Energy and the Environment

Program Evaluation FY11 Final Report

Prepared for

OMSI

Everyday Encounters with Science

by

Liz Rosino
Marcie Benne
Nelda Reyes
Scott Pattison

OMSI Evaluation & Visitor Studies Division

April 2012

Acknowledgements

Our sincerest thank you to all who contributed to this report or participated in the study. Special thanks to Brian Berry, Elias Cohen, Jenny Crayne, Brian Fassnidge, Randall Fastabend, Steve Hassett, Tim Hecox, Nancy Linnon, Emilee Monson, David Perry, Sean Rooney, Chris Stockner, and Sue Wu.

Executive Summary

In Fiscal Year 2011, the Evaluation & Visitor Studies division leveraged a combination of restricted and unrestricted funding, as well as some volunteer assistance, to support OMSI program evaluation. Evaluation & Visitor Studies staff members worked collaboratively with Education staff members; they also consulted with Grants team members and the Vice President of the Center for Learning Experiences. The overall agreement was to work toward developing systems, tools, and relationships that would foster a long-term collaboration for program evaluation between Evaluation & Visitor Studies staff and Education staff.

The follow sections briefly describe the objectives, activities, and deliverables related to FY11 education program evaluation.

FY11 objectives

The FY11 education program evaluation activities centered on three objectives:

- To develop and implement an outcomes-based evaluation plan for OMSI programs related to energy and the environment topics that would inform program improvement with regard to intended learning impacts.
- To develop collaborative relationships that supported evaluation capacity building for education program areas.
- To develop momentum and support for continued opportunities and projects related to program evaluation at OMSI.

FY11 activities and deliverables

The Evaluation & Visitor Studies division activities and deliverables for the FY11 education program evaluation are listed here. Most of these activities are reported in detail within the attached report.

<u>The development and implementation of an outcomes-based evaluation of FY11 Energy and the Environment programs resulted in the following deliverables:</u>

- A working logic model to guide the development of Energy and the Environment programs
- Completed evaluation reports for a sample of energy and the environment-related education programs
    - Support for intentional program planning
    - Program-specific evaluation protocols
    - Data collection tools and instruments that could easily be modified for future evaluation projects
    - Reports and oral debriefs for each program regarding key findings and recommendations
- The facilitation of a professional review of an *Energy and the Environment Program Development Guide* to help educators plan, develop, and deliver programs related to energy and the environment topics
    - A review of the literature related to best practices in informal science education that informed the guide
    - A report and oral debrief on the feedback from the professional review

<u>The development of relationships that supported program evaluation capacity building resulted in the following deliverables:</u>

- A collaborative system for conducting program evaluation including training to share evaluation efforts and build the evaluation capacity of education staff

- A workshop session on the collaborative program evaluation process delivered at the OMSI Educator Summit
- An evaluation of the OMSI Educator Summit event to inform planning and decision making for similar, future professional development events
    - A report and oral debrief with stakeholders on the key findings and recommendations

The development and support for continued opportunities related to program evaluation at OMSI resulted in the following activities:

- An ad hoc cross-functional team known as the *Advocates for Program Evaluation* (a.k.a. the *APE Team*) met regularly to discuss and leverage opportunities to support further education program evaluation*.*
- The online teacher surveys for classroom programs and assemblies were upgraded from surveymonkey.com to surveygizmo.com.
- Data were entered and analyzed for the *Boeing Teacher Workshops*.
- The methods required for gathering demographic data from OMSI program participants were researched and recorded.
- Support for Outdoor Science School evaluation was expanded in Spring 2011 from data entry and analysis to also include the support of protocol and instrument development and the monitoring of data collection.
- A presentation was submitted and accepted for a cross-functional session on *Integrating Evaluation in Educational Programs* at the annual Association of Science-Technology Centers (ASTC) conference in October 2011.
- Funds were included in the FY12 budget for the evaluation of a sample of programs experienced by school partners.

