Evaluation of the Bishop Museum's Science on a Sphere

Submitted to:

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D R A F T

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EXECUTIVE SUMMARY

This report presents the evaluation results for two education programs developed by the Bishop Museum to be used in conjunction with the museum's Science on a Sphere (SOS) instructional apparatus. The SOS apparatus, made available to the Bishop Museum by the National Oceanic and Atmospheric Association (NOAA), is a sphere upon which 360-degree images are projected. Pacific Resources for Education and Learning (PREL) was contracted to evaluate (a) the museum's public presentation on global warming and (b) science education programs presented to school groups that visited the museum.

GLOBAL WARMING

The SOS program on global warming was intended to increase understanding of global environmental concerns, Hawaii's connection to such concerns, and provide information on the ways in which individuals can reduce global warming. In evaluating the program PREL addressed the following two questions and found the following:

- Is the SOS live presentation an effective tool for teaching the public about global warming?

  Yes. The difference between pretest and posttest scores was statistically relevant with participants' knowledge of global warming, and, in particular, their knowledge of its causes, increasing from a mean score of 6.3 to 7.9 on a 10-point scale. In addition, a majority (52%) of respondents indicated that they would be more likely to do something about global warming and 80% of respondents were satisfied with the global warming presentation.

- How can the presentation be improved to increase its effectiveness?

  Recommendations varied. The removal of the flat screen visuals (an issue that has already been resolved by the museum) and the inclusion of additional information on what people can do about global warming were the basis of most recommendations. Additionally, some suggested the use of additional graphics, the discussion of opposing viewpoints, and/or the inclusion of additional interaction between the presenter and the audience. Our recommendations, derived from observation and participant feedback, include: (a) taking additional efforts to increase attendance, (b) maximizing audience attention, (c) enhancing presentation content, and (d) working to ensure consistency across presenters.

SCIENCE EDUCATION PROGRAMS

Bishop Museum prepared 25-minute science modules to K-8 students. These modules are stand-alone presentations on specific scientific content (e.g. how tsunamis are formed, climate and weather patterns, the formation of the earth). These modules form a part of a larger multicomponent curricula intended for use with public school instruction. In evaluating these modules, PREL addressed the following two questions: (1) Does the SOS presentation add value to teachers' coverage of the intended benchmarks? (2) What is the SOS presentation's impact on student learning? Data was collected from pretests and posttests administered before and just after presentations. The results were the following:

- Does the SOS presentation add value to teachers' coverage of the intended benchmarks?

  Yes. Teachers interviewed stated that the presentations clearly matched the selected HCPS III standards and benchmarks for their grade level. A review of scripts and tests found that benchmarks were included for all grade levels, but the coverage for grade 8 was not complete. Benchmark 8.8.5 (Explain how the sun is the major source of energy influencing climate and weather on Earth) was not directly covered in the script or the test.

- What is the SOS presentation's impact on student learning?

  The presentations were effective in producing learning. The differences between pretest and posttest scores were statistically significant and large for all but first grade. The failure to detect learning in the first grade children might have been due to a failure of the measure as opposed to a failure of the curriculum.

INTRODUCTION

This is the report or an evaluation of two educational programs developed by and pilot tested at the Bishop Museum in Hawai‘i. These programs use an instructional apparatus available from the National Oceanic and Atmospheric Association (NOAA). The apparatus is called Science on a Sphere.

BACKGROUND

The Bishop Museum acquired a grant under the environmental literacy program of NOAA to implement a 2-year project (September 2005–September 2007) called *Connections: A Comprehensive Environmental Education Program Centered on NOAA Science on a Sphere (SOS)*. The Sphere is a 6-foot diameter carbon globe suspended from a ceiling. Images of various types of content (e.g., weather patterns, growth patterns, ocean temperatures, Mars exploration) are projected by four coordinated computers encircling the Sphere at right angles. The images can run automatically, looping without direct human intervention, or be accompanied by live presentations.

The museum agreed to develop a number of informational and educational programs, including (a) classroom lesions centering on earth and ocean sciences, (b) lobby exhibits, (c) live demonstrations, (d) teacher workshops, and (e) special event programs that used the Sphere. Pacific Resources for Education and Learning (PREL) was contracted to evaluate two parts of the museum’s efforts: (a) a public presentation on global warming and (b) science education programs presented to school classrooms that visited the museum. These efforts were evaluated and are discussed separately.

GLOBAL WARMING

The activities of the museum’s SOS program were intended to increase understanding of global environmental concerns and Hawai‘i’s connection to those, and establish a basis for personal decision making and action. The museum produced a 20-minute live program, “Too Hot to Handle: The Science behind Global Warming,” for the public using the Sphere to depict the causes and effects of global warming (see, for instance, http://www.ipcc.ch/). The museum wanted to know whether the program was successful and how it might be improved. PREL designed an evaluation to provide the museum with formative information about the global warming presentation so that the program could be adjusted, if necessary.

DESIGN

The purposes of the global warming presentations were to alert the public to the reality of global warming and the problem it presents, to teach some of the facts involved, to sensitize the public to its importance, and to motivate the public to do something about the problem. Accordingly, the evaluation effort was designed to determine whether participants were engaged in the presentation, what they learned from it, how strongly they felt about global warming, and what action they took as a result.

The evaluation approach—the questions, indicators, and measures—is outlined in Table 1. Some indicators dealt with the process or context of the presentation (1.1). Outcomes that occurred just after the presentation as well as those that occurred later (proximal and distal outcomes, respectively) were evaluated. The measures are more fully described following Table 1.

Table 1. Evaluation Questions, Indicators, and Measurement Tools for Global Warming Module

Question	Indicator	Measure
1. Is the SOS live presentation an effective tool for teaching the general public about global warming?	1.1 Participants are engaged during the presentation (process)	Post-presentation written survey Interview (secondary) One-week follow up, telephone call with a smaller sample
	1.2 Participants increase interest in global warming (proximal outcome)	
	1.3 Participants increase knowledge of global warming (proximal outcome)	
	1.4 Participants are influenced to change behaviors related to global warming (proximal outcome)	
	1.5 Participants retain interest and/or knowledge (distal outcome)	
2. How can the presentation be improved to increase its effectiveness?	2.1 Logistics	Interview Observation Post-presentation written survey
	2.2 Content	

MEASURES

Descriptions of the measures used to gather information for the global warming project follow. The measures are described, the target audiences identified, the data collection methods given, and the period of administration specified.

Post-presentation written survey

- What: Brief written survey including closed-ended, open-ended, and demographic questions. Seven items measured participants' beliefs about the reality of global warming (2 items), their emotional response to it (2 items), and their general knowledge about global warming (3 items). After the presentation, respondents were asked to report their feelings before and after the presentation. A 10-point response scale was used that had one anchor at 1 labeled "not at all," and the other anchor at 10 labeled "extremely much." This retrospective pretest methodology (where respondents are asked how they felt before an intervention and how they feel now after the intervention) has been used when pretreatment tests are not possible, and, sometimes, even when they are (Lam & Bengo, 2003; Lamb, 2005, Summer; Pohl, 1982; Pratt, McGuigan, & Katzev, 2000; Umble, Upshaw, Orton, & Mathews, 2000, June 15). The questionnaire is in Appendix 1.
- Who: General public adult visitors who attended the SOS presentation on weekdays. All attendees of six randomly selected presentations participated. It was expected that an average of 10 participants would attend each presentation, for a sample size of 60.

- How: Written surveys were distributed to all participants immediately following the presentation.

In-person interview

- What: The interview provided feedback on the questions asked in the written survey. For instance, respondents were asked about the impact of the presentation and its suitableness for children, both points of interest for the museum.
- Who: One to two adult attendees from each of the 6 presentations were interviewed, whatever was logistically feasible. A range of people were sampled—men, women, and various age groups.

1-week follow up

- What: Following their visit to the museum, some respondents were asked to complete an e-mail response to three questions:(a) What, if anything, do you remember learning in the presentation?, (b) Since the presentation, did you happen to make any efforts to learn more about global warming? If yes, please explain, and (c) Since the presentation, did you happen to make any changes in your daily life that could help reduce your own impact on global warming? If yes, please explain.

