

ICE PLANET EARTH:

Summative Evaluation Report

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Ice Planet Earth
Evaluation Report

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OVERVIEW

Data show that IPE was successful in creating an engaging film that was valued by museum/planetarium visitors, teachers and their students, and museum partners. The film appealed to children (primarily those over age 10), adults, and family groups. Overall reaction to Ice Worlds was strongly positive at all the participating institutions. The PIs and IPE project staff used visitor feedback to make some adjustments to the film, which resulted in Ice Worlds 2, which was shown at both HMNS and CMNH.

The project sponsored several events and created deliverables including the Polar Explorer DVDs for teachers, several teacher workshops, and special events at most of the museum partner sites, including the Polar Weekends at CMNH and the opening of Ice Worlds and Ice Worlds 2 at HMNS. IPE staff worked with the museum partners to identify scientist-researchers to speak at these events, which were well-received by the visitors who attended the lectures.

Originally, IPE staff planned to create a user-friendly website to engage *both* members of the general public and teachers and their students. Evaluation data shows that museum visitors found the website and related activities, including Polar Explorer and Sea Icebox, somewhat difficult to use. Teachers, who were given these activities in the context of IPE workshops, may be more successful in using these activities with their students than casual museum visitors. The evaluators believe more could be done—for example—an introductory video to orient viewers to Polar Explorer activities—to make the activities more accessible to a wider audience, and facilitate use of the website.

Through IPE, museum partners were able to take Ice Worlds via traveling dome shows to underserved schools, and (in some cases) to host underserved students at their sites. Teachers who took their students to the dome shows emphasized the students' engagement with the film. Data from student surveys indicate that they learned new content from Ice Worlds. Open-ended surveys showed that students learned facts about the Earth, about the ice in the poles, and about ice on other planets. Specific content questions proved to be difficult for students, especially in more advanced concepts such as the effects of melting sea ice on sea levels. There were distinct differences in students' abilities between the different locations as well. Overall, however, the percentage of students answering correctly did improve from pre to post test.

Clearly, more work needs to be done to convey some of these complex concepts to viewers. The evaluators suggest that Polar Explorer DVDs, which contain many of the activities from teacher kits originally developed through IPE, be distributed to schools that request Ice Worlds. This would enable teachers to incorporate key concepts from the film into their teaching, and enrich students' understanding of changes taking place in the polar regions.

SUMMARY

Through a variety of activities and the film, IPE staff has stimulated interest in climate change and its impact on the poles. IPE created a new model of cooperation between planetariums, scientists, and the developers of a full-dome film. The museums/planetariums were pleased to host Ice Worlds and touch on issues of climate change on Earth, along with information about ice in space. The connection between the partner institutions and IPE scientists—and other researchers in the field—were strengthened and facilitated by IPE staff, who helped to bring scientists to the museums to speak about their work.

INTRODUCTION

In the spring of 2008, the University of New Hampshire (UNH) contracted with the Program Evaluation and Research Group at Lesley University (PERG) to evaluate the Ice Planet Earth (IPE) project, including the *Ice Worlds* film. IPE is a three-year NSF funded grant, which focuses on building awareness and understanding of polar processes and centering on the observance of the International Polar Year (IPY), which took place from March 2007-March 2009. The IPE project is a collaboration between scientists and researchers at UNH, the Houston Museum of Natural Sciences (HMNS) and several other domestic and international partners.

A key feature of IPE was the development and presentation of the *Ice Worlds* film. The film was designed for both general audiences including children and adults, and for students. The film is currently running in planetariums both in the United States and in several foreign countries, and in traveling dome shows, which go out to schools and afterschool programs. Partner institutions, which showed (and in some cases are still showing) *Ice Worlds*, include The Carnegie Museum of Natural History (CMNH) in Pittsburgh, PA; the Houston Museum of Natural Sciences in Houston, TX; the Louisiana Art and Science Museum in Baton Rouge, LA; the McAuliffe-Shepard Discovery Center (MSDC) in Concord, NH, and the Oregon Museum of Science and Industry (OMSI) in Portland, Oregon.

IPE was designed to stimulate interest in the International Polar Year through:

- Community lectures and forums with a polar researcher/scientist in conjunction with the show
- Development and presentation of the *Ice Worlds* film and other related products to engage members of the general public, as well as students and their teachers

PROJECT ACTIVITIES

Key project activities have been listed in our Year 2 and 3 Evaluation Reports. Additional project activities are described in the following summary, *provided by the project PI*:

Updates since June 2010:

Ice Worlds continues to play at CMNH, OMSI, and McAuliffe--Shepard in their planetariums and is available at several locations for school groups or special events (see: http://www.nsf.gov/news/now_showing/film/iceworlds.jsp)

July 16, 2010, Anya Suslova presented a webinar from Siberia on her experiences as a teenager helping a research team take samples from the Lena River for Polar Weekend at CMNH. Ice Worlds 2 was also shown during the weekend.

October 23, 2010 – Ice Worlds was shown continuously throughout the day at the NH Tech Fest held at Windham High School, Windham, NH. Over 800 students and their parents attended the event and the dome was busy all day.

March, 2011 -- 300 Polar Explorer CDs were distributed at National Science Teachers Association (NSTA) conference.

4-H connection:

National 4-H has been funded by the Noyce Foundation to implement “innovative science-based education to youth across the nation”. In New Hampshire, a 4-H Science Everywhere Discovery Institute and 4-H Science Ambassador Program is being implemented with a focus on four areas, of which climate change, and in particular, the polar regions, are featured. The IPE project was asked to participate in the Institute kick-off which was held at UNH on February 12, 2011. We showed Ice Worlds to 70 young people (ages 10-14) and their parents and displayed a series of posters about Antarctica from the Antarctica’s Climate Secrets Curriculum (<http://www.andrill.org/flexhibit/flexhibit/materials/index.html>) for the students to look at and ask questions about. The goal is for students to interact with science ambassadors – in our case, scientists from UNH who work in the Arctic or Antarctic, and to be able to take what they learn and teach it to other youth in their county through the 4-H program. We expect that we will be invited to show Ice Worlds at future county events that come about as the program gets going. (NOTE that we didn’t do hands-on activities because of time constraints, but there will be a follow up this spring for students to do some hands-on activities and probably create “flexhibits” using the Antarctica’s Climate Secrets curriculum).

(Project PI email communication)

EVALUATION

EVALUATION ACTIVITIES AND METHODOLOGY

In preparation for the summative report, the evaluation activities, (since the writing of the Year 3 Evaluation report in July 2010) have focused on analysis of data from the various museum partners. Some of this data was collected during site visits to MSDC in fall 2008 and winter 2009; CMNH in July 2009; and LASM in June 2010. The evaluators also collected student survey data from several sites—some from traveling dome shows and some from planetarium visits. In addition, we obtained surveys from a sample of adult visitors who viewed *Ice Worlds* at HMNS. (These surveys were collected by museum staff and forwarded to PERG evaluators).

The evaluators also held frequent conversations with project staff, especially with the project PI. PERG evaluators used a variety of naturalistic methods to obtain data during the course of the project including visits to three partner institutions, (noted above), which enabled the evaluators to survey visitors who viewed *Ice Worlds*. We also conducted a focus group with teacher-attendees at one teacher workshop, and collected data from many traveling dome showings of *Ice Worlds* (primarily through the participating museum partners), and surveyed some teachers who took their classes to see *Ice Words* (mainly in the traveling domes). We used multiple data sources to triangulate our findings.

The following table lists the various data sources and the number of items that were analyzed.

Data Sources

	<i>NH</i>	<i>PA</i>	<i>TX</i>	<i>Oregon</i>	<i>LA</i>	<i>Total</i>
<i>Public Data</i>						
<i>Exit Surveys</i>	47	55	67	0	33	202
<i>Follow up phone interviews</i>	0	4	0	0	0	4
<i>Survey/Follow up for Scientist Lecture</i>	0	4	32	0	9	45
<i>Student Data</i>						
<i>Open Ended Surveys</i>	77	20	0	0	0	97
<i>Pre/Post Surveys</i>	503	47	0	82	90	722
<i>Follow up with Teachers of Stud. Visit</i>	14	0	0	0	0	14
<i>Teacher Data</i>						
<i>Teacher workshop surveys</i>	12	14	0	0	0	26
<i>Teacher workshop follow up surveys</i>	0	7	0	0	0	7
<i>Web/Tech Data</i>						
<i>Sea Icebox User Interviews</i>	14	0	0	0	0	14
<i>Sea Icebox focus group</i>	6	0	0	0	0	6
<i>Sea Icebox online survey</i>	13	0	0	0	0	13
<i>Polar Explorer Interviews</i>	9	0	0	0	0	9
<i>Leadership Interviews</i>						
<i>Co-PI</i>						3
<i>Scientists</i>						3

EVALUATION QUESTIONS

Our evaluation questions were developed in conjunction with the IPE PIs, and consist of the following:

- 1) How do visitors react to Ice Worlds? What, if anything, have they learned about polar processes, seasonal changes and the impact of the poles/ice on climate change?
- 2) What, if any, questions do visitors have after viewing Ice Worlds and/or using the website? How, if at all, do they plan to investigate those questions?
- 3) How do planetariums and other informal science institutions view the film?
- 4) How do teachers and general users respond to the website? What features do teachers find most useful? How, if at all, do they plan to use these materials—including the teacher kits—in their teaching?
- 5) Do visitors value their interactions with scientists/polar researchers? How does their experience compare to those visitors who didn't interact with polar researchers?
- 6) How, if at all, has the project developed collaborations/connections between informal science institutions and scientists?

REPORT

This summative evaluation report examines the impact of IPE and particularly the Ice Worlds film and related products over the course of the project on various constituencies: the general public/adult viewers of the film; elementary through high school students and their teachers; staff at the partner institutions, and IPE staff. The report consists of the following sections: Introduction; Evaluation; Findings, and Discussion/Summary. Following the report is an Appendix, which contains the evaluation protocols.