Table of Contents

Introduction 1
Rationale
Activities and Deliverables
Part 1: Energy and the Environment Program Evaluation 3
Energy and the Environment Program Evaluation Logic Model
Energy and the Environment Program Evaluation
Energy and the Environment Program Development Guide Review
Part 2: Building Evaluation Capacity through Collaboration and Training 11
Collaborative Evaluation System
OMSI Educator Summit Evaluation
Part 3: Developing Momentum and Continued Support for Program Evaluation 14
Outdoor Science School
ASTC Conference Session
Fiscal Year 2012
Conclusion 15

Appendix 16
A: *Wind Power* and *From Pond Scum to Salmon Science* Reserved Labs Evaluation Report
B: *Nanotechnology* Classroom Program Evaluation Report
C: *Amazing Whales* Classroom Program Status Report
D: *Energy and the Environment Program Development Guide* Feedback Report
E: OMSI Educator Summit Evaluation Report

Introduction

From October 2010 through April 2011, evaluators from the Evaluation & Visitor Studies division worked with OMSI Science Education managers and educators to evaluate a sample of OMSI programs related to energy and the environment topics. Through this process, a collaborative system was developed that could continue into the future to evaluate more programs, including those on other topics or program formats. This project contributed to developing momentum and support for continued opportunities and projects related to program evaluation at OMSI.

Rationale

The intent of this evaluation project was driven by the June 2010 update to OMSI's Strategic Business Plan that identified the museum's primary strategies for the 2011 fiscal year. One of these strategies was to provide "engaging science experiences that focus on Energy and the Environment, using evaluation to inform our efforts." Through a new museum-wide strategic focus on Energy and the Environment, OMSI's goal is to become a leader in education on sustainability, renewable energy, and environmental science, reaching a broad audience and helping to foster the next generation of innovators in sustainable technologies.

To support this impact-driven business planning, the Evaluation & Visitor Studies division expanded their ongoing work with other divisions to also include the Museum Education and Outreach teams, who are planning and delivering informal science education programs. This was a relatively new collaboration with little to no history of formal program evaluation conducted previously. The strategy for action with this new group of stakeholders was to develop a collaborative system including training, where the evaluation efforts are shared between the evaluators and educators.

The FY11 education program evaluation activities centered on three objectives:

- To develop and implement an outcomes-based evaluation plan for OMSI programs related to Energy and the Environment that would inform program improvement with regard to intended learning impacts.
- To develop collaborative relationships that supported evaluation capacity building for education program areas.
- To develop momentum and support for continued opportunities and projects related to program evaluation at OMSI.

Activities and Deliverables

The activities and deliverables of this project led by Evaluation & Visitor Studies are described in summary here and then in further detail in the following pages.

The development and implementation of an outcomes-based evaluation of FY11 Energy and the Environment programs included providing support for intentional program planning, creating program-specific evaluation protocols, data collection tools and instruments, and delivering reports and oral debriefs regarding key findings and recommendations. The full evaluation reports are included as Appendices A and B (*Wind Power* and *From Pond Scum to Salmon Science* Reserved Labs Evaluation Report and *Nanotechnology* Classroom Program Evaluation Report, respectively).

Evaluators also supported the development of documents that contribute to intentional planning related to Energy and the Environment programs. Early in the process, a working logic model (Chart 1) was created in collaboration with Education managers to guide program development and align outcomes across programs. Later in the process, evaluators facilitated a professional review of the *Energy and the*

Environment Program Development Guide. The full feedback report and a draft of the guide are included as Appendix D (*Energy and the Environment Program Development Guide* Feedback Report).

Through this process, relationships were developed that supported program evaluation capacity building. A collaborative system for conducting program evaluation was created to share evaluation efforts between evaluators and educators and to build the evaluation capacity of education staff. Educators contributed by attending regular project meetings, documenting activities and intended outcomes of their programs, supporting instrument creation and data collection, and participating in debrief sessions. To orient current and future educators participating in evaluation, a workshop session led by evaluators on the collaborative program evaluation process was delivered at the OMSI Educator Summit. An evaluation of the summit event was also conducted to inform planning and decision making for similar, future professional development events created by Education managers. The full evaluation report for the summit is included as Appendix E (OMSI Educator Summit Evaluation Report).