  These questions were asked to find out what part of the presentation stood out, whether participants were seeking more knowledge about global warming, and whether the presentation might have influenced their behavior.
- Who: Half of the 60 participants.
- How: Participants' phone numbers and e-mail addresses were collected when they completed the written survey. About one-half of the participants were contacted one week following the presentation.
- When: One-week following the museum visit.

Observation

- What: Presentations were observed by PREL staff (a) to see if they were being implemented properly, (b) to report on audience engagement, and (c) to identify possible logistical and content improvements to the presentation.

RESULTS

PREL attended six randomly selected presentations of "Too Hot to Handle: The Science behind Global Warming" between April 12 and April 24, 2007. We viewed two weekend and four weekday sessions presented by five Museum staff (i.e., the Education Director, two Science Educators, and two casual hire staff). The amount of data collected was more limited than intended because (a) fewer than expected museum-goers attended full presentations; (b) some presentations ended late, reducing or eliminating time for participants to complete surveys and interviews; (c) fewer participants than expected provided their contact information, and (d) not all of those responded when contacted.

Survey Respondents. A total of 35 adults and 12 children were present for all or nearly all of the duration of a presentation, and an additional 54 people entered after the initial few minutes and stayed for the remainder of the program. Of the 35 original adults, 29 completed the postsurvey

(83%). Most of those who responded (75%) did not live in Hawai‘i, were women (57%), had a college and postcollege degrees (80%), and ranged in age from 23 to 80, with an average age of 54. Respondents generally had an affinity for science: On a 10-point scale, 85% rated their interest an 8, 9, or 10. One-fourth (26%) had a background in science (e.g., a college major or work in the field), and 59% were aware of the recent Intergovernmental Panel on Climate Change report (http://www.ipcc.ch/). (See Table 2 for participant demographics.)

Table 2. Respondent Profile

	Freq.	Percent of respondents
Hawaii Resident	6	26%
Non-Resident	17	74%
Total	*23*	*100%*
Male	12	43%
Female	16	57%
Total	*28*	*100%*
Adult under 54	12	48%
54 and over	13	52%
Total	*25*	*100%*
High School/Tech	5	20%
College	14	56%
Post-Grad	6	24%
Total	*25*	*100%*
Interest in science High (rated 8-10)	22	85%
Interest in science Medium (rated 4-7)	4	15%
Interest in science Low (rated 1-3)	0	0%
Total	*26*	*100%*
Science background	7	26%
No science background	20	74%
Total	*27*	*100%*
Read/heard of recent global warming report	16	59%
Did not read/hear of recent global warming report	11	41%
Total	*27*	*100%*

Changes in Knowledge and Feeling

Table 3 gives the means for the retrospective pretest and posttest, their differences, statistical significance, and the effect size for this difference[1] (Cohen, 1977; Lipsey & Wilson, 1993). The table lists the means for the three scales, belief, interest, and knowledge.

Table 3. Changes in Belief, Interest, and Knowledge of Global Warming

	Pretest Mean	Posttest Mean	Mean Difference (Post-Pre)	Sig. (2-tailed)	Effect Size (Pre-Post/Std. Dev. Pre)
Q1. Believe that the increase in the earth's average temperature over the past few decades is the result of carbon dioxide and other gases released into the atmosphere by human activity.	6.93	7.83	0.90	0.001	0.37
Q2. Believe that reducing our use of carbon dioxide will make a difference	6.69	7.76	1.07	0.001	0.47
SCALE: Belief in global warming	*6.81*	*7.79*	*0.98*	*0.001*	*0.47*
Q3 Worry about global warming	6.55	7.45	0.90	0.002	0.34
Q6 Care about the impacts of global warming	7.45	8.41	0.97	0.003	0.37
SCALE: Interest in global warming	*7.00*	*7.93*	*0.93*	*0.001*	*0.37*
Q4 Know about what causes global warming	6.31	7.86	1.55	0.000	0.67
Q5 Know about how the earth is impacted by global warming	6.41	7.76	1.35	0.000	0.68
Q7 Know about the things you can do to reduce global warming	6.54	7.68	1.14	0.001	0.60
SCALE: Knowledge of global warming	*6.36*	*7.71*	*1.36*	*0.000*	*0.74*

Notes: N=29 for all items except Q7, where N=28.

Differences between all means were statistically significant at the .01 probability level, using a 2-tailed *t* test for correlated samples. The effect sizes for the three scales ranged from .37 to .74. The Alpha reliability coefficient (Cronbach, 1951) for the 7-item scale was .90. For the three subscales, alpha coefficients were .56 for *belief*, .92 for *interest*, and for .76 for *knowledge*.

Changes in Behavior

The percentages of respondents who chose each of 5 response choices for the question asking how likely they were to change their behavior based on the presentation are given in Table 3,

Table 4. Changes in Behavior

Q9 After watching this presentation, how likely are you to make changes in your daily life to decrease global warming…	Freq.	Percent
5 Extremely	4	14%
4 A lot	11	38%
3 Somewhat	11	38%

[1] An effect size for the difference between two means is computed as their difference divided by the standard deviation of the pretest. Differences of .2 (i.e., two-tenths of a standard deviation) are conventionally considered small, those of .5 of medium size, and those .8 or larger to be substantial.

2 Very little	3	10%
1 Not at all	0	0%
Total	*29*	*100%*

Just over half (52%) of respondents said they would be at least “a lot” more likely to do something todecrease global warming.

Attitude Toward the Presentation

As shown in Table 5, over one-third of the audience said they were *extremely* satisfied with the presentation. Combined with those who said they were *a lot* satisfied (35%+45%), 80% of patrons said they were satisfied with the presentation.

Table 5. Overall Rating of Presentation

Q10 Overall, how satisfied are you with this presentation?	Freq.	Percent
5 Extremely	10	35%
4 A lot	13	45%
3 Somewhat	5	17%
2 Very little	1	3%
1 Not at all	0	0%
Total	*29*	*100%*

Open-ended Responses

Respondents were asked what they liked best about the Sphere (item 11) and what they would do to improve the presentation (item 12). Verbatim responses for these two open-ended items are presented in Appendix 2. The responses to the question about the best thing about the Sphere give a broad picture of the assets this device brings to an instructional venue: it is dramatic, effective, shows movement, allows visualization, is easy to see, and so forth.

The suggestions for improvement are left to program staff to peruse and deal with as they see fit. Two comments seem appropriate. There was some dissatisfaction about the manner in which the flat screens were used. This comment should be addressed. Some viewers mentioned the absence of any mention that there were counter arguments or, even, that the general weight of scientific opinion is now on the side of global warming and man’s contribution to it.

Interview Responses

Those interviewed were asked what was the biggest impact of the presentation, whether and how the Sphere helped with understanding, and whether the presentation was appropriate for children. The verbatim responses appear in Appendix 3. Our nonquantified summary of them follows.

Biggest impact. Responses ranged from impacts of various sorts to “no new information.” Those comments that registered impacts mentioned the causes and consequence of global warming. The visualizations made possible by the images shown were mentioned. This impact seemed consequential and durable.

Understanding. Respondents seemed to agree that the Sphere made things real (i.e., helped produce visualization). The whole-globe nature of the Sphere and the movement was also mentioned as a positive factor.

Appropriateness for children. There appeared to be a consensus that the Sphere was appropriate for children.

1-Week Follow-up

Appendix 4 gives responses for the six patrons who responded to the follow-up e-mail. Respondents were asked to name the biggest impact for them of the presentation, whether they had sought additional knowledge about global warming, and whether they had taken any personal steps to reduce global warming. In general, it seemed that the dramatic visualization of Waikiki and other locations being submerged as the planet warms was remembered. For this small sample, about half of the respondents seemed to pursue additional knowledge. Only four of the six responded to the item asking whether they had done anything different for addressing global warming.

FINDINGS

Is the SOS live presentation an effective tool for teaching the public about global warming?

Yes. Participants entered the presentation with positive beliefs, interest, and knowledge of global warming (all mean scores were above 6 on various 10-point scale items). The differences between prescores and postscores were statistically significant on all related questions. The largest impact of the presentation was on increasing participants' knowledge of global warming, and, in particular, their knowledge of its causes: The mean score increased by 1.6 points from 6.3 to 7.9. Table 3 shows statistically significant increases in mean scores on all seven questions and three composite scales related to global warming.