FINDINGS

GENERAL VISITOR EXPERIENCES: ICE WORLDS AND RELATED ACTIVITIES

[Insert demographics for visitor surveys]

	<i>NH</i>	<i>PA</i>	<i>TX*</i>	<i>OR</i>	<i>LA**</i>	<i>Total</i>
<i>Public Data</i>						
<i>Exit Surveys</i>	47	55	67	0	33	202
<i>Follow up phone interviews</i>	0	4	0	0	0	4
<i>Survey/Follow up for Scientist Lecture</i>	0	4	32	0	9	45

* Most data collected from sample of 36 surveys collected from opening of Ice Worlds 2 in May 2011

**Five (5) respondents from LA were between the ages of 12 and 17, while all other surveys were from adults

ICE WORLDS

Ice Worlds is a very well produced short film explaining the importance of ice on Earth, as well as in our solar system and beyond. (museum visitor)

Overall reactions

Overall reactions to Ice Worlds among our respondents were very positive, at all sites where data was collected. When we asked viewers how they would describe Ice Worlds to a friend, more than $\frac{3}{4}$ described the film in complimentary terms, saying Ice Worlds was “informative,” “interesting” and “thought provoking.” (Some visitors didn’t answer this question).

Visitor descriptions of Ice Worlds are reflected in the comments below, many of which focused on polar processes and changes at the poles:

A very informative film on what is happening at the poles and [other information] that scientists know. (museum visitor)

Very informative video on the polar ice caps and their climate changes and planets that may contain ice. (museum visitor)

Documentary about the global effects of the melting ice caps. (museum visitor)

Factually stimulated, visually engaging, especially 3-D images of Earth. (museum visitor)

Very interesting, beautiful photographs. (museum visitor)

Most visitors focused primarily on changes on Earth, though some emphasized the film's presentation of ice on other planets as well.

It was an informative movie. Kind of like something you'd see on Discovery. It showed Earth's ice poles and other ice planets. (museum visitor)

An interesting movie. Mentions some other "ice worlds" in our solar system (comets, moons). (museum visitor)

A minority of visitors described the film in more neutral or negative terms, such as "mediocre" or "pretty simple and basic." While some viewers enjoyed the animations such as the polar bear, others were disappointed with the visual effects and wanted more photographs/real images.

Interesting but could use more live shots. (museum visitor)

Nice photography, elementary content. (museum visitor)

The film did not measure up to my expectations. (museum visitor)

Fewer animations and more actual footage would have been nice/more engaging. (museum visitor)

Knowledge of International Polar Year (IPY)

Very few of our respondents were familiar with IPY. Even those who had heard about the Polar Year did not know specific details about it.

Our sample at HMNS, which were coincided with the opening of Ice Worlds 2, reflected a much higher percentage of scientists than our other samples. (About 2/3 of our 36 full surveys from Houston were completed by those in science-related fields, including geologists). However, even at HMNS, less than a quarter of respondents had significant knowledge of IPY.

Knowledge of polar processes

Most respondents had limited prior knowledge (before viewing Ice Worlds) of the polar ice caps and related topics. Most visitors who answered this question said the poles were shrinking or melting, and some mentioned global warming as a cause, but lacked more specific information about polar processes, as reflected in the comments below.

Just that they're melting and decreasing year by year. (museum visitor)

That they are receding at an alarming rate. That there are field scientists constantly studying, including [those from] UNH. (museum visitor)

That because of global warming the ice caps are in more danger than they have been before. (museum visitor)

Others cited the poles as a source of fresh water and/or discussed seasonal variations.

Not much—that the water contains minerals, hence the blue color in the ice. (museum visitor)

Hold a large percentage of the world's fresh water and are rapidly depleting.(museum visitor)

That they do grow and diminish with each rotation of summer/winter.
(museum visitor)

Some respondents, particularly those in scientific fields, possessed more knowledge about the poles.

They are melting. CO-2 increase in the ice record. (museum visitor)

[I know] quite a bit. I'm a geologist. (museum visitor)

Scientists make ice core samples to review past world climate conditions. [The poles are] a kind of desert with snow. (museum visitor)

We had a whole class about climate change. (museum visitor)

Sources of Information

Most respondents cited various media as their primary source for learning about the poles. Primary sources (in order of frequency) included:

- Television, including the Discovery Channel and Public Television
- Magazines
- School including college courses
- General reading
- Internet
- General news media
- Newspapers
- Academia and research interests

Learning through Ice Worlds

More than 80% of those who answered our survey question said they had learned new information by viewing Ice Worlds. Many respondents noted changes in ice and attributes of ice on Earth and its existence on other moons and planets. Others discussed changes, such as the thinning of the ice in polar regions and seasonal variations at the poles.

Listed below are common topics cited by our respondents, according to estimated frequency of response:

- **Ice on other planets, moons, ice in space**

There is so much ice on moons and the ice geysers (museum visitor)

- It made me think about ice worlds beyond planet Earth (museum visitor)
- Yes, the possibilities of inter planetary bodies of water was quite a surprise.(museum visitor)
- The ice on other planets/moons, the cycles of ice, how animals and wildlife are sustained. (museum visitor)
- The moon that rained methane. I thought methane was created by plankton and animal matter. (museum visitor)
- **Changes at the poles—thinning of ice caps, reduction of ice and its impact on Earth and its people, and issues related to global warming**

Global warming is seen at one pole and not the other. The really fast and bad moves of the glaciers were very interesting; consider showing 2 frames at each time point to allow us to see them better (museum visitor)

There is substantial support for those who fear global warming. (museum visitor)

Shrinking ice has changed the way of life for people living near it. (museum visitor)
 - **Seasonal variations and cycles of ice**

The South Pole expands while the North Pole retracts and vice-versa. (museum visitor)

Just the intensity of the weather changes on poles, how so little light gets to them one part of the year, and the rest of the year it's always daytime. (museum visitor)

The reciprocity of ice coverage at the poles (museum visitor)
 - **Physical features and properties of the poles and arctic regions**

I had not realized that the Arctic Ice Cap covered water (museum visitor)

Didn't know such a majority of ice was in the Antarctic. (museum visitor)

Characteristics of glaciers. They are more dynamic than I thought. (museum visitor)
 - **Changes over time in the polar regions and ice sheets**

I didn't realize that some changes were so recent such as the separation of the British Isles only 10,000 years ago. (museum visitor)
 - **Impact on polar life including krill**

- Algae formed on the ice and gave food to the krill (museum visitor)
- The krill are disappearing at an alarming rate... (museum visitor)
- **Northwest Passage, political issues, and resources**

I was not aware of the efforts that had been made in the past to clear a pathway between the continents [Northwest Passage]. I had also never thought about the natural resources [in the region]. (museum visitor)

Russia claiming the North Pole, there is less land in Antarctica than I thought.(museum visitor)

All the natural resources [at the north pole]. (museum visitor)
 - **Research activity in the arctic regions**

We actually have collected samples of ice from Antarctica and have them labeled and stored in tubes, so we can compare them chemically through the ages.(museum visitor)
 - **Other observations**

Yes, all the changes shown in the graphics were new to me. The measurements were new to me. (museum visitor)

Visitor questions

About half of our respondents had questions sparked by Ice Worlds. About one-third of visitors did not answer this question, while others did not have questions sparked by the film.

Many visitor questions focused on global warming, climate change and what, if anything, could be done about this issue, as reflected in the questions below:

- What will happen if all the ice melts? (museum visitor)
- Where is all the water going, is it along our shores, taking our sands back out? They talked about the Gulf getting warmer. I noticed a manatee coming to Massachusetts. What's going on in the ocean? (museum visitor)
- Is global warming still making the ice melt faster? (museum visitor)
- The future of climate change (museum visitor)
- How serious is it being taken by governments, we have to be concerned about the next generation, not just the current generation. Science is taking it seriously but how much [is being done] by government that could have a bigger impact in making change. (museum visitor)
- Why do people continue to deny the effects of global warming? (museum visitor)

Several questions focused on whether global warming was primarily caused by humans.

Whether global warming is a result of man or just a natural occurrence despite man.
(museum visitor)

I wonder why the krill population is shrinking. Is global warming a partly natural phenomenon? How is the human presence affecting it?
(museum visitor)

How can (will) we differentiate our impact on climate from that which happens naturally?
(museum visitor)

Other questions related to ice on other planets and properties of ice and water on Earth, and about those worlds in more detail:

If fresh H₂O is running off the polar ice sheets into earth's seas, then why are the seawaters salty?
(museum visitor)

If liquid water is possible on far away planets and moons, then is it possible (with future technological advancements) to make them suitable for life?
(museum visitor)

Will the Earth become like Mars, was Mars previously like Earth?
(museum visitor)

The cause of pressure—related to volcanic and chemical activity, the nature of Mars underground water
(museum visitor)

Several visitors were interested in research activities and exploration on Earth and beyond.

I'm pretty curious how and when scientists plan to study planets and moons so far from earth.
(museum visitor)

I would like to know how the research is being conducted. (museum visitor)

Following up on questions

About $\frac{3}{4}$ of visitors who had questions said they were likely to explore them, to varying degrees. Some visitors said they would read general information about related topics after viewing Ice Worlds, and many said they would use the Internet to explore their questions. Several visitors were particularly interested in learning about what they could do to address the problems of global warming and climate change.

Sure I will continue to read all the information out there in order to stay up to date/educated. (museum visitor)

Perhaps - through reading, TV program, internet research. (museum visitor)

I will pay more attention to ice studies. (museum visitor)

Other areas of learning

We asked visitors if they were surprised by anything in Ice Worlds, which provided another opportunity to gauge visitor learning. Approximately half of visitors discovered new

information or were surprised by something in Ice Worlds, particularly in the areas of attributes of ice on other planets and on Earth, issues related to global warming and climate change, and the impact of these changes on animal and plant life in the polar regions. (Another 1/3 did not answer this question), and others were not surprised by anything in the film.

How sensitive the glaciers are to slight climate changes. I was surprised at the technique of measuring mass with satellites. (museum visitor)

That ice was different on all sorts of planets and moons. I liked the ice that sprayed out and curved 90 degrees. (museum visitor)

Frozen water and possible liquid water elsewhere in the solar system, possibility of the Earth getting its water from comets. (museum visitor)

That information is contained and recorded for hundreds of years [in the ice].(museum visitor)

The extent of ice, the importance of ice. (museum visitor)

The change from dog sled to boat usage in [Greenland]. This shows significant global warming! (museum visitor)

Russia claiming the North Pole, there is less land in Antarctica than I thought.(museum visitor)

I was really surprised that countries are actually trying to claim the ocean/land around the pole. (museum visitor)

One visitor was struck by the visual representation of changes in polar ice over time.

Seeing the fluctuation of the ice in graph form was more striking than simply hearing it has happened, or even than seeing ice caps increase or decrease.(museum visitor)

Visitor Suggestions

We asked visitors for their feedback about how to improve Ice Worlds. As discussed previously, most viewers enjoyed the film, but some visitors did provide suggestions to *improve* the film. (It should be noted that there were some differences as to how Ice Worlds was presented at various sites—at most of the partner institutions, the pre-show and main portion of the film were presented sequentially, and voiced by two different actors. A revised version (Ice Worlds 2) opened in Houston in May 2010, which integrated some information from the pre-show into the film itself, and used one narrator (rather than two) with a standard American accent.