This project also contributed to the continued momentum and support for opportunities and new projects related to program evaluation at OMSI. During the fiscal year, the Evaluation & Visitor Studies division also provided additional support in multiple ways for evaluation-related activities outside of the energy and the environment-related scope of this project. These included transferring Traveling Programs teacher surveys between different online providers, data entry and analysis for Boeing teacher workshops, and researching and recording the methods required for gathering demographic data from OMSI program participants. An ad hoc cross-functional team known as the *Advocates for Program Evaluation* (a.k.a. the *APE Team*) met regularly to discuss and leverage opportunities to support further education program evaluation.

Activities more closely related to the Energy and the Environment Program Evaluation included the submission and acceptance for a cross-functional session on *Integrating Evaluation in Educational Programs* at the annual Association of Science-Technology Centers (ASTC) conference in October 2011. This session used the Energy and the Environment Program Evaluation as a case study. The Evaluation & Visitor Studies division's support of OMSI Outdoor Science School program evaluation was also expanded in Spring 2011 from data entry and analysis to also include the support of protocol and instrument development and the monitoring of data collection. A logic model for the program was recently created that used the Energy and the Environment intended program outcomes as guidance for developing the outdoor school specific outcomes. Finally, funds were also included in the FY12 budget to continue the collaborative program evaluation system developed through the Energy and the Environment Program Evaluation project for the evaluation of a sample of programs experienced by school partners.

Part 1: Energy and the Environment Program Evaluation

OMSI offers a wide range of informal science education programs both on-site as well as at numerous off-site locations. Programs range from camps and classes, outdoor science school, traveling programs, reserved labs and camp-ins to professional development workshops for educators and home school immersion. The program themes fall within STEM topics, including many that are related to energy and the environment. The objective of the program evaluation was to understand the impact of current OMSI energy and the environment-related programming on participants in order to inform future programs.

Energy and the Environment Program Evaluation Logic Model

To begin this evaluation project, evaluation staff worked with the education managers to identify the needs, audiences, impact framework, and intended outcomes for existing programs related to energy and the environment. This led to the development of a working logic model to describe the logical linkages among these items and to provide a guide for both consistent program development and evaluation planning. The logic model in Chart 1 is the most recent version which was updated after the evaluation was complete.

Chart 1. OMSI Energy and the Environment Program Evaluation Logic Model (v.4.28.11)

Evaluation Need	Audiences	Impact Framework			Intended Program Outcomes	Evaluation Methods
		***CLE Impacts*[1]**	***OMSI Science Education Programs*[2]**	***NRC Strands*[3]**		
To understand the impact of current Energy and the Environment-related programming to inform future E&E programs.	Experience and Delivery program participants	Foster informed citizens	Inspire Wonder Science Literacy • Knowledge development • Decision-making skills • Information evaluation skills	1. Developing interest in science 2. Understanding scientific knowledge 3. Engaging in scientific reasoning 4. Reflecting on science 5. Engaging in scientific practices	***Knowledge*** Participants will understand the big ideas: "The living environment results from the interdependent relationships between the Earth as a physical system, living systems, and human society" and/or "Energy used in our daily lives comes from a variety of sources that have different impacts on the environment." ***Skills*** Participants will engage in scientific reasoning related to Energy and the Environment science topics.	Embedded Assessment Observations
		Reduce gaps in STEM participation and performance	Inspire Wonder Science Identity • Promote and support STEM careers	1. Developing interest in science 5. Engaging in scientific practices 6. Identifying with the scientific enterprise	***Attitude*** Participants will report a high level of interest in Energy and the Environment science topics. ***Identity*** a) Participants will see themselves as someone who can affect their environment. b) Participants will report interest in a career related to Energy and the Environment.	Survey
		Foster identities as Science learners				

[1] OMSI Center for Learning Experiences Impact Logic Model, v. 12.15.09
[2] OMSI Internal Curriculum Standards: Energy and the Environment Initiative, v. 9.28.10
[3] National Research Council. (2009). *Learning science in informal environments: People, places, and pursuits*.Washington, D.C.: National Academies Press.