Additionally, Table 4 shows that nearly all participants said the presentation influenced their intentions to make changes in their lives to reduce global warming at least somewhat, including 38% who said "a lot" and 14% who said they were "extremely" likely to make changes after watching the presentation.

Although these results clearly demonstrate the effectiveness of the presentation as a whole, the Sphere technology in particular was an important component of the presentation's effectiveness. Open-ended survey questions and face-to-face interviews revealed that the Sphere was recognized by some as a better presentation tool than a flat screen, and that the Sphere technology made the information more realistic and authentic. Additionally, time-lapsed, worldwide temperature change, worldwide sea level rising, and Waikiki flooding—images that used the technology fully (i.e. time-lapsing, data mapping)—were particularly memorable.

Findings for the second question for the global warming presentation, *How can the presentation be improved to increase its effectiveness?,* are presented in the *conclusions and recommendations* section.

CONCLUSION AND RECOMMENDATIONS

As elaborated in the findings section, the presentation on global warming was effective in teaching the public about the causes and effects of global warming. Of course, the size of this impact was governed by the limited exposure time of 25 minutes.

Our recommendations for the global warming presentation are derived from our observations and from participant feedback.

First, participants rated the presentation very positively. On a scale of 1 to 5, 80% rated it a 4 or 5. Additionally, only 10 respondents provided written comments about ways to improve the presentation. Their suggestions were: improve or remove the flat screen visuals (4) (an issue which has already been resolved by the museum), discuss opposing viewpoints (2), provide more information on what people can do about global warming (2), use more graphics (1), and more interactivity/questions (1).

We believe the presentation could be improved in four areas.

1. **Increase Attendance**: Punctual and intentional attendance to these presentations seemed low, particularly compared to the number of people who were present 10 to 20 minutes later for the planetarium show. Given the positive impact of the presentation, it seems very worthwhile to increase attendance by (a) confirming that attendance to this presentation is low compared to other presentations and (b) identifying the reasons why more museum goers are not attending this presentation.
2. **Maximize Audience Attention**: Overall, our impression was that audience members seemed quite interested in the presentation, and nearly all remained watching the presentation once they began; however, there are opportunities to reduce distractions and increase audience engagement.
    - *Decrease traffic flow.* The most significant problem we found was the number of museum-goers and museum staff entering and exiting the room from the front and back doors during the presentation. One suggestion is to put a sign on the outside door to alert latecomers of what they entering; another is to alert museum staff to be considerate of the distractions they might cause.
    - *Improve setup.* Not all presenters had set up any or a sufficient number of chairs prior to the presentation to seat all audience members. Having people setting up chairs or the presenter stopping to direct them to do so was distracting.
    - *Accommodate multiple* viewing angles. We noted (and one audience member commented) that those not sitting in front of the presenter were not always seeing the same images that were being discussed. Latecomers, in particular, were not positioned well. Improving the setup could help; another possibility is to show the same image on multiple sides of the Sphere simultaneous (e.g. the Waikiki flooding slide).
    - *Increase audience participation.* In general, there seemed to be few opportunities for audience interaction during the presentation. Although there is one participant activity built into the presentation, only one presenter used it. There were few questions posed by either presenter or audience members during the presentation.
3. **Enhance Content**: Participants' memory and learning focused on accelerating temperature increases and sea level rises. There was little mention of other images, such as Pangea, forest fires, ice cores, or hurricanes. The Museum may want to review the presentation and decide if there are additional ways to convey the story of global warming. A few survey respondents and interviewees said they wanted to know more about the consequences and implications; others said they wanted more on what they can do to make a difference. Given that there is an exhibit on global warming surrounding the Sphere that covers these aspects of the issue, there may be opportunities to incorporate the exhibit into the presentation or recommend that participants spend time with it.

4. **Ensure consistency** across presenters: We observed that all presenters had good knowledge of the presentation's content, though some emphasized certain points more than others, and some slides were skipped due to a lack of time. Although some variation is expected, the museum may want to develop a system of peer review to ensure that all staff provide a high quality presentation that covers all the primary objectives.

EDUCATION PROGRAMS

As part of the NOAA grant, the Bishop Museum prepared and presented 25-minute science modules to students in grade levels K-8. These modules are stand-alone presentations of limited science content (e.g., how tsunamis are formed, climate and weather patterns, formation of the earth). These modules form part of a larger, multicomponent curricular series to be incorporated as part of science instruction in public schools, but those curricula were not part of this evaluation.

During the week, classrooms, mostly from public schools, attend the presentation as part of an educational visit to the museum that involves other presentations as well.

DESIGN

PREL's evaluation tasks centered on addressing two questions: (a) Does the SOS presentation add value to teachers' coverage of the intended benchmarks? (b) What is the SOS presentation's impact on student learning?

Learning

To determine the impact of the presentation on student learning, PREL analyzed samples of test results from grade levels 1, 3, 4, 6, and 8. These grade levels were a priority for the museum. Tests were collected during visits to the museum in September 2007.

Random samples of tests were selected by numbering all tests available for each grade level and using the Excel random number function to select test identification numbers (the consecutively numbered tests) until the quota of tests was filled. The sample size (the quota) was obtained from a calculator available on the Web (http://www.surveysystem.com/sscalc.htm#ssneeded). The quota for each grade level was calculated as follows. Given the total number of available tests, a sample size was obtained for each grade level that produced a confidence interval of 8 percentage points at the 95% confidence level.

Benchmarks

The HIDOE has benchmarks for science for all grade levels. In order to determine whether these benchmarks were covered by the curricular modules, PREL compared the benchmarks for each grade level to the corresponding presentation scripts and tests (document review) and interviewed teachers.

MEASURES

Learning

The tests for each presentation were created by museum staff. Pretests and posttests were the same. Tests were administered before and just after the presentation. Tests were placed on individual clipboards. Tests were not piloted nor were psychometric analyses used to guide development. The tests are included in Appendix 5.

Scoring. Items were scored right (1) and wrong (0) according to the answer key provided by the museum. PREL found that some items were more accurately answered if partial credit were given.

Total scores were derived by summing item responses for each test. Pretest and posttest totals were compared using a 2-tailed *t* test for dependent samples (the same persons were involved in both tests) at the conventional .05 probability level.

Benchmarks

Two methods were used to determine whether the relevant grade level benchmarks were represented in the education programs. A document review involved our judgment of whether relevant benchmarks were covered in the scripts used for the presentations and the tests created by the museum to assess the amount of learning stimulated by the presentations. Second, teachers were asked on the phone whether they thought the benchmarks were coved by the presentation.

The museum provided the phone numbers for 12 teachers representing grade levels 1, 3, 4, 6, and 8. Half of these (6) were sampled for the interview. All 12 teachers were called. The sample of teachers interviewed was the first six who were reached directly or who called back. The sample represented grade levels 1, 4, 6, and 8.

RESULTS

Learning

The results of the 2-tailed tests of mean differences for dependent samples follow. Using grade level 4 as an example, the table can be interpreted as follows. Eighty-one (81) 4th grade students were analyzed. Out of a total possible score of 6, the pretest mean was 1.53; the posttest mean was 2.99; the difference between these was 1.46; this difference was statistically significant; the standard deviation for the pretest was 1.54, and the effect-size was 0.95.

An effect size is calculated by dividing the difference between the control group mean and treatment group mean by the standard deviation of the control group. (Here, the control group is represented by the pretest.) An effect size, then, is the proportion of the standard deviation represented by the difference between means. For example, if the difference between two means is 7 and the standard deviation of the control group is 14, the effect size would be .5 (7/14). Conversely, if the difference between two means is 14 and the standard deviation of the pretest 7, the effect size would be 2 (14/7). In education contexts, effect sizes above .8 are generally considered large.