Visitor suggestions fell into the following categories:

- *Technical issues, graphics, visual content:* Many viewers wanted more photographs and “real images,” and some preferred less animation. Some viewers, particularly those at CMNH, complained about technical glitches, and the formatting of the film.

Note: The theater at CMNH is not a full-dome, and some parts of the film did not appear directly on screen.

- *Content:* Some viewers wanted more in-depth content information, particularly about global warming and what individuals can do about it, why these changes are occurring, and how this will impact daily life in the future. Several wanted more scientist participation in the film—i.e. some ‘talking heads.’
- *Opening/pre-show:* Some viewers found the pre-show (introduction) to Ice Worlds somewhat confusing, and said it didn’t seem to fully connect with the main film. (This was not an issue with Ice Worlds 2). Some viewers found the film’s narrative disjointed, saying it “jumped around” between topics, such as ice on Earth and ice in space.

RELATED ACTIVITIES FOR GENERAL AUDIENCES

Scientist Lectures

At several sites, the partner institutions presented scientist lectures in conjunction with the opening of Ice Worlds. (The PI and IPE staff helped to locate presenters for these events). Most visitors who attended the lectures found them engaging, and enjoyed learning about the scientists’ work in the polar regions. The evaluators collected data from visitors at CMNH, LASM and [through museum staff] at HMNS. (We also observed researcher presentations at MSDC, but did not formally collect data there.)

Our data show that most of visitors who attended a scientist lecture and viewed Ice Worlds found the combination of the two presentations interesting and informative. At HMNS, 32 of 36 survey respondents listened to a lecture before watching Ice Worlds; their feedback is presented in comments below:

The variety of approaches to getting the information across was very helpful.(museum visitor)

Listening to the lecture expanded on the themes of the show. (museum visitor)

Much greater appreciation of the dramatic changes occurring. (museum visitor)

I have learned a great deal and now have a better understanding of what’s going on. (museum visitor)

[It provided] real world data. Interesting that arctic is more involved than Antarctic. (museum visitor)

A few visitors said some of the information presented in the HMNS lecture was unclear, and that the pace was too slow. Some wanted more context, in terms of changes at the poles.

Sometimes answers are too long; being more succinct would make things easier to follow and pay attention to. Trying to connect more with an average audience would also be good. It’s pretty dry. (museum visitor)

Shorter answers are easier to understand. Too much information for non-scientists and for me. Some analogies would help. (museum visitor)

The scientist did not talk very much about the poles, just Greenland. (museum visitor)

In Louisiana, five of nine visitors said viewing the film and listening to the lecture had impacted their understanding of changes at the poles, as reflected by the following comments.

It personalized the experience and the film. (museum visitor)

It helped me see how things are changing. (museum visitor)

Global warming is there—what to do? (museum visitor)

At CMNH, the evaluators interviewed four visitors who had attended the scientist lectures. (Most had not seen *Ice Worlds*). Two visitors said they enjoyed the presentations, while two had neutral or negative reactions, calling them “a little dry” and “lacking in the delivery.”

All said they had learned something new by listening to the lecture, as noted below.

It was very informative, lots of details regarding Greenland and the ice sheets. (museum visitor)

I didn't realize that so much of the ice had permanently melted and impacted hunting by causing people to use boats instead of dogsleds. (museum visitor)

Two of these four visitors identified questions that were sparked by the presentations.

Is overpopulation and industrialization exceeding this or would the melting be happening anyway? What lives and grows in the water underneath the ice? Are the people in Greenland over-fishing? (museum visitor)

What needs to happen to reverse carbon fuel use? What can be done to change the energy policy? The US is starting late in its attempts to change energy use. Will we be able to make changes to affect change in a 10-20 year window? (museum visitor)

Finally, visitors offered a few suggestions to enhance the scientist's lecture.

Have the presenter use a different pointing device. It was hard to follow this device. (museum visitor)

Make the presentation more visually appealing and stunning. Use less graphs. Make the presentation appeal to a broader audience such as children. (museum visitor)

At CMNH, the scientist lectures were presented as part of “Polar Weekend,” an annual event including the showing of *Ice Worlds*, discovery carts with hands-on activities staffed by museum docents, and a lecture by a glaciologist at UNH, affiliated with IPE. For the July 2009 weekend, the museum also offered a discussion via satellite hook up with a researcher currently doing research in Northern Siberia. For the 2010 weekend, IPE sponsored a lecture by Anya

Suslova, a young scientist in Siberia, who spoke with museum visitors by video hookup. A series of other activities, including a showing of Ice Worlds 2, were included in the weekend activities.

SEA ICEBOX

The evaluators tested an early version of the Sea Icebox activity with a group of teachers enrolled in a graduate course at Lesley University, and with a sample of museum visitors at the Boston Museum of Science during Year 2. Respondents' feedback about Sea Icebox was mixed; many users, particularly among the museum visitors, found the activity somewhat confusing and difficult to use. Based on this feedback, IPE staff added an introductory video and additional information about how to explore the activities embedded in Sea Icebox. IPE staff also decided to focus the use of Sea Icebox and Polar Explorer primarily (though not exclusively) for teachers and their students, rather than members of the general public.

For a complete discussion of our findings and users' comments about these activities, see the IPE Year 2 evaluation report.

POLAR EXPLORER

The evaluators conducted a series of informal interviews/interactive observations with visitors at Boston's Museum of Science in December 2010. PERG evaluators conducted 9 interviews with a total of 16 visitors, who were asked if they would give us feedback on a website/series of activities dealing with the polar regions. Visitors spent 10 to 20 minutes using the activities, while the evaluators observed and encouraged respondents to make comments and share their thoughts as they used Polar Explorer.

Our respondents explored these activities, which are linked to the IPE website (and available for download) and included on the Polar Explorer CD, which has been distributed at some IPE-sponsored teacher workshops. (Please see the following section for information on teachers' feedback about Ice Worlds and related activities).

Overall reactions

Visitors found some of the activities and information presented in Polar Explorer to be interesting, but most said the text was too dense, and found the *amount* of information somewhat overwhelming. Many experienced the activities as unrelated or weren't sure what they were supposed to *learn or take away* from the site. As one young woman explained, "I'm looking for a more structured experience—some kind of narrative." Without the context of the film, visitors experienced the activities as relatively *disconnected* and were unclear about the goals of those activities, or Polar Explorer in general.

Visitor exploration and feedback

We asked respondents to explore the activities using the tabs on the ‘front page.’ Almost all worked from left to right, beginning with the Polar Ice tab. The following sections summarize visitors’ reaction and feedback about each section of Polar Explorer. Many of the comments below concern visitors’ navigation through the activities and usability issues.

Note: These activities were viewed on a laptop screen, which made viewing somewhat difficult.

Polar Ice

Almost all visitors looked at the Global View and appeared to find it interesting. Some had trouble finding the control buttons/player to see the cycle of one year. Visitors were *looking for directions*—this was a problem in many areas of Polar Explorer. The Seasonal View often seemed to confuse viewers. They commented on how fast the cycle was going/Earth was turning and most didn’t appear to fully understand what they were looking at, or if the yearly cycle at the bottom of the screen related to the seasons. The Earth appeared to rotate at two different speeds—picking up speed later in the year, for no clear reason. Most visitors skipped the Data View/Sea Icebox section; those who did see it found it too dense to be of interest. A few did watch the cycle of one month over time, but did not make observations or appear to draw conclusions about what they were seeing.

Polar Melt

Most visitors found this interesting, though some naturally wanted to see *New England* or other regions that were not visible. Several expected to be able to click *on the map* and move around. About half needed help in locating the scale of sea level rise at the bottom of the screen; some would not have found it without guidance. (More explicit directions would solve this problem). A key/legend could be helpful in providing more information about how these areas would be affected, red = below sea level, probable floods, etc.

Polar Claims

Some visitors found this section engaging, while others quickly moved on to something else, probably due to the density of the text. A few visitors didn’t see the connection to the issue of climate change at the poles. (This ties into the larger, and more widespread reaction that the activities presented a lot of information but visitors did not know what they were supposed to learn or take away from these experiences).

Polar Life

Visitors were split on this section—some enjoyed playing the game, while others thought it was superficial and not informative. Most became somewhat frustrated in attempting to locate the

correct locations for the penguins and polar bears (no one found all the correct habitats), and many felt the directions were not clear. Visitors had to be shown the ‘drag and drop’ feature, or it took some time for them to figure it out. They wanted “a hint” or more information about where the animals lived. One visitor suggested having information about how the changing ice/global warming was impacting the animals’ lives.

Polar Update

This section initially presents a blank [black] screen, and many visitors were unsure of what to do. We often had to tell them to use the drop down menu. Respondents found the lists overwhelming and usually went on to other areas. Those who did discover the NASA video of the cryosphere found it interesting; one suggested using the video as an introduction to all the activities, to provide more of a context for viewers.

Polar Video

Respondents did not watch the film; they seem unlikely to do so in a kiosk setting.

Magnetic Poles

Visitors had some difficulty figuring out the need to click on the map (though the directions are given on screen). Some enjoyed the game of finding the poles, but most did not understand what “magnetic poles” are, or why they had changed their locations over time.

Map Explorer

Visitors enjoyed looking at the map (usually in Blue Marble mode) but they had difficulty locating the ‘chooser’ to change the map view. Also few discovered the viewer, until we showed them. Respondents expected to be able to zoom in further; several visitors commented on the interface as being less effective than Google Earth’s. They also wanted to know what the various colors meant—there is no legend or explanation as to what the colors mean (in ‘elevation’ for example), or even in Blue Marble.

Summary and additional thoughts

Visitors made many comments/suggestions about issues of usability and navigation while using Polar Explorer. Museum visitors (a very different group than teachers and K-12 students) are looking for a social experience and accessible information at the museum, and don’t usually want to “work that hard,” as one college student explained. The activities raised some questions for visitors, but in many cases—for example in Polar Life—the site didn’t answer those questions, or the information (in the Data view of Polar Ice and in the Polar Update sections), is not easy to find and not presented in a user-friendly format.

With some additional context and directions, these activities could be more meaningful, and therefore more engaging for general museum visitors. For example, the co-PI at HMNS reported that the museum had set up single activity kiosks, so that their visitors could try two of

the Polar Explorer interactive activities—one at each kiosk—without having to navigate through the entire menu.

