it a 10 for you?

Please complete this sentence: "I never knew that …."

What would you say was the main message of this program?

Was anything in the program confusing? Yes _____ No _____
If so, tell me about it.

Can you describe the conditions that must be present for a tropical cyclone to form?

Which visual image on the sphere was most useful in explaining tropical cyclones?

What did you learn from this program about the impacts of tropical cyclones on people?

I have just a few more questions. These are about you.

What year were you born? _____ (e.g., 1975)

Where do you live? State _____ Country _____

The interviewee is *Male* *Female* *(circle one)*

On a scale from 1 to 5, how interested are you in science? (circle one)

Not at all interested 1 2 3 4 5 **Extremely interested**

What is your highest level of education? (mark their response)

_____Some elementary school
_____Some secondary school
_____High school graduate
_____Some college
_____Associate's degree
_____College degree
_____Some graduate school
_____Master's degree
_____Doctorate
_____Other

About how many times, including this one, have you watched a *Science on a Sphere* presentation (here or elsewhere)? _____ times (if this is the first time, enter a 1)

Is there anything else you'd like to say about the program?

THANK YOU FOR YOUR COMMENTS!

FACILITATED TROPICAL CYCLONES QUESTIONNAIRE

THANK YOU for providing feedback about the *Science on a Sphere* presentation. Your anonymous comments will help the Maryland Science Center staff improve their programs.

Date _____ Time _____

How would you rate the program overall on a scale from 1 to 10, with 1 being the lowest rating and 10 being the highest? (circle one)

Lowest 1 2 3 4 5 6 7 8 9 10 **Highest**

What would make it a 10 for you?

Please indicate how much you agree or disagree with these statements. (circle your responses)

	Disagree strongly	Disagree moderately	Disagree somewhat	Agree somewhat	Agree moderately	Agree strongly
The presentation was enjoyable.	1	2	3	4	5	6
I learned something new from the presentation.	1	2	3	4	5	6
I learned how tropical cyclones form.	1	2	3	4	5	6
There were parts of the presentation that were personally meaningful.	1	2	3	4	5	6
I thought the program was easy to understand.	1	2	3	4	5	6
I liked the visual images on the sphere.	1	2	3	4	5	6

How much did you know about tropical cyclones BEFORE seeing the presentation?
Please indicate on a scale from 1 to 10 with 1=nothing and 10=a great deal. (circle one)

Nothing 1 2 3 4 5 6 7 8 9 10 **A great deal**

How much do you know NOW about tropical cyclones? (circle one)

Nothing 1 2 3 4 5 6 7 8 9 10 **A great deal**

PLEASE COMPLETE THE OTHER SIDE

FACILITATED TROPICAL CYCLONES
QUESTIONNAIRE

Please complete this sentence: "I never knew that ...."

What was the main message of this program?

What conditions must be present for a tropical cyclone to form?

Please describe a visual image that helped you understand tropical cyclones.

What year were you born? _____ (e.g., 1975)

Are you (circle one) Male Female

Where do you live? State _____ Country _____

On a scale from 1 to 5, how interested are you in science? (circle one)

Not at all interested 1 2 3 4 5 **Extremely interested**

Highest level of education (check one)

_____Some elementary school
_____Some secondary school
_____High school graduate
_____Some college
_____Associate's degree
_____College degree
_____Some graduate school
_____Master's degree
_____Doctorate
_____Other

About how many times, including this one, have you watched a *Science on a Sphere* presentation (here or elsewhere)? _____ times (if this is the first time, enter a 1)

PLEASE PUT THIS QUESTIONNAIRE AND CLIP BOARD IN THE BIN MARKED "SOS QUESTIONNAIRES."