Table 6. Pretest and Posttest Results for Grade Levels 1, 3, 4, 6, and 8

Grade Level	Number of Items	*N*	Mean		Absolute Difference	Statistically Significant	STD Pretest	Effect Size
			Pretest	Posttest				
1	3	76	2.62	2.63	0.13	No	0.65	0.20
3	6	74	3.41	4.35	0.94	Yes	0.85	1.11
4	6	81	1.53	2.99	1.46	Yes	1.54	0.95
6	6	51	1.73	3.97	2.25	Yes	1.12	2.01
8	3	60	1.00	2.30	1.30	Yes	0.85	1.53

For all but grade 1, the differences between the pretest and posttest means were statistically significant and large, using effect size as a metric. The failure for the first grade test to demonstrate

treatment effects is likely due to the high scores participants had on the pretest. The mean was 2.6, and this was 87% of the total number of points (3) possible on the test.

It is possible to determine what percentage of the total possible scores a given score represents. For instance, the pretest mean for grade 4 of 1.53 is 26% of the total possible pretest score of 6 (1.53/6=.26). Running this calculation out for the five grade levels gives percentages for the pretests and posttests as shown in Table 7.

Table 7. Percent of Possible Score on Pretest and Posttest

Grade Level	Total points	Means		% of Possible		Improvement
		Pretest	Posttest	Pretest	Posttest	
1	3	2.62	2.63	87%	88%	0%
3	6	3.41	4.35	57%	73%	16%
4	6	1.53	2.99	26%	50%	24%
6	6	1.73	3.97	29%	66%	37%
8	3	1	2.3	33%	77%	43%

These percentages can be interpreted as follows. The average score on the 8th grade pretest (1), for example, was one-third (33%) of the total possible points for this test (3 points). The average score on the 8th grade posttest (2.3) was three-quarters (77%) of the total possible points for this test (3 points). So, it might be said that, on average, 8th grade students knew about one third of the content tested before they attended the presentation. After the presentation, they knew, on average, about three quarters of the material tested.

These results show that for two of the tests (grade levels 1 and 3), over half of the material to be taught (as reflected in the pretest) was already known. Because so much of the intended material seemed already to be known, the tests, instruction, or both should probably be modified.

Please note that interpretations of these test results depend on the validity of the tests upon which these interpretations are based. Because we did not study or develop the tests, PREL can make no claim about their validity. We note that it might be best to think of them as pilot tests.

Benchmarks

The reviews of the correspondence between the benchmarks and instructional modules are given for each grade level in Appendix 6.

The benchmarks were included in the scripts and tests for all grade levels, but the coverage for grade 8 was not complete. Benchmark 8.8.5 (Explain how the sun is the major source of energy influencing climate and weather on Earth) was not directly covered in the script or the test.

Every teacher interviewed stated that the presentations clearly matched the selected HCPS III standards and benchmarks for their grade level. One eighth-grade teacher noted that one benchmark stated in her materials was not covered and said the other benchmarks were covered. The other five teachers agreed that the Sphere curriculum matched the benchmarks perfectly.

Two teachers mentioned that the Sphere provided an engaging and riveting experience for their students. One teacher said that the visual and multidimensional presentation enabled by the Sphere helped her students better understand concepts she had been teaching in class. She said the

Sphere allowed them to experience the concepts in a way she could not accomplish in the classroom. One teacher stated that while some students may not have grasped all the concepts, they would be more open to conversations about the topic because the Sphere presentation had drawn them in. Overall, there was consensus that the presentations utilizing the Sphere were a valuable resource for helping students gain science content knowledge appropriate to their grade level and the HCPS III standards.

One teacher stated that the level of presentation was just a bit too high for her first graders, since they did not have the background. She felt that first graders from another school may have understood it. She noted that could be easily rectified if teachers had some understanding of what would be covered and could go over key concepts in class before coming to Bishop Museum. She understood that this iteration of the curriculum was a pilot test and suggested that, once the curriculum was fully developed, teachers receive the script and related material before taking the trip to Bishop Museum.

FINDINGS

The presentations were effective in producing learning in all but the first grade. The increases in posttest scores were statistically significant and large for all but first grade. Because it is hard to detect cognitive or affective states for children as young as first graders using written tests (Colton, 2007, September 17; EvalTalk, 2007, September 13), this failure to detect learning in these 1st-grade children might have been partly due to a failure of the measure and not the curriculum. The high percentage of content known at pretest exacerbated the problem.

The benchmarks for all but one grade level (grade 8) were fully reflected in the scripts and tests of the presentations. This finding was confirmed by interviews with teachers.

DISCUSSION

The tests developed by the museum to detect learning from the science presentations were serviceable, but should be considered pilot tests. If they are to be used again to assess learning, the tests and their scoring systems should be developed. An item analysis might be conducted on the data from these or other pilot tests. The item scoring should be reviewed. The effect of weighting produced by multipoint items should be noted. For example, if a test has two items, and one of those items has 2 points and the other 1 point, the 2-point item will carry twice the weight as the 1-point item. The result will be that the objective or benchmark represented by the 2-point item will be twice as important in test results as the benchmark represented by the 1-point item. If this weighting is not intended, it could lead to invalid conclusions.

The museum should also consider using more multiple-choice items on the tests. This would facilitate and standardize scoring.

The globe was not a good way to represent all content. For instance, the content of the grade 7 presentation, organelles, did not seem suited to representation on a spherical medium. In other words, it may be that only content that relates to the spherical nature of the earth, or other bodies in space, is appropriate for presentation using the NOAA Sphere.

During observations of the presentations, PREL noticed that the focus of attention was often fixed on a global location so that patrons had either to gather facing the point of focus on the Sphere or wait until the image was revolved to their view plain. In the former instance, the viewing space could be crowded. In the latter instance, what was being viewed on the “back” of the globe would not be synchronized with the discussion of the focal point facing the moderator at the front of the globe. At times when the view of the globe is localized, the museum might consider switching to a projection

that divides the globe into four identical views. That way, the view from any position around the sphere would focus on the same thing.

CONCLUSION AND RECOMMENDATIONS

We concluded that the one-session science modules developed by Bishop Museum for use with classrooms of students were well delivered and received. Learning was demonstrated, and the learning was consistent with appropriate benchmarks for the HIDOE.

1. We recommend that the tests of learning from the modules be developed more. Item analyses and scoring of the current items should be considered. Also, the museum should consider developing multiple-choice items.

2. We don't think all science content is well suited for presentation on a globe. The museum should consider whether they agree with this opinion and, if so, use their conclusion to revise the current presentations and direct development of future modules.

3. The grade 1 test did not show learning gains, in part, because so much of the content was know before students arrived for the presentation. The test, curriculum, or both should be revised if the museum wants to demonstrate presentation effects.

4. The grade 8 test did not fully reflect associated benchmarks. The presentation, too, may have been a little weaker than it might be. We suggest revision of both.

REFERENCES

Cohen, J. (1977). *Statistical power analysis for the behavioral sciences (Rev. ed.)*. New York: Academic Press.

Colton, D. (2007, September 17). Happy face Likert scale-citations: EvalTalk.

Cronbach, L. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*, 297-334.

EvalTalk. (2007, September 13). Happy face Likert scale: EvalTalk.

Lam, T. C. M., & Bengo, P. (2003). A comparison of three retrospective self-reporting methods of measuring change in instructional practice. *American Journal of Evaluation, 24*(1), 65-80.

Lamb, T. (2005, Summer). The retrospective pretest: An imperfect but useful tool. *Evaluation Methodology* volume XI, No. 2. Retrieved October 5, 2005, from http://www.gse.harvard.edu/hfrp/eval/issue30/spotlight.html

Lipsey, M. W., & Wilson, D. B. (1993). The efficacy of psychological, educational, and behavioral treatment: Confirmation from meta-analysis. *American Psychologist, 48*(12), 1181-1209.

Pohl, N. F. (1982). Using retrospective pretesting to counteract response-shift confounding. *Journal of Experimental Education, 50*(4), 211-214.

Pratt, C., McGuigan, W., & Katzev, A. (2000). Measuring program outcomes: Using retrospective pretest methodology. *American Journal of Evaluation, 21*(3), 341-349.

Umble, K., Upshaw, V., Orton, S., & Mathews, K. (2000, June 15). *Using the post-then method to assess learner change.* Paper presented at the American Association for Higher Education Assessment Conference, Charlotte, North Carolina.