Overall, visitors were looking for more interactive and engaging ways to learn about the poles, global warming, and its effects. The evaluators believe that it would not be difficult to make some adjustments to make Polar Explorer more interesting for museum visitors and website users.

TEACHERS' RESPONSE TO ICE WORLDS AND RELATED ACTIVITIES

OVERALL REACTIONS TO ICE WORLDS

Teacher feedback

PERG evaluators collected data from participating teachers, including a sample of educators whose students viewed Ice Worlds in one of the traveling domes at their schools, and others who attended teacher workshops at CMNH and UNH. Those teachers whose students had viewed the film (primarily in the domes) reported that the children enjoyed Ice Worlds. About 2/3 of teachers said the film tied in with their curriculum. (For a more complete discussion of teacher reaction to Ice Worlds and IPE-sponsored teacher workshops, see the Year 3 Evaluation Report).

Almost all teachers said that their students had learned something new and found the film engaging. About half of our respondents did some preparation or follow up either before or after their students had seen Ice Worlds. (Most of our respondents were elementary or middle-school teachers, though we also spoke with two high-school teachers).

One teacher stressed the value of providing some information to educators, including possible pre/post questions, before students see the film. (Providing copies of the Polar Explorer DVD to schools would alleviate this problem.)

Since that was the first time I had seen the film, I didn't have any particular pre or post questions, but that would be a good idea—to give teachers in advance some resources for before or after [their classes view] the film.

(high school teacher)

OVERALL REACTIONS TO IPE TEACHER WORKSHOPS AND SCIENTIST LECTURES

Ice Worlds film and related activities

We collected data from 14 teachers who attended a teacher workshop at CMNH in July 2009, and 12 teachers who attended a workshop in May 2010 at UNH. The teachers represented a range of grade levels, from elementary through high school.

Teachers had generally positive reactions to the film, various activities, and the scientist lectures. Several teachers did suggest that clearer linkages could be made between ice and related conditions on Earth and in space; they found the juxtaposition of the two topics somewhat confusing.

Because the students and even to some degree the general public is not going to be able to make those connections. We understand it because we know more than the general public or our kids. Maybe making it more explicit would make it easier for those on a different level to understand. (teacher)

The other thing would be like have a little more segue time between ice in space, ice on earth, ice on the moon, ice on a comet. It is great that they touched on them all so that they (the students) can see the relationship but if they don't do that segue the kids just sort of...(voice trails off.) I know what I was looking at, they [the students] don't. (teacher)

At UNH, teachers viewed the film in a traveling dome. Most found Ice Worlds engaging and thought it would be educational for their students, though a few said they would prefer to have them see the film in a planetarium rather than a small dome.

The New Hampshire teachers tried out a variety of activities, which they found potentially useful in the classroom. These teachers also tried out Sea Icebox, with guidance from IPE staff, and some planned to use it with their students. At CMNH, teachers were given materials/kits but did not actively try out the activities. Most of those teachers also said they had gained useful materials and information through the workshop. (For more detailed analysis of our findings, see our Year 3 report).

Scientist lectures

Teachers at both workshops enjoyed having a scientist/researcher participate in the program. At UNH, several teachers commented on how they would share the information gained through the lecture with their students.

I find the data fascinating, and the reasoning that goes along with the data, as well as how the reasoning relates to people's opinions in the real world. (teacher)

Yes - very. Having a researcher give part of the presentation lends a real level of credibility to the information we receive and therefore to the information we share with

students.

(teacher)

That is the best/most important part. I really enjoy learning what current research is happening and what hypothesis are out there.

(teacher)

At CMNH, focus group teachers also found the lecture particularly valuable, as they explain below:

I am not a high school science teacher nor do I plan to be, but I got everything he said. I think it reinforced what I have said in the past and what I need to say in the future. I thought he was phenomenal.

(teacher)

I like that it is not biased. I like that he [scientist] gave facts and didn't put a lot of opinions in. He just said what we are observing. This is the information we are collecting and this how we are charting it. A lot of times you get scientific information that is very biased that looks at just one side. He worked at presenting the facts and the information that they got...

(teacher)

Carryover into the classroom

As noted above, teachers generally found the activities provided to be relevant to their teaching. A few teachers, who taught younger (primary grade) children, thought some concepts in the film and some of the activities were too advanced for their students, but most said they planned to use some of the activities in their classrooms.

Well I loved the experiments. I would use them because I teach a whole month long unit on polar animals. I have a smart board in my classroom and I would use a lot of those websites. I don't think they [elementary students] have a concept of what a glacier is. I think they have a concept that it is a big chunk of ice that sits there and I think the websites might help to make that clear.

(teacher)

...you talk about fossil fuels and alternative energy sources but working stuff in about climate change and how the glaciers are changing and how that is affecting our climate is something that I think the 9th graders definitely need. Either in my earth and space or in my straight biology. Yeah, the hands on experiments and the hands on things that are portable and easy to do are definitely always a plus, so being able to work that in is definitely better.

(teacher)

Ice melt on land vs. water is very transferable to physics, general science, earth science...etc.

(teacher)

I can fit them into different areas. (Heat exchange, effects of climate change, biological adaptations).

(teacher)

The evaluators conducted a follow up survey and got responses from 7 teachers who attended the CMNH workshop. These teachers were generally pleased with the workshop and several had used information and activities from the session with their students. They particularly enjoyed the scientist's presentation and listening to researchers in Siberia (via video hookup).

I remember lots of things. The video-conference and the discussion at the museum with the glaciologist was very informative. Also the various activities to use in the classroom was very helpful. (teacher)

I was really interested in talking to the team in Siberia it was so cool to hear first hand experience. (teacher)

Several respondents discussed how they had used the information in their classrooms, as noted below:

It fit in very nicely because I teach Environmental Science. (teacher)

I was transferred from third grade to first grade, so the information and data as specific as it was, was not used in the classroom, specifically. However, I felt the background knowledge I gained were well worth my time and your program. I feel it strengthened my ability to talk with children about how important it is to be proactive, educated and to continue to learn. In our weather unit I referenced changes in our world, and some information that is being gathered, how and why it is gathered, to help us learn, and make informed, smart decisions. (teacher)

I used the temperature differences in different reflecting surfaces. I used the CD to add to information already presented in class. The energy beads to show how the sun's energy is always present, although sometimes hidden. (teacher)

Note: For more information about teacher response to the CMNH workshop, see the Year 3 Evaluation Report.

STUDENT SURVEY RESULTS

Surveys were collected from youth/students in four locations; New Hampshire (MSDC), Pennsylvania (CMNH), Louisiana (LASM), and Oregon (OMSI). The evaluators and museum staff collected two different types of surveys from students. Much of the student data was collected in traveling dome shows sponsored by three of the four institutions. (OMSI hosted school groups at the museum). The first was a multiple-choice survey, which asked about students' interest in polar issues, as well as a very short set of pre/post content questions. Additionally, a short open-ended survey was passed out to a smaller number of students during select screenings to gather more in-depth reactions to the show.

MULTIPLE CHOICE SURVEY – ATTITUDES AND BELIEFS

Evaluators collected a total of 1496 pre/post surveys from student groups who viewed Ice Worlds. Because on-site personnel often collected the data, there were some differences that make cross-site analysis impossible for various items. In New Hampshire, data was collected using electronic clickers, which only provided aggregate data, not allowing for cross tabulation by question. In Oregon, content questions were not asked before and after the show, instead only asking them afterwards, making pre/post comparisons impossible. For these reasons, in the following section there are often multiple tables per survey item, depending on the respondents' location.

Table 1: Number Student Multiple Choice Surveys Collected and Analyzed

Location	Collected	Analyzed	% of Those Analyzed
<i>Louisiana</i>	270	90	12%
<i>Oregon</i>	243	82	11%
<i>Pennsylvania</i>	47	47	7%
<i>New Hampshire</i>	936	503	70%
Total	1496	722	100%

Of the 1,496 surveys collected, a sample of 219 student surveys was randomly chosen to be analyzed using SPSS statistical software and Microsoft Excel. Because of the low numbers from Pennsylvania, all surveys collected there were included in the analysis.

Tables 2 and 3 below show the gender and age distribution for the sample responses. Slightly over half of students were males, and slightly over half were students under 12 years old (most between 8 and 12). Another 37% were between 12 and 15 years of age, while the remaining students were 16 years and older.

Table 2: Frequency of Males and Females Responding to Survey

	<i>Frequency</i>	<i>Percentage</i>
<i>Male</i>	388	54%
<i>Female</i>	296	41%
<i>No Response</i>	38	5%
Total	722	100%

Table 3: Ages of Students Responding to Survey

	<i>Frequency</i>	<i>Percentage</i>
<i>Under 12</i>	373	52%
<i>12 to 15</i>	269	37%
<i>16 to 18</i>	23	3%
<i>Over 18</i>	27	4%
<i>Blank</i>	30	4%
Total	722	100%

All locations had similar distributions of males and females, and most had slightly over 50% of their group under the age of 12. Pennsylvania was the only exception, with 62% of their group between the ages of 12 and 15, and only 38% under 12.

Attitudes and Beliefs

Prior to viewing the show, students were asked, “*What do you think is the main cause of global warming?*” in order to gauge their perspective on the mechanisms behind changes in our Earth’s climate. As can be seen in table 4 below, student responses varied; the greatest percentage believed that global warming is primarily a man-made crisis. This was closely followed by the belief that humans have played only *some* part in causing climate change, and that scientists were still unsure of the true causes.

Table 4: What do you think is the main cause of global warming? (All responses)

	Frequency	Percent
<i>a. It is natural and not caused by humans</i>	84	12%
<i>b. Humans have played some part</i>	162	22%
<i>c. It is primarily a man-made crisis</i>	205	28%
<i>d. I don't know</i>	67	9%
<i>e. Scientists are still unsure of the causes</i>	164	23%
<i>No response</i>	40	6%
Total	722	100%

There were clear regional differences in responses to this question by location. Thirty (30%) percent of students in Louisiana believe that global warming is natural and not caused by humans. In contrast, the most frequent response in Oregon and Pittsburgh was that humans play *some* part in global warming, while in New Hampshire, 35% of students think global warming is primarily a man-made phenomenon. Another 30% in New Hampshire believed that scientists were still unsure about the cause of global warming.