Impact Framework

The three columns in the impact framework located in the center of the model acknowledge and tie together goals and impacts identified in related sources. The three resources listed helped to guide the discussion and creation of the intended outcomes listed in the sixth column that were developed for the Energy and the Environment programs. The first source is the OMSI Center for Learning Experiences (CLE) Impact Logic Model (version 12/15/09). This is a working model that describes the audience, need, impacts, educational approaches, and strategies for programs and exhibits at OMSI. The impacts located in the first column of the impact framework came from that model.

The second resource is the internal curriculum standards document (version 9/28/10) that was developed by education managers in the early stages of the Energy and the Environment initiative. This document outlines impacts that were identified as specifically important to programs and these are included in the second column of the framework. The third resource is a publication from 2009 by the National Research Council's Committee on Learning Science in Informal Environments that presents six interwoven strands that describe the interrelated practices for learning science in informal environments. These six strands are found in the third column of the impact framework.

The content within these three columns in the impact framework is meant to be read across the two rows, as all of the columns overlap and relate to each other. In the top row, fostering informed citizens relates to promoting science literacy and at minimum the first five science strands. Fostering informed citizens through science literacy is most focused on the knowledge and skills related outcomes for participants. In the bottom row, reducing gaps in science, technology, engineering, and math (STEM) participation and performance and fostering identities as science learners relates most to science strands 1, 5, and 6. These impacts are most focused on the attitude and identity related outcomes for participants. Inspiring wonder is found in both rows as this is something of special value to informal learning environments, and generating excitement and interest is a foundation for other forms of science learning.

Program Outcomes

The intended learning outcomes for Energy and the Environment education programs in the sixth column of the logic model were created in consultation with the education managers and informed by the impact framework. These outcomes were used to guide both consistent program development and evaluation.

- (Knowledge) Participants will understand the big ideas: *the living environment results from the interdependent relationships between the Earth as a physical system, living systems, and human society* and/or *energy used in our daily lives comes from a variety of sources that have different impacts on the environment*
- (Skills) Participants will engage in scientific reasoning related to energy and the environment science topics
- (Attitude) Participants will report a high level of interest in energy and the environment science topics
- (Identity) Participants will see themselves as persons who can affect their environment
- (Identity) Participants will report interest in a career related to energy and the environment

Energy and the Environment Program Evaluation

Once a working version of the logic model was created, the team chose which programs to evaluate. Small groups were then formed for each program that typically included an evaluator, educator, and often a manager or coordinator who would meet regularly to work on program development and evaluation planning. At the end of the process, the evaluation findings for each program were written in a report that was presented and discussed within the group. The full version of each report is located in Appendices A and B (*Wind Power* and *From Pond Scum to Salmon Science* Reserved Labs Evaluation Report and *Nanotechnology* Classroom Program Evaluation Report, respectively).

<u>Program Sampling</u>
Three different energy and the environment-related programs offered during the fiscal year were included in the final evaluation sample. These programs were selected because they directly relate to energy and the environment topics, their scheduled dates would fall within the data collection period of the evaluation, and they reach both on- and off-site participants.

Programs evaluated:

- Two different one-hour Reserved Labs that each took place twice during the 2010 Winter Break Classes at OMSI with second and third grade children
    - *Wind Power*
    - *From Pond Scum to Salmon Science*
- A traveling one-hour Classroom Program that was recently developed and delivered twice to fourth and fifth graders at an elementary school in Portland
    - *Nanotechnology*

The original evaluation plan included additional programs that did not make it into this final evaluation sample. Once more specific planning began, it was realized that the Spring Break classes and camps that were being offered did not relate to a theme of energy or the environment, so they were not included. Extensive program redevelopment and evaluation planning did take place for an additional classroom program, *Amazing Whales*. This program was never scheduled by a school during the data collection period, so data collection was not possible for the evaluation. The protocol and tools were created and could be used to collect data and evaluate the program in the future. A summary of the work involved so far on this program is attached in Appendix C.