Appendix 1. Global Warming Questionnaire

DATE:

Too Hot To Handle: The Science Behind Global Warming

Help the Bishop Museum improve this presentation. Give us your feedback!

For items 1–7 circle one number to rate your feelings BEFORE you attended this presentation and one number for your feelings now, AFTER the presentation. The number can increase, decrease, or stay the same from before to after.

1. How much do you believe that the increase in the earth's average temperature over the past few decades is the result of carbon dioxide and other gases released into the atmosphere by human activity?

	Not at all									Extremely Much
BEFORE the presentation	1	2	3	4	5	6	7	8	9	10
AFTER the presentation	1	2	3	4	5	6	7	8	9	10

2. How much do you believe that reducing our use of carbon dioxide will make a difference?

	Not at all									Extremely Much
BEFORE the presentation	1	2	3	4	5	6	7	8	9	10
AFTER the presentation	1	2	3	4	5	6	7	8	9	10

3. How much do you worry about global warming?

	Not at all									Extremely Much
BEFORE the presentation	1	2	3	4	5	6	7	8	9	10
AFTER the presentation	1	2	3	4	5	6	7	8	9	10

4. How much do you know about what causes global warming?

	Nothing at all									Extremely Much
BEFORE the presentation	1	2	3	4	5	6	7	8	9	10
AFTER the presentation	1	2	3	4	5	6	7	8	9	10

5. How much do you know about how the earth is impacted by global warming?

	Nothing at all									Extremely Much
BEFORE the presentation	1	2	3	4	5	6	7	8	9	10
AFTER the presentation	1	2	3	4	5	6	7	8	9	10

6. How much do you care about the impacts of global warming?

	Not at all								Extremely Much	
BEFORE the presentation	1	2	3	4	5	6	7	8	9	10
AFTER the presentation	1	2	3	4	5	6	7	8	9	10

7. How much do you know about the kinds of things you can do to reduce global warming?

	Nothing at all								Extremely Much	
BEFORE the presentation	1	2	3	4	5	6	7	8	9	10
AFTER the presentation	1	2	3	4	5	6	7	8	9	10

PLEASE CONTINUE ON THE BACK

8. What were the most important things you learned in this presentation? Write your answers below.
   →

   →

   →

	Not at all	Very little	Some what	A lot	Extremely
9. After watching this presentation, how likely are you to make changes in your daily life to decrease global warming.	1	2	3	4	5
10. Overall, how satisfied are you with this presentation?	1	2	3	4	5

11. What did you like best about the Sphere?

12. What would you do to improve the overall presentation?

Please tell us about yourself:

13. Rate your interest in science on a scale of 1 to 10, where 1 is "I have absolutely no interest in science" and 10 is "I am extremely interested in science."

"No interest"	1	2	3	4	5	6	7	8	9	10	"Extremely interested"

14. How many other people are here with you today? # Children:__ Age of children:_____# Adults:__

15. Are you… [ ] Male [ ] Female 16. Age: 17. Zip code:

18. What is the highest level of education you have completed? _____

19. Do you have advanced training in science (e.g., college major or work in a science field)? [ ] No [ ] Yes

20. In the past few weeks, have you read or heard in the news about a new report on global warming published by an international group of scientists? [ ] No [ ] Yes

May we contact you? It is important for us to know if this presentation is memorable. In the next few weeks we are conducting brief (no more than 5 minutes) follow up interviews with a few randomly selected participants. Please provide your contact information so that if you are selected we can reach you. We appreciate your participation!

First name: Phone number: (____) -____ - _____ Email:

Your participation is confidential. We will not share your contact information or your responses.

Appendix 2. Responses to Open-ended Items on Questionnaire

Responses to item 11: *What did you like best about the Sphere?*

What did you like best about the Sphere?
1. stunning real-time visuals
2. could see something on 4 sides and then back to global picture
3. demonstrated the cause and effects of global warming in a clear 3-d format from ground level all the way to space.
4. that you could see around the world, that you could see the earth over time.
5. extremely effective presentation
6. better than flat-reminds one of the Sphere we live on and its relevance to our lives
7. It's ability to convey so much information and hold children's interest
8. realistic visual
9. helped understand
10. the appearance that it rotates
11. the clear, bright graphics
12. the graphic images on the Sphere serve to emphasize and make memorable the facts given in the presentation
13. easy to see
14. dramatic visual
15. it's novel
16. that you have it
17. A picture is worth a terabyte of words
18. the way it helped present the information much better than on a flat screen.
19. the movability-- up/down/tilt
20. how it showed hot spot and Waikiki under water
21. everything
22. excellent learning tool, 3d, can see from all sides, perfect for learning about the earth

Responses to item 12: *What would you do to improve the presentation?*

	What would you do to improve the presentation?
1.	maybe a few more minutes of the positive parts or a bit more information on exactly the steps people can take. M
2.	more info on the usage of fossil fuel and its effect on global warming
3.	use alternative energy/not to vote for the republicans
4.	more use of graphics
5.	more interactivity/questions
6.	opposing views
7.	I thought it was good
8.	very good as is
9.	raise the flat screens above sphere
10.	more or bigger flat screens
11.	have more flat screens. Put the flat screen stuff in the Sphere
12.	learned much more from 20/20 show last night. It would be good to end this presentation with the specific sugges suggestion.
13.	not ask the first person in line and delay entrance
14.	maybe present the other side of the argument if just to disprove it. was just the mention that most of the world's s

Appendix 3. Interview Responses

Responses to the postpresentation interviews.

Biggest impact?	Did the Sphere help you understand?	Does it work for children?
The impacts of global warming	Yes, The Sphere is attention-getting, but you need to do something about the flat screens. They are too hard to see.	
The level of the shoreline rising. Seeing Waikiki. It was really mind blowing.	Yes, because it's moving. It let's you see what's going on in Africa. It gives you a good perspective, rather than just saying it. seeing the hotspots. More informative.	OK for daughters. They stayed quiet!
Visualization as opposed to reading. The first visuals made the whole thing authentic. Based on fact. I gave me buy-in to the presentation. I saw Seattle and the cloud cover over it now and that made it authentic.	Yes, I'm a teacher. The visualization.	
Relevance to children. It connects issues of global warming to youth.	Yes-wholer perspectives, conveys information on wider scale	Yes-they enjoyed it, were interested. Ages 15, 11, 8. The 8-year old just starting to understand. The 15-year old understand more, has an especially personal connection
Not much new info	Yes - Ocean currents.	NA
The history section. How the planet evolved/continents formed. Global warming.	Yes - Visualization for all of the information.	NA
Relevance of global warming to me.	Yes - sphere helped demonstrate relevance of world events.	NA
No new information	Yes - I got to see where I live on the globe.	NA
What's going to happen if things keep going the way they are	Yes - good visuals for all of the information.	NA
The information presented; some of it was shocking.	Yes - images and speaker's use of pointer.	Children really liked presentation. One said it was better than science class. Familiar topics to what kids are learning in school (high school and elementary). Wish there was a summer camp.
The pictures demonstrating sea-level rise in stages.	Yes - the whole globe made it possible to compare countries. Especially liked how countries were color-shaded.	Children really liked the presentation and are interested in the topic. Different levels of understanding according to age. The 8-year-old was more familiar with vocabulary and concepts. The 4-year-old really liked the pictures.

Seeing the water rising, the water level in Waikiki. Read the displays in the room and thought some of those had more of an impact, seeing huge icebergs break off. Didn't see that in the presentation. the iceberg they showed in presentation was not shocking. Also saw in display how much gas we use. Would like to have seen more of that.		I thought it captured her attention even at 6 years old.
secific sea level changes impacted waikiki as opposed to general effects of global warming.	recently saw inconvenient truth. The images mad e a difference. It's a good way to display it on the globe. It makes it a little more realistic, believable.	Her 12 year old son paid attention, he seemed impressed, he seemed to understand

Appendix 4. Follow-up Responses

Responses to three follow-up questions.