Table 5: Causes of Global Warming by Location

	n	a. Natural	b. Humans some part	c. Man-made	d. I don't know	e. Scientists unsure	NR
LA	90	30%	26%	16%	16%	10%	3%
OR	82	6%	49%	11%	20%	12%	2%
PA	47	4%	32%	26%	11%	0%	28%
NH	503	10%	17%	35%	7%	30%	1%

When the same question was analyzed by gender and age, only slight differences were found. Students under 12 years old were more varied in their responses, with 23% saying that they “don't know” the cause of global warming, and their other responses spread across the categories. Older students most often responded that humans played *some* part in climate change. There were no major differences between males and females.

The next two questions asked students about their level of interest in learning about changes at the poles, and about learning about ice on other planets. These were also asked before the show.

Table 6: How interested are you in learning about changes at the poles?

	<i>Frequency</i>	<i>Percent</i>
<i>Very Interested</i>	193	27%
<i>Somewhat Interested</i>	274	38%
<i>Not Interested</i>	146	20%
<i>No Response</i>	109	15%
Total	722	100%

Thirty-eight (38%) percent of students said that they were “somewhat interested” in learning about changes at the poles. When analyzed by location, 61% of participants in Louisiana said that they were “very interested.” Additionally, 58% of those under 12 were “very interested” as well. There were no differences between males and females.

Table 7: How interested are you in learning about ice on other planets/moons?

	<i>Frequency</i>	<i>Percent</i>
<i>Very Interested</i>	368	51%
<i>Somewhat Interested</i>	203	28%
<i>Not Interested</i>	112	16%
<i>No Response</i>	39	5%
Total	722	100%

Half of all respondents were “very interested” in learning about ice on other planets. The percentage of males and those under 12 who were “very interested” was slightly higher than that of females of those who were 12-15 years old. Once again, a high percentage of students in Louisiana (71%) were “very interested,” versus no more than 50% of participants in other locations.

STUDENT LEARNING

Open ended responses

In order to gauge what students learned from watching Ice Worlds, they were given one of two surveys. A smaller sample was given an open ended set of questions, including one that simply asked “Did you learn anything new from watching Ice Worlds?”

Students responded to this question with a variety of answers about new things they learned. Most were facts about our planet:

That the number of ice each year in the north and south pole change during the months

I learned that krill is very important

We are a country that wants to claim the arctic

I learned that they think Antarctica was a tropical island

I learned that the world had an ice age

In the ice age New York would be covered in a kilometer of ice

I learned that there is land under Antarctica

The second most common type of response described learning about ice on other planets. Many responses noted the fact that ice *exists* on other planets.

Saturn's rings are ice

I didn't know there was ice on different planets

Some responses were specific to the changes happening in the poles:

I learned that we should save the ice caps

I learned that ice can affect the environment

I learned how the world changes over time I learned that we need to take care of the earth so we can be here for future generation

Surveys also asked students if anything surprised them about the show. Two-thirds of the students said yes, and described something that surprised them. Most responses were similar to the above question; students were surprised to learn that ice exists on other planets, that there is land under Antarctica, and at the role that ice plays on Earth.

Yes, I can't believe Mars has ice, krill is dying and now the CO2 levels rocketed after the industrial revolution.

Yes, that people take ice from snowstorms and different places and put it in a container from different years too.

That Antarctica is land and how much ice was in NY.

Responses to the previous few questions also indicated some misconceptions that the students formed. This was only a small number of responses, and usually this came out of remembering the differences between the north and south poles.

For instance:

I learned that there's clear land under the north pole.

I did not now that polar bears was the biggest animals in that Antarctica.

The north pole used to be tropical.

Most students responding to the survey had questions based on what they saw in the film. These covered a wide range of topics:

Just because there is ice why does it mean life?

How do we know that there is land under the ice in the south pole?

How did they know all about the planets and what's in them?

How can glaciers move?

How many polar bears are left on earth?

How many planets contain ice?

Are the other planets melting?

How long until ALL the ice is gone, and how will it affect us?

About half of these students said they would follow up with their questions by looking them up somewhere, most commonly the internet, a book, or by asking a teacher or scientist.

Pre/post content questions

Students watching Ice Worlds were also given four content questions, before and after the film, as a quick measure of their understanding of some major concepts presented in Ice Worlds. Due to a difference in data collection methods, however, students in Oregon were only given the questions *after* viewing the film, therefore the numbers differ slightly or Oregon is not included (as noted). Responses are also broken down by location, age of respondent, and gender, to explore possible differences. (Correct answers are in bold)

Table 8: When there is more ice cover, sea levels:

	<i>Pre (n=137)</i>	<i>Post (n=219)</i>
<i>a. Rise</i>	34%	23%
<i>b. Fall</i>	21%	40%
<i>c. Stay the same</i>	18%	9%
<i>d. Change at the poles</i>	23%	23%
<i>No response</i>	4%	5%

Overall, students who watched Ice Worlds increased their knowledge of the effects of ice cover on sea levels. Before the film 21% of youth answered correctly, while afterwards this increased

to 40%. However, as these surveys were taken immediately after watching the film, the fact that only 40% of students were correct indicates that the clarity of this concept could be improved.

Note: The choice of answers presented in this question may have confused some respondents; option ‘d’ (change at the poles) could be considered correct in some cases.

Table 9: Percentage Responding Correctly by Location

	<i>Pre</i>	<i>Post</i>	<i>Change</i>
<i>Louisiana (n=90)</i>	18%	30%	12%
<i>Pittsburgh (n=47)</i>	28%	49%	21%
<i>Oregon (n=82)</i>	na	45%	na
<i>New Hampshire (n=413)**</i>	72%	83%	11%

**In New Hampshire, this question was asked in reverse: If ice cover on Earth melts, what happens to the ocean level? NH responses are not included in table 8.

Breakdown by location indicates that students in New Hampshire answered their modified version of this question with much greater success than those in other sites. This could be due to the increased clarity of the question. There were no significant differences between males and females, or the age groups in the three locations where comparisons were possible.

The next question concerned the appearance of the sun in the arctic. Students struggled with this question, with only 27% answering correctly on the post-test.

Table 10: In the Arctic summer, the sun:

	<i>Pre (n=137)</i>	<i>Post (n=219)</i>	<i>Change</i>
<i>a. Does not rise</i>	16%	32%	16%
<i>b. Moves from North to South</i>	24%	16%	-8%
<i>c. Moves from East to West</i>	24%	13%	-11%
<i>d. Circles the horizon</i>	22%	27%	5%
<i>No response</i>	15%	11%	-4%

Table 11: Percentage Responding Correctly by Location

	<i>Pre</i>	<i>Post</i>	<i>Change</i>
<i>Louisiana (n=90)</i>	26%	19%	-7%
<i>Pittsburgh (n=47)</i>	15%	32%	17%
<i>Oregon (n=82)</i>	na	33%	na
<i>New Hampshire (n=423)</i>	61%	60%	-1%

A greater percentage of students in New Hampshire answered correctly on this item, however the percentage did not improve after viewing the show. Analysis of Louisiana and Pennsylvania data indicated that students aged 12 to 15 increased their percentage of correct responses by 22%, while all other age categories decreased.

Table 12: Why are Penguins Threatened by Less Sea Ice?

	<i>Pre</i> <i>(n=137)</i>	<i>Post</i> <i>(n=219)</i>	<i>Change</i>
<i>a. No place to roost</i>	28%	21%	-7%
<i>b. Less ice for algae which feed krill</i>	31%	46%	15%
<i>c. More water to spread out the krill</i>	18%	15%	-3%
<i>d. More whales eat their food</i>	18%	12%	-6%
<i>No response</i>	6%	6%	0%

Responses in Louisiana, Pennsylvania and Oregon improved on this item. The percentage of students answering correctly increased by 15% to 46%.

When examining respondents by location, it can be seen that the percentage of students in Pittsburgh and New Hampshire answering correctly greatly increased from pre to post show.

Table 13: Percentage of Correct Responses by Location

	<i>Pre</i>	<i>Post</i>	<i>Change</i>
<i>Louisiana (n=90)</i>	37%	44%	7%
<i>Pittsburgh (n=47)</i>	19%	45%	26%
<i>Oregon (n=82)</i>	na	49%	na
<i>New Hampshire (n=475)</i>	31%	69%	38%

The final question asked where the Earth might have gotten a lot of its water from in the past. Originally, the most frequent response was that our water might have come from the moon. After the show, however, an additional 13% of students answered this question correctly.

Table 14: Earth may have gotten half of its water from:

	Pre (n=137)	Post (n=219)	Change
<i>Mars</i>	13%	19%	6%
<i>Europa</i>	22%	22%	0%
Comets	21%	34%	13%
<i>The Moon</i>	39%	19%	-20%
<i>No response</i>	5%	6%	1%

Table 15: Percentage of correct responses by location

	Pre	Post	Change
Louisiana (n=90)	21%	26%	5%
Pittsburgh (n=47)	21%	51%	30%
Oregon (n=82)	na	33%	na
New Hampshire (n=472)	30%	45%	15%

Students in Pittsburgh and New Hampshire improved significantly on this item, while the percentage of students answering correctly in Louisiana and Oregon remained well under 50%.

Overall, the data shows that a greater percentage of students were able to answer content questions after the show than they were before, indicating that they had learned about the poles by watching the film. However, on two of the four questions, less than half of students answered correctly after viewing the film, indicating that these key facts may not have been clearly conveyed. On no items did more than 68% of students answer correctly.

Additionally, there were regional differences in student responses. Most of the time a higher percentage of students from New Hampshire answered correctly than from other regions, usually followed by Pittsburgh.

Table 16: Percentage of Students Answering Correctly on Post-Film Questions

	<i>N</i>	<i>% correct (post test)</i>
When there is more ice cover, sea levels:	639	68%
In the Arctic summer, the sun:	595	49%
Why are penguins threatened by less Sea Ice?	689	61%
Earth may have gotten half of its water from where?	700	41%

Post Show Questions

Table 17: Would you recommend Ice Worlds to a friend?

<i>Definitely</i>	332	46%
<i>Probably</i>	197	27%
<i>No</i>	133	18%
<i>No response</i>	60	8%
Total	722	100%

Table 18: After watching the film, are you wondering about anything you saw?

	<i>Frequency</i>	<i>Percent</i>
<i>Yes</i>	122	56%
<i>No</i>	62	28%
<i>No Response</i>	35	16%
Total	219	100%

Table 19: If you said yes, how would you investigate those questions?