<u>Program Development and Alignment</u>
The evaluator and educator teams spent significant time during the evaluation planning phase working on further program development for all of the four programs (two labs and two classroom programs) to align them more intentionally to the outcomes in the logic model. The teams also spent time identifying specific strategies within program activities to potentially achieve these outcomes. Both *From Pond Scum to Salmon Science* and *Amazing Whales* had been previously developed and regularly delivered. Some changes were made to these existing programs to increase their intentional alignment with the desired outcomes for participants. *Wind Power* and *Nanotechnology* were still in the process of being created so both were developed with the Energy and the Environment outcomes as a framework.

<u>Evaluation Methods</u>
A mixed-method data collection approach was used that included embedded assessment, observation, and written surveys. This triangulation of methods helped to increase the confidence and richness of results through cross-verification from more than one tool and also allowed for discovering unanticipated outcomes. Due to the diversity of the programs within the sample, specific data collection protocols and tools were designed for each and are further described in each report located in the appendix.

<u>Measures of Success</u>
A measures of success model specific to each program being evaluated was created as a planning and documenting tool in collaboration between the evaluator and lead educator. This model demonstrates in the first two columns how the Energy and the Environment outcomes relate to the intended outcomes for the specific program, which typically would be different program to program because each has unique

content and activities. In the next column the model includes the indicators for what those unique outcomes would look like if they occurred. Next to each indicator is the method that would be used to collect the data to measure and compare what actually happened with what would be anticipated to happen if the outcome was successful. This comparison, occurring after data collection and analysis, between the success indicators and the actual results was added into a final column which helped to determine where the strengths and weaknesses are in each program. The measures of success models for each program that was evaluated are located in the next section along with a summary of the discussion and recommendations from each full report.

Key Findings and Discussion

Chart 2. Measures of Success: *Wind Power* Lab

Outcome Category	Outcomes		Success Indicator	Evaluation Method	Actual Results
	Energy and the Environment Programs	***Wind Power Lab***			
Knowledge	Participants will understand the big idea: Energy used in our daily lives comes from a variety of sources that have different impacts on the environment	Participants will understand the big ideas: 1. Wind is a good source of renewable energy 2. There are many factors that influence wind energy production	67% of respondents can identify that wind is a good source of energy because it can't run out.	Post-Survey	**Only 14% (3 out of 22) of responses mentioned wind being renewable.** 64% (14 out of 22) of legible survey responses identified valid reasons why wind is a good source of energy. Most were related to its use in creating electricity.
			67% of respondents can recall at least two important factors influencing energy production from wind (blade size, blade angle, wind speed, location).	Post-Survey/ Observation	**26% (6 out of 23) were able to name on the survey at least two of the important factors that influence energy production from wind.** Though in group presentations during the lab, all groups did mention at least two important factors.
			The majority of participants will answer all of the questions correctly about wind energy during the quiz.	Embedded Assessment	**The majority of participants answered each of the questions correctly about wind power**.
Skills	Participants will engage in scientific reasoning related to E&E science topics	Participants will problem solve using the engineering design process	All groups would be observed to use at least 67% (4 out of 6) of the engineering design process while completing tasks during the wind turbine activity.	Observation	**All but one group was observed to use all of the six engineering design process skills during the wind turbine activity.** One group used five because they were unable to implement the best solution.
Attitude	Participants will report a high level of interest in E&E science topics	Participants will report a high level of interest in learning more about wind energy	75% of respondents report a high level of interest (e.g., 4 or higher on a scale of 1–5) in learning more about wind power.	Post-Survey	**71% (15 out of 21) of respondents reported a high level of interest in learning more.** The average rating of interest was 4.19 out of 5.
Identity	Participants will report interest in a career related to E&E	Participants will report a high level of enjoyment in enacting the role of an engineer during the lab	75% of respondents report a high level of enjoyment (e.g., 4 or higher on a scale of 1–5) in enacting the role of an engineer during the lab.	Post-Survey	**76% (16 out of 21) of respondents reported a high level of enjoyment in enacting the role of an engineer during the lab.** The average enjoyment rating was 4.38 out of 5.