What do you remember?	Learn more?	Do anything different?
I remember the map of the earth showing the impact of a 3 ft. rise in sea levels.	Not really. We have been on vacation from the time of the presentation until now. But this weekend I will be learning more at a workshop held by a company called CoolNRG, which does energy efficiency projects to reduce greenhouse gases in Australia.	We have been traveling since the presentation, but we have been making a conscious effort to reduce the amount of packaging that we are buying, including the kids on that. Also, more efforts to turn lights off.
I think I do recall learning that the Earth's temperature has increased by 0.18 degrees Celsius in the past century. I have definitely learned a great deal though.	Unfortunately no. I believe the Bishop Museum has covered about everything I needed to know.	Yes. Turning the light off more often and recycling more.
The main thing I remember is the globe itself, closely followed by the dynamic animations of weather, heat projections, etc.	I had and continue to read about global warming in my newspaper, Time magazine and on the BBC news website.	No immediate changes - I am already pretty energy conscious - my car averages 54 miles per gallon.
Now that i am back in New York state, where we have lake Ontario, 60 miles across by 150 long and 400 deep i am impressed with this treasure. As the decades pass, it will be tough not to share it with the less fortunate. your presentation brought home to me that, ultimately, great swaths of agricultural land in the world may become desert, and shoreline cities may vie with the legend of Atlantis. Thank you for a very informative and impressive presentation,		
about the ocean rise around the globe	I had recently seen An Inconvenient Truth, so this was familiar to me	Because I have a 12-yr old son, I started when he was little to recycle and bring him up in a household where awareness is second nature.
That Waikiki will be basically under water when this warming takes place.	I am planning on watching the Glenn Beck special, tomorrow, debating the other side of global warming. I have also just recently heard that John Stossil's "Myths,	No

What do you remember?	Learn more?	Do anything different?
	Lies and Downright Stupidity" has a chapter pointing out the "myth" of global warming. I am somewhere in the middle on this issue, and would like to know more so I can either support it or speak intelligently against it.	

Appendix 5. Tests of Student Learning for Grade Levels 1, 3, 4, 6, and 8

BISHOP MUSEUM

Here Comes the Sun

1st grade

Tell us what you know. Please complete this side of the paper BEFORE you visit the Bishop Museum and participate in the Science on the Sphere program. Then, give it to your teacher.

Name: _____ **Grade:** _____

School: _____ **Circle one: Girl Boy**

1. Circle the word that warms the earth, air, and water.

MOON **SUN**

2. Circle the season when the earth is very warm and sunny.


SPRING


SUMMER


FALL/AUTUMN


WINTER

3. Circle what appears when sunlight shines through raindrops.


RAINBOW


MUD PUDDLE


FROG

BISHOP MUSEUM

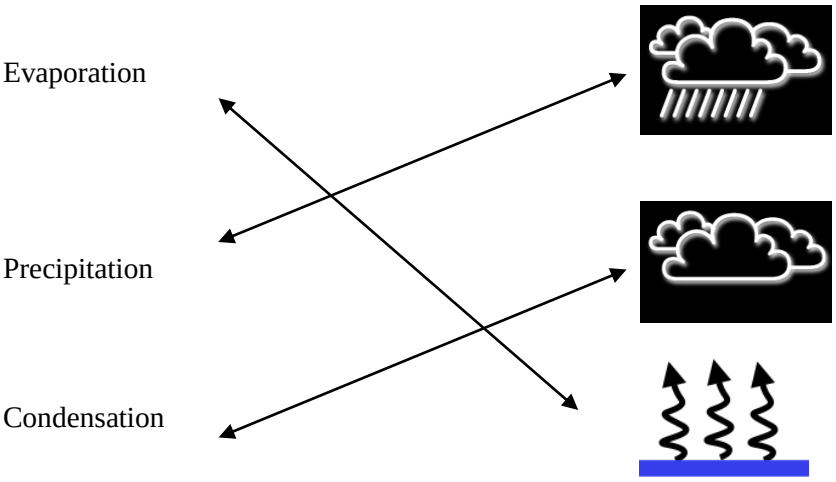
1WOW! Wonders of Water

3rd grade

Share what you know!

ANSWER SHEET – Total points = 8pts

1. The Water Cycle – Match the word to the illustration with a line (3pt – 1 pt for each correct answer)



2. Circle the parts of the water cycle that usually happen on a rainy day (4 pts – 1 pt for each correct answer)

Condensation √ Precipitation √ Run-off √

No precipitation No condensation Infiltration √

3. What does pollution do to rivers and streams? (1 pt)

(NB: Can be any of the following, does not need to be word for word)

- Makes the water dirty.
- Makes creatures (fish etc.) and plants living in rivers and streams sick.
- Makes people using the water sick.

BISHOP MUSEUM

Extreme Makeover: Earth Edition

4th grade

ANSWER KEY

Share what you know!

Tell us what you know. Please complete this side of the paper **BEFORE** you visit the Bishop Museum and participate in the Science on the Sphere program. Then, give it to your teacher.

Name: _____ Date: _____ Circle One:

School: _____ Grade: _____ Boy Girl

1. Where are most of the world's earthquakes found?

   On the plate boundaries (edges).

2. What can form when two of Earth's plates collide?

   Mountains (i.e. Himalayas) or volcanoes (i.e. Andes)

3. What can form when two of Earth's plates separate?

   A chain of underwater volcanoes (i.e. Mid Atlantic Ridge)

4. How did the Hawaiian Islands form?

   From a hot spot. (Long answer: The hot spot stay stationary while the Pacific Plate moves to the Northwest and each of the islands form in succession).

5. How many volcanoes make up Oahu?

   2

6. What evidence of erosion do you find on Oahu?

   Carved valleys, sculpted mountains (i.e. Koolau and Waianae Volcanoes)

BISHOP MUSEUM

Tsunamis: Walls of Water

6th grade

ANSWER KEY

Share what you know!

1. How do most tsunamis form?

   From earthquakes, plates grinding against one another, etc.

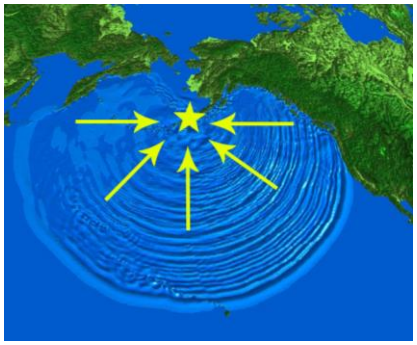
2. Where do most of the world's earthquakes occur?

   On plate boundaries or edges.

3. How do scientists measure the strength of earthquakes?

   By using a seismometer (or looking at a seismograph which tells them the magnitude of the earthquake on the Richter scale).

4. Imagine that an earthquake ( ) generated a tsunami. **CIRCLE** the drawing whose arrows show the correct direction the tsunami waves travel?



5. What tools and technology do scientists use in a tsunami warning system?

   Buoys, satellites, seismometers are all acceptable answers.

6. What should you do if you hear the tsunami siren go off (and it is not just a drill)?

Run to higher ground or if you don't time, go to the top floors (6th floor or higher) of a tall building.

BISHOP MUSEUM

Under the Weather

8th grade

BEFORE

Share what you know!

Tell us what you know. Please complete this side of the paper you visit the Bishop Museum and participate in the Science on the Sphere program. Then, give it to your teacher.

Name: _____ Grade: _____

School: _____ Circle one: Girl Boy

1. What season is it in the northern hemisphere when the Earth's axis is tilted away from Polaris (the sun)?

WINTER

2. What is the "fuel" that powers hurricanes?

WARM WATER

3. What is the name of the dramatic change in ocean current temperatures that typically occurs around Christmas?

EL NINO

Appendix 6. Analysis of Correspondence Between Presentation Scripts for Grade Levels 4, 6, and 8 and Associated Benchmarks

Bishop Museum Connections
Mapping Curriculum to Science Benchmarks

Grade 1

GRADE 1 **Standard 1:**	**Standard 8: Physical, Earth, and Space Sciences:** **EARTH AND SPACE SCIENCE: Understand the Earth and its processes, the solar system, and the universe and its contents**		
Topic	The Universe		
HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
Benchmark SC. 1.8.1	Describe that the sun warms the land, air, and water	Understanding of the sun, particularly its role in warming the land, air, and water around us. Explain how the sun is the major source of energy influencing climate and weather on Earth.	Winter is what happens when the Earth is tilted on its axis away from the sun and it gets cold. Summer is what happens when the Earth is tilted on its axis toward the sun – summer can be very warm.
Sample Performance Assessment (SPA)	The student: Describes the differences in the warmth of land, air, and water in the morning and afternoon or on cloudy and sunny days.		Circle the word that warms the earth, air, and water. Circle the season when the earth is warm and sunny.