	<i>Frequency</i>	<i>Percent</i>
<i>No Response</i>	40	18%
<i>Internet</i>	89	41%
<i>Teacher</i>	29	13%
<i>Family member</i>	29	13%
<i>Newspaper or TV</i>	18	8%
<i>Probably won't</i>	14	6%
Total	219	100%

Almost three-quarters of students who viewed Ice Worlds indicated that they would definitely or probably recommend the show to a friend. Additionally, for more than half of participants, the film sparked questions in students about what they saw.

MUSEUM PARTNERS

I liked the content, the animation and overall, I liked the process of not only the program [film] based on the grant but the process of you following up and providing a lecture and delivering it in different ways like in the theater and the portable [dome] and we could have done a teacher workshop and then you [evaluator] providing questionnaires and follow up....it gives us a better idea of how our audience responds.....as opposed to just getting a film with no follow up. (museum staff)

First I thought everybody we worked with in terms of obtaining the film was positive, everyone was cooperative, no issues. In general, we want to have a wide variety of shows at the discovery center that encompass earth science, so it fits in great with our mission here. (museum staff)

OVERALL REACTIONS

The evaluators interviewed planetarium directors or museum staff from CMNH, MSDC, LASM and OMSI. (We also spoke with one of the co-PIs, who is a staff member at HMNS). All our respondents said that Ice Worlds successfully engaged their visitors and were pleased with the film and (for those institutions that held special events), the scientist lectures and related activities.

Museum staff said that the film generally fit in well with their museum's mission, though one staff member said the film was "too careful" and didn't support their mission related to the Earth's sustainability.

It sure did, a nice offering for that grade level, we'd like to have another show as an offering, and it fits the museum mission about the environment and health....trying to promote that with the museum's mission as well as the planetarium. (museum staff)

Yeah, definitely, I think it worked out during the summer season. Over the years we noticed increase in attendance when we have water related topics...cool topics, it worked out well. And I think it worked in the portable too.

(museum staff)

The film Ice Worlds supported our museums' mission in multiple ways, it had information in it that a well-read adult was unlikely to know and moments in it 3rd graders loved like the bear paw coming down...It incorporated real data, it's important for the museum to go in that direction. It was done in a careful way, not to state 'this is global warming and it is happening and you should be frightened'...it was *too* careful, it didn't support the museum's mission on sustainability, I think the public looks to the museum to *interpret* large amounts of data, important to say this is the data, it's factual information, and after sharing data, to helping people interpret it....I think it's the museum's job to interpret the data....Some interpretation of data would be appropriate and is expected by our audiences at the museum. (museum staff)

RECOMMENDATIONS

The evaluators asked museum staff if they would, (or have) recommend Ice Worlds to other museums and planetariums. All respondents said they would recommend the film, and several had discussed Ice Worlds with colleagues from other institutions, as described below:

You bet....Because it has a wonderful mix of graphics, it's exciting to watch, content at various levels, it's different than most stuff that's out there.....there are thousands of tours of the solar system, and the universe, there's only one Ice Worlds.....it makes a connection between the solar system and the Earth—museums need to focus on this and understanding the Earth, the bulk of the information [in the film] is really about Earth.
(museum staff)

I would recommend it. Not directly, it was posted on our website, so we know other planetariums look at our website. (museum staff)

In general I would recommend it if they have a full dome system....the opportunity to have funding to go with the show for [underserved] groups, that was a big thing for us, teachers really appreciated it...I spoke informally with others who are setting up full dome systems in Salt Lake City and Seattle.....and Eugene, Oregon.(museum staff)

One staff member was pleased with Ice Worlds 2, because it was more concise and fit into the museum's context.

The 25-minute format is easier for us to schedule than the 40 or 45-minute format...I can't touch the longer shows for my audience. We have 20 acres of exhibit space, they [visitors] want 20 minutes to sit down and relax so the length of the movie is correct.
(museum staff)

One respondent felt the sound and narration in Ice Worlds could be improved.

I thought it was a good film, addressed all the current issues involving ice and comparison to ice in the solar system and goes along with discussion in the classroom, visually interesting, narration could be better, some people found it difficult....Many felt the music was overpowering the voice, it was sometimes hard to understand her [the narrator] when the music was a louder than her voice, it may be our system too but our system is well equipped....that was feedback we received. (museum staff)

Finally, we asked respondents if they planned to continue showing Ice Worlds. All said they are continuing (as of April 2011) to show Ice Worlds in their theaters and/or offering it in the traveling domes.

We definitely are going to continue it as a group offering even after June, keep it in our library for the future, a successful run, 18,000 [viewers] is pretty good. Not as big as some but we didn't do as much promotion, but the title of show was something people wanted to see, we could have had more if it was geared toward a younger audience but it did well and I was glad we were able to be involved. (museum staff)

VISITOR RESPONSE: MUSEUM STAFF VIEWPOINT

Our respondents said that their visitors appeared engaged by Ice Worlds, and that the film appealed to a wide audience including students, teachers and the general public. Many cited the positive response from visitors who filled out a survey questionnaire developed by the evaluators, as well as informal feedback they received as viewers left the theater.

I run the show in the theater and talking to the presenters, groups enjoy Ice Worlds b/c the visuals are interesting and they've been talking about it in the classroom and they enjoy the presentation. It's an environment they have nowhere else and the ice on other planets is new to them and looking at other planets and the comparison [with Earth], in general people enjoy it.

(museum staff)

I think [we got feedback] mostly from the questionnaires, we had most of them fill out questionnaires, most were very favorable and really opened their eyes about what's happening at the poles and its' effect on us. I heard [people say Ice Worlds was] informative, somewhat entertaining....after one show a family of six appreciated the film very much, a family of all ages, a good indicator it was effective at both adult and children's levels. I didn't hear any negative....no one said anything to our staff or guides who are there in the show....No one disagreed with climate change or the contents or the animations, that's a positive.

(museum staff)

There are very few walkouts during Ice Worlds; teachers especially are vocal in being pleased with the content in the show.

(museum staff)

Did you do outreach to underserved groups? Yes we served 1300 students and 300 adults that received financial aid, many are low income [schools] within Portland Public Schools, and they were very appreciative of being able to visit the planetarium.

(museum staff)

The evaluators asked museum staff if they had noticed increased interest in the polar regions and related topics among visitors, after they had seen Ice Worlds. Most respondents were unsure, but several did cite visitor questions on the topics of ice on Earth and on other planets.

In the time I was doing showsmost questions came from kids not from adults.....the kids, 4th-6th grade, the questions are mostly about ice on other worlds, they thought that Earth is the only place that has ice....questions about how ice is formed, what is it made of, is there life like we see like we see on earth?....I think these are good questions, they're trying to make a comparison.

(museum staff)

It definitely sends people to Polar World [arctic exhibit], the show mentions that we have the hall about how people live in the arctic, people come out looking for it.

(museum staff)

SCIENTIST PRESENTATIONS AND RELATED EVENTS:

Those museums that hosted a scientist talk and special Ice Worlds events, such as Polar Weekend at CMNH, and the opening of Ice Worlds at MSDC, were pleased with the scientist presentations. (All the partner institutions except OMSI hosted scientist talks and at least one special event during Ice Worlds' run). All said they liked the model of combining new shows with informative presentations by researchers/content experts, as noted below:

That was a definitely a good thing, we haven't done it since but made a good opening.....We do try [to host a scientist lecture] when we open a new show, we try to make an event of it. (museum staff)

Needless to say, it was three years ago but I had positive memories of the event and I hung out near the ice core samples and heard a lot of 'wows' when people realized they were looking at air bubbles formed thousands of years ago and that data could be extracted from air bubbles. (museum staff)

We had [scientist] come in. I don't think we had a huge audience but 40 or 50 people plus teachers as well. When we needed a focus group for another climate change project, sometimes it's hard to get teachers and we got instant response from teachers who had attended the [Ice Worlds-related] workshop..... (museum staff)

I personally think that's a great idea. Having a lecture with an informative person who could talk about the theme of film is really additive, a benefit to the audience. (museum staff)

Yeah, certainly I think opening a new show should be part of a multi-day thing with enough stuff so there's momentum and bringing in an outside scientist is a critical component and bringing in posters with local graduate students in the area is important, so people can see real scientists and that research is happening in this area and people can see this 25 year-old is doing real work and having a teacher workshop, things on the floor—activities...(museum staff)

In addition, IPE staff enabled several of the museum partners to develop new connections with scientists, including two of the project's co-PIs.

Do you have your own science network or would you rely on the grant? Both, the grant helps but we have good contact with LSU, they provide guest speakers in physics, geology, from the natural history museum , and working with [IPE co-PI] in Houston....collectively we've had quite a list of guest speakers from grants and the local university. (museum staff)

Several participating institutions, including CMNH and HMNS, held IPE-themed teacher workshops. (As noted previously, UNH also sponsored a teacher workshop). CMNH had two special "Polar Weekends" in 2009 and 2010, coinciding with the opening of Ice Worlds and Ice Worlds 2. MSDC used the film at several non-IPE-sponsored events.

The Polar Weekends.....those are the strongest events, every summer. This summer [2011] it will be the second weekend in July. The film will keep showing. (museum staff)

Yes, we have had a couple of teacher professional development workshops related to climate change where we've shown Ice Worlds, and we had a summer camp for middle-schoolers called "Defending Earth" to show the film. So it has been part of other events.
(museum staff)

SCIENTISTS

Each of the three scientists interviewed for this evaluation were involved in the development and administration of IPE; two were co-PIs on the grant. However, all found their work on IPE, particularly in the area of outreach to teachers, youth and to the general public, to be useful in enabling them to communicate aspects of their research clearly and succinctly to non-scientists. They also found the work rewarding on a personal level, as reflected in the following summary.

The scientists described the development of Ice Worlds as a “collaboration” between the Evans and Sutherland [production company] team, the HMNS, and the development team at UNH.

I think it was a collaboration because people came at it from different points of view. HMNS has a view of who their audience is and what their audience knows...[co-PI] would send me emails about something that had been in the news, how about this [idea for the film], and I'd give her our perspective on sea level rise and climate change. The [HMNS] museum staff is trying hard to come up with something useful and interesting....people came at this from different points of view, that added to the process.
(IPE scientist)

It seemed like a fun project to be involved with and there were differences with this project, working with a museum and the production company making the show, that was intriguing and exciting. I work with a lot of science [activities]...but I really liked the combination of the museum and making the film.
(IPE scientist)

We asked the scientists how they viewed the science content presented in Ice Worlds. Overall, they believed that the film was effective in presenting changes occurring in the polar regions. One said the film “covered a lot of ground in 20 minutes.” One scientist said that the effects of climate change were conveyed in the film but were somewhat subtle.