The *Wind Power* lab's strength is in the skills, attitude, and identity outcomes. Participants solved problems related to wind turbines using the engineering design process, reported a high level of interest in learning more, and enjoyed performing the role of an engineer. The knowledge outcome is where this lab was the weakest. The main idea that wind is renewable, which is why it is a good source of energy, was generally not understood by participants. The issue seems to be whether children that young can have an appreciation for what renewable energy is. Another related consideration is that there may not be enough time to focus on both accomplishing the engineering objective as well as learning about renewable energy. The engineering aspect seemed to have the most focus across the lab as a whole.

Chart 3. Measures of Success: *From Pond Scum to Salmon Science* lab

Outcome Category	Outcomes		Success Indicator	Evaluation Method	Actual Results
	Energy and the Environment Programs	***From Pond Scum to Salmon Science Lab***			
Knowledge	Participants will understand the big idea: The living environment results from the interdependent relationships between the Earth as a physical system, living systems, and human society	Participants will understand the big idea: Over their lifespan, salmon rely on certain living and non-living things in their environment to survive	67% of participants can identify one thing they did at the stream table that was helpful to salmon and why.	Embedded Assessment	**All participants were able to name something they did at the stream table that would be helpful to salmon.** 86% (24 out of 28) of the total responses were able to identify why.
			67% of respondents can recall at least two living or non-living things that salmon need in their environment to survive.	Post-Survey	**91% (21 out of 23) respondents could name at least two things salmon need to survive that they learned that day.** 70% (16 out of 23) could recall three.
Skills	Participants will engage in scientific reasoning related to E&E science topics	Participants will use a microscope to make accurate observations about pond water	67% of participants will be accurate during the majority of their observations at the microscope.	Embedded Assessment	**81% (17 out of 21) of questioned participants were accurate during the majority (2 out of 3) of their observations at the microscope.** 24% (5 out of 21) were accurate during all three of their observations.
Attitude	Participants will report a high level of interest in E&E science topics	Participants will report a high level of interest in learning more about salmon and their environment	75% of respondents will report a high level of interest (e.g., 4 or higher on scale of 1–5) in learning more about salmon and their environment.	Post-Survey	**61% (14 out of 23) of respondents reported a high level of interest in learning more**. The average rating of interest was 3.61 out of 5.
Identity	Participants will report interest to share their E&E science knowledge with others Participants will report interest in a career related to E&E	Participants will see themselves as someone who can affect their environment	75% of respondents can identify at least one thing we as humans can do to help salmon.	Post-Survey	**83% (19 out of 23) of respondents could identify something we as humans can do to help salmon.**

The *From Pond Scum to Salmon Science* lab's strength is in the knowledge, skills, and identity outcomes. Participants demonstrated that they understood the big idea about salmon's habitat needs, used observation skills with a microscope, and could identify how humans can help salmon. The attitude outcome of having a high level of interest in wanting to learn more about salmon and their environment was where the lab was weakest. During a debrief meeting, the lab's educator remarked that it is hard to make a program about such an "outdoor" topic as interesting when doing it indoors. It was observed that for a lab about salmon, there was very little to show what the real fish looks like or what their real habitat is like. New ways to bring real-life examples of the "outdoors" in and enhance the *wow* factor could be considered in order to potentially increase participants' interest and excitement in the topic.