Bishop Museum Connections
Mapping Curriculum to Science Benchmarks

Grade 3

GRADE 3 **Standard 8:**	**Standard 8: Physical, Earth, and Space Sciences:** **EARTH AND SPACE SCIENCE: Understand the Earth and its processes, the solar system, and the universe and its contents**		
Topic	**Forces that Shape the Earth**		
HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
Benchmark SC. 3.8.2	Describe how the water cycle is related to weather and climate	Students will review the process of the water cycle.	Water moves between the ocean, atmosphere (sky) and land. First, let's see what happens on the ocean as well as lakes and rivers. The sun gives the water cycle power to spin. The surface of the water heats up with the sun and turns into vapor. The vapor then rises up into the sky. What's this called? This is called EVAPORATION. (Say together) Let's take a look at the sky. Remember the vapors made from evaporation? The airborne vapors then rise into the sky. Here they join together to form clouds. What's this called? This is called CONDENSATION (Say together) What else happens in the sky? Eventually these clouds get so full of vapors, and high and cold enough that the water in the clouds form back into liquid water drops. The water drops are heavy and fall down to earth bringing stormy weather as rain, hail or snow. What's this called? This is called

GRADE 3 **Standard 8:**	**Standard 8: Physical, Earth, and Space Sciences:** **EARTH AND SPACE SCIENCE: Understand the Earth and its processes, the solar system, and the universe and its contents**		
Topic	**Forces that Shape the Earth**		
HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
			PRECIPITATION (precipitation) Now lets take a look at the water cycle in action! A lot of people don't realize that when we have a rainy or sunny day that it is because our water cycle is up to something. Our weather is related to the water cycle. Just like a team of scientists, lets take a look at a weather report and see how the weather is related to the water cycle.
Sample Performance Assessment (SPA)	The student: Illustrates the water cycle and explains its relationship to weather and climate.	Students will understand the link between different stages of the water cycle through 2 basic types of weather and related extreme climate events.	The Water Cycle – Match the word to the illustration with a line 2. Circle the parts of the water cycle that usually happen on a rainy day Condensation Precipitation Run-off No precipitation No condensation Infiltration

GRADE 3 **Standard 7:**	**Standard 7: Geography:** **WORLD IN SPATIAL TERMS-Use geographic representations to organize, analyze, and present information on people, places, and environments and understand the nature and interaction of geographic regions and societies around the world**		
Topic	Environment and Society		
HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
Benchmark SC. 3.7.4	Examine the ways in which people modify the physical environment and the effects of these changes	Students will evaluate how people have changed the physical environment relating to water and the affects of these changes through a local and global example. Students will gain an awareness of what they can do to conserve water on earth through these examples.	"Only a little bit of the earths water can be used by us humans as most of its salt water in the sea or frozen in the north and south poles. We also have to share it with all the plants and animals on earth. So do you think we need to look after it? I've noticed that there's been some problems with the water cycle because us humans aren't looking after it. We've been making the water cycle unhealthy. This is the Aral Sea, in Khazakstan. The Aral Sea is a very important water source for the people of Khazikstan as it is where they fish, get water for irrigation as well water for their homes. A while ago, people on the other side here decided they needed more water to grow crops and have water in their homes to brush their teeth etc, so they put in a dam to store up the water from the river that goes into the Aral sea. (freeze dam inage)Who can tell me what a dam is? But let's take a look at what happened to the Aral Sea on the other side of the dam. (unfreeze image to continue animation) There was less water going into the

GRADE 3 **Standard 7:**	**Standard 7: Geography:** **WORLD IN SPATIAL TERMS-Use geographic representations to organize, analyze, and present information on people, places, and environments and understand the nature and interaction of geographic regions and societies around the world**		
Topic	Environment and Society		
HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
			sea, why? Because of the dam and what happened? It has dried up. Result, many of the fishing boats became stranded, what other problems do you think may have happened? Yes, and all because people wanted more water for their homes! If only people would be willing to use only their share! We use water in our homes for baths, to do dishes and to brush our teeth. Who wants to see how much water we use when we brush our teeth? Who knows what pollution is? Lets take a look at somewhere closer to home. Where is this? Hawaii, Waikiki. Does anyone know what the name of this canal is? The Alawai Canal. Who can remember last year when we had 40 days of rain? Everything became flooded right and a lot of garbage off the street went into the canal. But not only that, because of all the flooding, the sewage lines (pipes that take our poop and shi shi!) overflowed so the city pumped raw

GRADE 3 **Standard 7:**	**Standard 7: Geography:** **WORLD IN SPATIAL TERMS-Use geographic representations to organize, analyze, and present information on people, places, and environments and understand the nature and interaction of geographic regions and societies around the world**		
Topic	Environment and Society		
HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
			sewage into the canal. Augh. Since then, the Alawai is a little bit cleaner, but it's still pretty dirty with stuff we humans keep letting get in there which wash off the street and down drains. Did you know that the Alawai Canal is actually a river with fish and living things!"
Sample Performance Assessment (SPA)	The student: Evaluates how people have changed the environment (e.g., irrigation, clearing land, planting crops, building roads) and the effects of these changes.		What does pollution do to rivers and streams?

Bishop Museum Connections
Mapping Curriculum to Science Benchmarks

Grade 4

GRADE 4 **Standard 8:**	**Physical, Earth, and Space Sciences:** **EARTH AND SPACE SCIENCE: Understand the Earth and its processes, the solar system, and the universe and its contents**		
Topic	Forces that Shape the Earth		
HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**

Benchmark SC. 4.8.1	Describe how slow processes sometimes shape and reshape the surface of the Earth	• Students will learn that the Earth has undergone many changes over time.
		  ○ Some of these changes are slow process like plate tectonics and erosion.
		  ○ Others are quick processes like earthquakes and volcanoes.
		• Students will know how and why the Earth's continents have shifted over millions of years.
		• Students will know what types of features form at different plate boundaries.
			"Now we know that the Earth's plates are moving at the pace your fingernails grow so we don't see the continents moving in our lifetimes because it is such a slow process. Do you think the Earth looked pretty much the same or a lot different 240 million years ago? Let's jump in our time machine and find out! *(Start animation)*. Let's watch as the continents begin to come together and form a massive super-continent called Pangaea 240 million years ago. *(Pause animation)* You can see that slow movements of the plates over hundreds of millions of years can cause large changes in the way that our Earth looks.
			(Students do an activity where they fit together foam pieces of North America, South American and Africa)"

Sample Performance	The student: Describes how the surface of the		Where are most of the world's earthquakes found?

GRADE 4 **Standard 8:**	**Physical, Earth, and Space Sciences:** **EARTH AND SPACE SCIENCE: Understand the Earth and its processes, the solar system, and the universe and its contents**		
Topic	Forces that Shape the Earth		
HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
Assessment (SPA)	Earth is shaped and reshaped through slow processes (e.g., waves, wind, water, ice).		What can form when two of Earth's plates collide? What can form when two of Earth's plates separate?