Note: The pre-show was not used at some sites, and was deleted for Ice Worlds 2, though some information from the pre-show was integrated into the film.

The goal was to make people aware of high latitudes and make people more aware of the role it [ice] plays.....the message [of climate change] does show up, it's subtle.

The pre-show could have additional changes, things could be added, but audiences found it distracting. HMNS cut and pasted [parts of pre show] in the last round [Ice Worlds 2] to integrate it into the film.
(IPE scientist)

I think it [Ice Worlds] was very successful overall, they did a nice job with the imagery, they covered a lot of material in approx 20 minutes, I was pleased with the product they put out.
(IPE scientist)

One of the scientists explained that viewers needed additional context to understand the effects of climate change and its impact on the poles.

I don't know how much people [non-scientists] know coming in, teachers in Pittsburgh seemed receptive. I don't know that people are attuned to that, they've probably heard

that things are coming apart [at the poles] but don't have context, Ice Worlds was trying to communicate the context and the change..... (IPE scientist)

Two of the scientists, who had made presentations to teachers and the general public, talked about the knowledge they gained from speaking to these audiences, and the value of their talks.

...this is my first stretch into the outreach and education side, I found it to be interesting....The main thing is the requirement to step out of the terminology we use among scientists and stepping back and explaining to interested and intelligent folks that don't have a strong [science] background.....It really helped to put different things I do in a different context and different level of importance. We might focus on statistical methods of data processing but teachers and other people want to know the overall theme, the big picture, what are the two most important points. The film is looking at a larger global perspective...the energy, water and broad changes. (IPE scientist)

I tend to give talks to other scientists that show people what is going on and why I think it is....putting things in context, not that different than what we did with Ice Worlds, how sea ice grows and contracts and how ice moves...I think we started on that road with Ice Worlds. We initially spent time talking about how to communicate idea of ice changing....you want people to think that ice in your glass and ice in Antarctica is the same thing.....I think it was really helpful to have the context of the movie, it let you talk about things in detail and know people would have some background, that was useful to have immersive context, I'd be happy to do Ice Worlds or something like that [again], nice model, it has potential.... (IPE scientist)

One scientist said he gained professionally, by updating his knowledge outside of his primary field of research, in order to meet the needs/interests of teachers and the general public.

The other thing I found very interesting, I'm an earth systems scientist, but I was able to touch on other fields like atmosphere and glaciation and I was able to jump into these areas and bring myself up to speed, it was an amazing learning experience...related to development of the film, the talks and the teacher workshop, I jumped into some areas I thought they [teachers and the general public] would be interested in, primarily driven by the film and what I thought they'd be interested in.....I hadn't had the opportunity [before] and this gave me the opportunity and I found it a lot of fun, b/c some of the questions they ask are challenging, there are assumptions scientists make, but then I have to step back and put things into words I don't usually think of and that's challenging and good personal development. (IPE scientist)

The two scientists who made presentations found their audiences engaged and often somewhat knowledgeable and interested in polar research and changes at the poles, as evidenced by the questions they asked.

When they opened second version [Ice Worlds 2] in Houston, the idea was to make science available to the public. There were a fair number of people, they had questions, they were informed and interested...science teachers can be like that too. Science teachers want to know how to translate this back to the classroom, they have an

audience in mind.....This project made us [as scientists] think of who we're trying to talk to....it's different than doing a scientist talk and by communicating to people whose view is not the same, I learned a lot about communicating to other points of view.(IPE scientist)

All of the scientists said they believed that the outreach they completed within IPE as relevant to their research work, and that they would be interested in doing more outreach in the future.

Yeah, very likely [I would do similar work again]....one of the [IPE PI's] colleagues in Texas asked me to put in a letter to be a science advisor. Being involved in projects like that, working with school age kids--many people are out doing great science but communicating that, whenever you get a chance, it's exciting and challenging....you have to figure out how to connect with them.....one of the rewards is to get them to see something they've never seen before, open up ideas, that's exciting..... My work has been directing this office funded by NSF, for my PhD looking at science and policy implications and how decisions are made and how do different stakeholder groups reconcile what's happening [in the polar regions] and how people come from different points of view.....it's what I have done and what I'd like to do.....(IPE scientist)

Yes, I would. It keeps me honest terms of what I'm doing and relevance to the average person, keeps me well rounded and thinking of stuff not directly in my proposals and broadens my scope, being an earth science person, that's important, the kind of things I read up and learn about. (IPE scientist)

This scientist also believed these outreach activities complemented his research interests, and satisfied NSF's outreach requirements, as discussed below:

Absolutely...the most direct and selfish reason, any NSF proposal you must have broader impacts and the more I do these the more comfortable I am talking about how what I do fits in a broader picture and I also enjoy this.... (IPE scientist)

Another scientist stressed the value of outreach in educating the public on climate change and related issues.

I think learning how to communicate well is fundamental to what we do for two reasons. One, we're working on a system that shows the climate is changing, we need to convey that in a sound bite world. We haven't gotten better but we get more attention than we used to, like several [scientists] were interviewed in Rolling Stone....it's fundamental b/c we're working with public money tracking changes in the planet, the public needs eyes on this situation and I don't want to spend my time fighting other points of view, but I do want to explain what I see.....

Two, just trying to get people's heads to the same place as yours in a limited amount of time, that's why this understanding of the polar regions matters.....people need to see the whole thing works together. I don't know how to communicate that other than vehicles like Ice Words....it gives us an entrée to talking to teachers and museums. (IPE scientist)

Finally, one scientist said that he is working with one of the co-PIs (another IPE scientist) to create a resource list for the Museum Alliance, with 15-20 researchers in various fields, who would be willing to speak at various museums and planetariums.

IPE STAFF

The evaluators interviewed two IPE staff members, the PI and a co-PI based at one of the museum partners. Both reported that the collaboration between IPE staff and scientists and the museum/planetarium partners had gone well, and that the project had developed a relatively new model for presenting a film about climate change in the planetariums.

One staff member reflected on the film's adherence to the data, and relative neutrality related to issues of global warming.

This show doesn't go beyond the data, allows people to take it from there, and to produce something that people are happy about, brings red and blue states together. Teach what we know what to be true and let people under the guise of discussion to take it further.....kids need to see how complex the questions are.....we tried to make a show everyone could rally around as a point of discussion.... (IPE staff)

The PI emphasized the reach of Ice Worlds and how it impacted viewers both in the US and abroad.

I think we've reached a lot of people, and as much as I know about people who came and saw lectures and the film, I thought they had learned things. I'm excited that Ice Worlds is going to be used in schools and I'm working with 4-H and they're developing a curriculum on climate change and they're going to use Ice Worlds here in New Hampshire [as pilot]. I know people around the world saw the filmoverall I was happy with the way it turned out and reached a large audience, well received....Part of our grant was to give museums funds to take it to schools and that worked out really well.....this was all to underserved schools...that was a good way to reach those audiences. (IPE staff)

The co-PI stressed the importance of getting teacher input during the development of Ice Worlds 2, and how the state standards were incorporated into the film.

We put the show together with teacher assistance ,what was important for kids to learn, so that the ultimate goal of the show was educational and includes Texas standards.... we looked at what had to be kept based on what Texas says kids have to learn. (IPE staff)

The co-PI described the development of Ice Worlds 2, in order to make a more seamless viewing experience for planetarium visitors.

I think the film worked well...what we appreciate being able to do was to renovate and do a second film, which we did. We created an introductory piece, that was things E&S didn't put in the film, things kids learn, we got comments from a continuous survey at Houston for two years. We found it was more difficult than we thought to run an introduction, to have an abrupt change in the flow of the show, it didn't feel right....we

tried many approaches to how we segued from one to another but it didn't work out as we thought, so in our third year we did a new Ice Worlds, in which we integrated things from the introduction and took out some things that were repetitive and we cut one voice [narrator] for all of it. (IPE staff)

One of the goals of IPE was to create connections between museums and planetariums and research scientists. To some extent, IPE facilitated those relationships, as discussed below:

I have a list of scientists who did some lectures for us or would like to, joining the National Museum Alliance group....we've brokered that, we've developed that relationship. It grew out of this project—we sponsored 3-5 lectures and there were other scientific colleagues who wanted to do something, so we're connecting them with NASA's Museum Alliance, a network of 400 museums... (IPE staff)

I could say that this project extended our connection to Rice University, we did several things with Rice University, the final DVD included [IPE scientist's] lecture with questions and answers and we took the questions posed by teachers and his answers added to the DVD of the show, includes 45 minute lecture, and PowerPoint slides are embedded, and he discussed common questions asked by kids. (IPE staff)

One of the primary challenges faced by project staff was the development of a user-friendly website "dynamic web resource" aimed at the general public. Eventually, IPE leadership decided to focus on resources for teachers, which were compiled on the Polar Explorer DVDs. (A basic website was developed, but our data show that users found some aspects of it confusing/difficult to use). Project staff also found the logistics of working with some museums challenging, in the sense that each museum had its own procedures and it was sometimes difficult to bring other IPE materials, into the museums.

I would not have tried to make a website for the public, [we] initially wanted to do that as a support for educators but we tried to build a site for the public, but its really hard, their attention span is not that great, unless they're really interested....(IPE staff)

The project generated a series of products, including Ice Worlds, as noted by the PI. The PI expressed interest in building in more resources for teachers to connect with Ice Worlds, and hoped that a new project with New Hampshire 4-H would enable her to build on IPE activities such as Sea Icebox.

Ice Worlds 2, which is being distributed by Discovery Dome network, Polar Explorer.....The 4-H opportunity to integrate the film and activities....using another kit, Antarctica's climate secrets with Ice Worlds and Sea Icebox (IPE staff)

IPE staff oversaw development of teacher kits with activities passed out at various workshops. Eventually, many of those activities were included on the Polar Explorer DVD. The PI reported that more time would have been helpful in developing support for teachers in connecting Ice Worlds with their teaching.

Ice Worlds was our unique contribution, and trying to build around all these activities around it. Three years wasn't long enough to build a good foundation around it where teachers can come and be supported and get a kit.....I'm real excited about 4-H, that's a way to interact with educators, they need to interact with scientists, we have a good relationship in NH. (IPE staff)

DISCUSSION

Data show that IPE was successful in creating an engaging film that was valued by museum/planetarium visitors, teachers and their students, and museum partners. The film appealed to children (primarily those over age 10), adults, and family groups. Overall reaction to *Ice Worlds* was strongly positive at all the participating institutions. The PIs and IPE project staff used visitor feedback to make some adjustments to the film, which resulted in *Ice Worlds 2*, which was shown at both HMNS and CMNH.