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Benchmark SC. 4.8.2	Describe how fast processes (e.g., volcanoes, earthquakes)	• Students will learn that the Earth has undergone many changes over time. ○ Some of these changes are slow process like plate tectonics and erosion.	The script contains several discussions of fast processes. A few are noted below: As the plates move and build up stress over time

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	sometimes shape and reshape the surface of the Earth	○ Others are quick processes like earthquakes and volcanoes. • Students will understand the relationship between earthquakes and the Earth's plate boundaries. • Students will understand how the Hawaiian Islands formed by movement of the plate and the hot spot. • Students will the growth and evolution of Oahu.	and they release this stress through earthquakes. This animation is a build up of earthquakes from 1980 through 1995. All the little yellow dots you see building up on the Sphere represent earthquakes. If there are a lot of earthquakes in an area, the dots turn red in color. Does anyone notice a pattern as to where the earthquakes are occurring? That's right, they are occurring on the plate boundaries or edges." This animation shows you how a stationary hot spot inside the Earth generates heat which rises to the surface and forms volcanoes or islands. If the Pacific Plate (the one Hawaii lies on) were not moving, we would just have one large Hawaiian Island. However, the Pacific Plate moves to the northwest so the hot spot creates a string of islands which you see here. You can see that the islands which have moved off the hot spot are no longer active, but the one directly over the hot spot is indeed active. "What about our island, Oahu? Does anyone know how many major volcanoes make up Oahu? That's right, 2 volcanoes. Watch as the Waianae Volcano erupted and grew 4 million years ago. About 2-3 million years ago, the

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			Koolau Volcano begins to grow and eventually combines with the Waianae Volcano to form a single island. After the volcano stops erupting, wind and water gradually erode away the island into what we see today."
Sample Performance Assessment (SPA)	The student: Describes how fast processes have shaped and reshaped the Hawaiian Islands.		How did the Hawaiian Islands form? How many volcanoes make up Oahu? What evidence of erosion do you find on Oahu?

Bishop Museum Connections
Mapping Curriculum to Science Benchmarks

Grade 6

GRADE 6 **Standard 2:**	**The Scientific Process:** **NATURE OF SCIENCE:** Understand that science, technology, and society are interrelated		
Topic	Science, Technology, and Society		
HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
Benchmark SC.6.2.1	Explain how technology has an impact on society and science	The student explains ways in which technology has changed our society and science. Specifically, what tools and technology do scientists use in a tsunami warning system.	"Luckily we have a good warning system in the Pacific Ocean because of a network of buoys…This is how a tsunami buoy works (Press OK Button)…When it records a tsunami wave has passed overhead, it sends that information up to the surface, then up to a satellite, and then down to all of the tsunami warning stations." "If you look at the Hawaiian islands, you can see that we are surrounded by buoys all around us. That means we will have ample warning if a large earthquake generates a tsunami along the Pacific Ring of Fire"
Sample Performance Assessment (SPA)	The student: Explains ways in which technology has changed our society and science.		"What tools and technology do scientists use in a tsunami warning system?"

GRADE 6 **Standard 2:**	**The Scientific Process:** **NATURE OF SCIENCE:** Understand that science, technology, and society are interrelated		
Topic	Science, Technology, and Society		
HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
GRADE 6 **Standard 6:**	**Physical, Earth, and Space Sciences: NATURE OF MATTER AND ENERGY:Understand the nature of matter and energy, forms of energy (including waves) and energy transformations, and their significance in understanding the structure of the universe**		
Topic	**Waves**		
HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
Benchmark SC.6.6.10	Explain how vibrations in materials set up wavelike disturbances that spread away from the source	The student manipulates models of waves to demonstrate how waves spread away from their sources. Students show how an earthquake produces a tsunami.	This image shows you the tsunami 3 minutes after it starts." Keep your eye on the timer which shows how much time has gone by. Let's watch the tsunami in action. Notice how quickly the tsunami travels…I'm showing you how the tsunami travels across the ocean, but can anyone tell me what caused the tsunami? That's right, an earthquake…" "Now let's take a journey to see if we can understand how exactly the Indian Ocean earthquake generated a tsunami. As we zoom into the earthquake's location, the yellow line represents about a thousand miles of Earth that slipped by about 50 feet in a matter of minutes…" "Remember that these is water above the plate, so

GRADE 6 **Standard 2:**	**The Scientific Process:** **NATURE OF SCIENCE:** Understand that science, technology, and society are interrelated		
Topic	Science, Technology, and Society		
HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
			when the plate snaps up, it pushes up the water above it and generates a tsunami…as the tsunamis get closer and closer to land and starts to feel the bottom of the ocean, it gets taller and taller until it hits the shore with wave heights up to 30-50 feet tall."
Sample Performance Assessment (SPA)	The student: Manipulates models of waves to demonstrate how waves spread away from their sources (e.g., using a water table).		'How do most tsunamis form?"

Bishop Museum Connections
Mapping Curriculum to Science Benchmarks

Grade 8

GRADE 8	**Physical, Earth, and Space Sciences:**		
Standard 8:	**EARTH AND SPACE SCIENCE: Understand the Earth and its processes, the solar system, and the universe and its contents**		
Topic	Earth in the Solar System		
HCPS III		**Learner Outcomes (taken from Connections Curriculum) Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
Benchmark SC. 8.8.3	Describe how the Earth's motions and tilt on its axis affect the seasons and weather patterns	Describe how the Earth's motions and tilt on its axis affect the seasons and weather patterns.	"Ask students to hold their earth ball in front of their chest, with North Pole pointing straight up. Explain that the earth's axis is NOT straight up and down, but in fact tilted towards the North Star, Polaris. Ask students to tilt their earth balls towards Polaris (point out where the star is). Check to see if all the balls are tilted towards Polaris." "Ask one student who is farthest away from Polaris whether his/her north pole is tilted towards or away from the sun. Ask another student who is closet to Polaris whether his/her north pole is tiled towards or away from the sun. Ask the class to make a guess as to which student represents the earth in the summer and which student represents the earth in the winter."
Sample Performance Assessment (SPA)	The student: Diagrams and explains how Earth's motions and tilt on its axis affect the seasons and weather		"What season is it in the northern hemisphere when the Earth's axis is tilted way from Polaris?"

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Topic	Earth in the Solar System		
HCPS III		**Learner Outcomes (taken from Connections Curriculum) Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
	patterns.		

GRADE 8	**Physical, Earth, and Space Sciences:**		
Standard 8:	**EARTH AND SPACE SCIENCE: Understand the Earth and its processes, the solar system, and the universe and its contents**		
Topic	Forces that Shape the Earth		
HCPS III		**Learner Outcomes (taken from Connections Curriculum) Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
Benchmark SC. 8.8.4	Explain how the sun is the major source of energy influencing climate and weather on Earth	Explain how the sun is the major source of energy influencing climate and weather on Earth	IN THE SCRIPT, THERE IS NO DIRECT EXPLANATION OF THE SUN AS A SOURCE OF ENERGY. HOWEVER, IDEAS RELATED TO THE SUN'S ROLE IN SEASONS AND CLIMATE ARE IN THE SCRIPT AS NOTED BELOW: Explain that the sun is in the same place, but the earth is now in a different part of its orbit around the sun. Make a guess: what month is showing on the

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HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
			Sphere?. Start the time sequence animation. Explain that this is showing changes in land over the course of one year. First look at North America. What do you see happening (snow and ice advancing southward in November-March)
Sample Performance Assessment (SPA)	The student: Describes how the sun's heating of the Earth drives weather systems, ocean currents, and the water cycle.		NO QUESTION IN PRE-POST TEST THAT IS DIRECTLY RELATED TO THIS SPA.

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HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
Benchmark SC. 8.8.7	Describe the physical characteristics of oceans	Describe the physical characteristics of oceans.	THERE IS NO DIRECT LINK IN THE SCRIPT TO PHYSICAL CHARACTERISTICS (SIZE, DEPTH, OCEAN FLOOR, CURRENTS). HOWEVER THERE ARE CONCEPTS RELATED TO PHYSICAL CHARACTERISTICS AS OUTLINED BELOW: Explain that the image shows sea surface temperatures…start the time sequence animation…observe how temperature changes over the course of a year. What do you see happening? Turn the Sphere to the Pacific, Point out the general water temperatures at the beginning of 1997…start the time sequence animation… Notice there is a lot of cloud activity over warm water. What do you think is happening? (storms are forming over warm water) Explain that hurricanes are storms that form over warm water. Is it likely that a hurricane would form in January?
Sample Performance Assessment (SPA)	The student: Describes a variety of the ocean's physical characteristics (e.g.,		What is the 'fuel' that powers hurricanes? What is the name of the dramatic change in ocean

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HCPS III		**Learner Outcomes** **(taken from Connections Curriculum)** **Connections Curriculum**	**Excerpts from Connections Curriculum Scripts and Assessments**
	size, depth, geologic history, ocean floor, currents).		current temperatures that typically occurs around Christmas?