The project sponsored several events and created deliverables including the Polar Explorer DVDs for teachers, several teacher workshops, and special events at most of the museum partner sites, including the Polar Weekends at CMNH and the opening of *Ice Worlds* and *Ice Worlds 2* at HMNS. IPE staff worked with the museum partners to identify scientist-researchers to speak at these events, which were well-received by the visitors who attended the lectures.

Originally, IPE staff planned to create a user-friendly website to engage *both* members of the general public and teachers and their students. Evaluation data shows that museum visitors found the website and related activities, including Polar Explorer and Sea Icebox, somewhat difficult to use. Teachers, who were given these activities in the context of IPE workshops, may be more successful in using these activities with their students than casual museum visitors. The evaluators believe more could be done—for example—an introductory video to orient viewers to Polar Explorer activities—to make the activities more accessible to a wider audience, and facilitate use of the website.

Through IPE, museum partners were able to take *Ice Worlds* via traveling dome shows to underserved schools, and (in some cases) to host underserved students at their sites. Teachers who took their students to the dome shows emphasized the students' engagement with the film. Data from student surveys indicate that they learned new content from *Ice Worlds*. Open-ended surveys showed that students learned facts about the Earth, about the ice in the poles, and about ice on other planets. Specific content questions proved to be difficult for students, especially in more advanced concepts such as the effects of melting sea ice on sea levels. There were distinct differences in students' abilities between the different locations as well. Overall, however, the percentage of students answering correctly did improve from pre to post test.

Clearly, more work needs to be done to convey some of these complex concepts to viewers. The evaluators suggest that Polar Explorer DVDs, which contain many of the activities from teacher kits originally developed through IPE, be distributed to schools that request *Ice Worlds*. This would enable teachers to incorporate key concepts from the film into their teaching, and enrich students' understanding of changes taking place in the polar regions.

SUMMARY

Through a variety of activities and the film, IPE staff has stimulated interest in climate change and its impact on the poles. IPE created a new model of cooperation between planetariums, scientists, and the developers of a full-dome film. The museums/planetariums were pleased to host Ice Worlds and touch on issues of climate change on Earth, along with information about ice in space. The connection between the partner institutions and IPE scientists—and other researchers in the field—were strengthened and facilitated by IPE staff, who helped to bring scientists to the museums to speak about their work

APPENDICES

Appendix A: General Public Exit Survey

Appendix B: Student Pre-Survey

Appendix C: Student Post-Survey

Appendix D: Student Open-Ended Survey

Appendix E: PI Summative Interview Protocol

Appendix F: Scientist Interview Protocol

Appendix G: Museum Partner Summative Interview Protocol

Appendix H: Teacher Workshop Follow-Up Interview Protocol

APPENDIX A – GENERAL PUBLIC EXIT SURVEY

Date: _____ Time of show: _____

- Thursday July 9th
- Friday July 10th
- Saturday July 11th

Are you:

- Male
- Female

Age Range:

- 18-35
- 36+

Do you work in a science-related field?

- No
- Yes

If yes, what field _____

Are you a member of the Carnegie Science Center?

- Yes
- No

Background information

What if anything did you know about the *International Polar Year* **before** you came in today?

(i.e. What is it? Why is it important?)

What if anything did you know about the Polar ice caps **before** you came in today?

Where did you learn this information? (i.e. school, television, internet...)

Ice Worlds Show

How did you hear about today's show?

Did you discover anything new in the show? Please give some examples of facts/information that were new to you:

Did anything in Ice Worlds surprise you? Please explain: [what and why?]

Did this raise any new questions for you? If so, what are they?

Will you pursue/investigate your questions? How?

How would you describe Ice Worlds to your friends or colleagues?

The team is interested in your ideas about how to improve *Ice Worlds*. What if anything would have improved the show for you? (i.e. clarifying information, more images, more scientist participation)

Did you attend the scientist's lecture or phone call (Saturday at 1 or 2pm only) before viewing Ice Worlds?

- No
- Yes, the lecture
- Yes, the phone call
- Yes, both

If yes, how did this event or events add to your understanding of Ice Worlds?

APPENDIX B – STUDENT PRE SURVEY

1. Please tell us your age range.

- under 12
- 12-15
- 15-18
- 18+

2. Gender

- Male
- Female

3. What grade will you be entering this fall?

4. Which of these cities was buried in ice during the last ice age?

- London
- New York
- Rome
- Beijing

5. When there is more ice cover, the sea level

- rises
- falls
- stays the same
- is not effected

6. Why are penguins threatened by less sea ice?

- no place to roost
- less ice for algae which feed krill
- more water to spread out the krill
- more whales either their food

7. The Earth may have gotten half of its water from

- Mars
- Europa
- Comets
- the Moon

8. The rings of Saturn are made of

- snow balls.
- car-sized ice.

- water droplets.
- solid sheets of ice.

9. The Northwest Passage would connect

- North America and Europe
- North America and Asia
- The Atlantic and Pacific Oceans
- The Arctic and Antarctic Oceans

10. Would you recommend Ice Worlds to others?

- never
- sometimes
- for some audiences
- for everyone

Have you studied global warming or the polar regions in school?

- Yes
- No

APPENDIX C: STUDENT POST SURVEY

PERG Ice Worlds Post-Survey

1. Please tell us your age range.

- under 12
- 12-15
- 15-18
- 18+

2. Gender

- Male
- Female

3. What grade will you be entering this fall?

4. Which of these cities was buried in ice during the last ice age?

- London
- New York
- Rome
- Beijing

5. When there is more ice cover, the sea level

- rises
- falls
- stays the same
- is not effected

6. Why are penguins threatened by less sea ice?

- no place to roost
- less ice for algae which feed krill
- more water to spread out the krill
- more whales either their food

7. The Earth may have gotten half of its water from

- Mars
- Europa
- Comets
- the Moon

8. The rings of Saturn are made of

- snow balls.
- car-sized ice.
- water droplets.
- solid sheets of ice.

9. The Northwest Passage would connect

- North America and Europe
- North America and Asia
- The Atlantic and Pacific Oceans
- The Arctic and Antarctic Oceans

10. Would you recommend Ice Worlds to others?

- never
- sometimes
- for some audiences
- for everyone

Have you studied global warming or the polar regions in school?

- Yes
- No

Please describe something your learned more about by watching the show.

Is there something that you're wondering about now, after seeing the show?

APPENDIX D: STUDENT OPEN ENDED SURVEY

Are you: Male Female

Age: Under 12 12-15 16-18 Over 18

1) Did you learn anything new from watching Ice Worlds? Yes No

If yes, please describe what you learned:

2) Did anything in Ice Worlds surprise you? *Please describe:*

3) After watching the show, please share a question or something you are wondering about:

4) Do you think you might explore this question? Yes No

5) *How* might you find the answer to your question?

APPENDIX E: PI INTERVIEW PROTOCOL – END OF PROJECT

1) Please talk about how the project has gone overall...where it stands now: (project overview)

How do you think IPE was successful in advancing the general public's (and teachers/students) understanding of the importance of the polar regions?

Based on what you know now, what would you have done differently?

Probe: What aspects of the project were less successful:

2) According to the proposal, you were going to be developing a website for both teachers and general visitors. I see you have a website on line, but parts are not user-friendly. What challenges did you run into with the website, and what is its role now/who is the primary audience?

3) In the proposal you discussed including updates in the show. How did you do this through Ice Worlds 2?

Probe: Any provision for adding new information over time?

4) What feedback have you received from the museum partners about Ice Worlds?

5) How has the project helped to connect museums/planetariums with scientists?

6) Please tell me about your outreach to teachers through the project. Do you have any evidence of teachers' use of the teacher kits or film in their classrooms?

7) What products have come out of IPE? What will be left behind beyond the life of the grant? Probe: What has the project done well/areas of success?

8) Based on what you know now, what would you have done differently?

9) Is there anything else you want to tell me?

APPENDIX F: SCIENTIST INTERVIEW PROTOCOL

Please tell me about your involvement with IPE/Ice Worlds—what have you done?

Have you done similar work with other NSF projects?

Please describe:

How do you think the science was presented in Ice Worlds?

Do you think the presentation was effective? Why or why not?

Tell me about your discussions/interaction with the public.

Did anything surprise you in terms of visitor response?

What do you think visitors/teachers/students got out of the presentation?

How did you gauge visitor learning/response?

Based on your experience with Ice Worlds, would you do similar lectures or presentations again? Why or why not?

Do you see this type of work as significant to your overall research work? Why or why not?

Is there anything else you want to tell me?

APPENDIX G: MUSEUM PARTNER INTERVIEW PROTOCOL

Name:

Institution:

1) What was your overall reaction to Ice Worlds?

Probe: Would you recommend it to another planetarium? Why/why not?

2) How long did the film play—has it been playing?

Why have you continued or discontinued the film?

3) How did your visitors respond to Ice Worlds?

Probe: What did you hear from them—and how do you know this—observation, anecdotal evidence, surveys, etc

4) Would you recommend it to other planetariums or museums? Why or why not?

Have you discussed the film with colleagues at other institutions?

5) Did you see any evidence of increased visitor interest in the poles or climate change?

Probe: How do you know this/evidence?

6) If your institution had a scientist/researcher come in—was that beneficial for the planetarium/museum? Why or why not?

7) How did visitors respond?

Probe: Would you be likely to invite another scientist to come in and coordinate the visit with one of your films?

8) Did you do any related activities/special events connected with Ice Worlds?

Probe: Teacher workshops, family nights, etc.

9) Is there anything else you want to tell me about the film or your experience in presenting it?

APPENDIX H: TEACHER WORKSHOP FOLLOW UP INTERVIEW**Name:****Location:**

Date:

Phone:

Grade/subject:

- 1) Tell me about the workshop you attended last summer—what was your overall reaction?

- 2) How, if at all, did the Ice Worlds workshop and related activities fit in with your curriculum?

- 3) What was the most useful/valuable thing about the workshop?

- 4) Have you used any activities from workshop [including the Sea Icebox web activity] in your teaching?

If you answered yes, please describe:

- 5) What do you think your students learned from participating in these activities? [please give one or two specific examples]

- 6) Did you use the film—either by taking your students to the Carnegie Museum or by having a dome show at your school—with your students?

- 7) What do you think your students took away from the film?

- 8) Do you have any additional feedback about the film or the Ice Worlds workshop?