Chart 4. Measures of Success: *Nanotechnology* classroom program

Outcome Category	Outcomes		Indicators	Methods	Actual Results
	Energy and the Environment Programs	***Nanotechnology Classroom Program***			
Knowledge	Participants will understand the big idea: Energy used in our daily lives comes from a variety of sources that have different impacts on the environment	a. Participants will understand nanoscale science and engineering basic properties	65% of participants will respond correctly for each question about nano scale and properties during the embedded assessment quiz.	Embedded Assessment	**At least 86% (43 out of 50) of participants responded correctly for each question about nano scale and properties.** The mean percentage of correct answers per question is about 88%.
		b. Participants will conceptualize the current and potential applications of nanotechnology in renewable energy technologies	80% of participants will recall at least three current or potential applications of nano in renewable energy technologies.	Post-Survey	**42% (19 out of 45) of respondents named at least three current or potential applications in renewable energy technologies.** 82% named at least two. Most were about ways to harness solar energy.
Skills	Participants will engage in scientific reasoning related to E&E science topics	Participants will observe the properties of nanoscience and nanotechnology and make predictions about their use in the future.	65% of participants will be able to make at least one prediction about the use of nanotechnology in the future.	Embedded Assessment and Post-Survey	**During the embedded assessment, 87% (34 out of 39) made at least one prediction. On the survey, 100% (45 out of 45) made at least one prediction.** Most inventions were related to materials such as paper or textiles.
Attitude	Participants will report a high level of interest in E&E science topics	Participants will express a high level of interest in learning more about nanotechnology.	75% of particpants will report a high level (e.g., 4 or higher on scale of 1–5) of interest in learning more about nanotechnology.	Post-Survey	**76% (34 out of 45) of respondents reported a high level of interest in learning more.** The average rating of interest was 4.18 out of 5.
Identity	Participants will report interest in a career related to E&E	Participants will report a high level of enjoyment in enacting the role of a nanoscientist.	75% of participants will report a high level of enjoyment (e.g., 4 or higher on scale of 1–5) in enacting the role of a nanoscientist.	Post-Survey	**82% (37 out of 45) of respondents reported a high level of enjoyment in enacting the role of a nano scientist.** The average enjoyment rating was 4.26 out of 5.

The *Nanotechnology* classroom program exceeded almost all of its success indicators. Its particular strengths were found to be in the skills, attitude, and identity outcomes. Participants demonstrated they understood and observed basic nanoscale properties and used this to make predictions about the use of nanotechnology in the future, often related to renewable energy technologies. Participants were also found to be interested in learning more about the topic and enjoyed enacting the role of a nanoscientist. Only one of the knowledge outcomes related to nano and renewable energy technologies was not met as measured against the indicator that was originally planned. This most likely resulted from an inconsistency between the indicator (to recall at least three applications) and the program's content (only offering three examples) rather than a weakness of the program. A revised indicator more appropriate to the number of examples given (e.g., recall at least two applications) is recommended if the program is to be evaluated again in the future.

Reporting

The full reports which feature more detailed descriptions of the programs, evaluation methods, results, and discussion are located in Appendices A and B. They were written after each program was evaluated and were presented and discussed during debrief meetings with the educator and other relevant staff. During the meeting, next steps for changing or improving the programs were discussed based on what was learned from the evaluation.

Energy and the Environment Program Development Guide Review

As part of the Energy and the Environment initiative, OMSI created a program development guide to describe the Energy and the Environment initiative and provide OMSI educators and developers guidance and key steps for creating programming related to energy and the environment topics. OMSI's Energy and the Environment Coordinator led the development of the guide, in collaboration with museum educators, evaluators, and program development staff.

To inform this process, evaluators collected feedback from staff on a draft of the guide during the 2011 Educator Summit through discussion and a short questionnaire. Evaluation staff also facilitated a debrief session with the project team after the summit to summarize participants' feedback. The feedback report and a draft of the guide, located in Appendix D, documents results from both the summit and the debrief meeting.

Summary of results and discussion

Overall, the team felt that educators were interested in the guide. In particular, many educators recognized that the guide would help to align programs and activities developed throughout the museum with OMSI's strategic vision and goals. Educators also seemed to value information about the content standards in the guide and suggestions on how to align their programs with those standards. Session participants had a number of questions and suggestions related to information about national standards; the importance of including specific examples in the guide; guide formatting, distribution, and sharing; and creating a list of partners OMSI has worked with for the Energy and the Environment initiative.

Reviewing participant feedback also motivated the guide development team to discuss several issues not specifically mentioned by educators. It was discussed how different types of goals might be appropriate for different types of programs and experiences and that the guide should help educators choose appropriate goals. Logic models were also discussed and how they might be introduced in the guide. During the concurrent session, the idea of logic models seemed to be new to most participants. Finally, the team highlighted the importance of communicating the process of program development in the guide, including the iterative nature of development and the importance of peer review.

Part 2: Building Evaluation Capacity through Collaboration and Training

Collaborative Evaluation System

This project included collaboration between the Evaluation & Visitor Studies division and Museum Education and Outreach managers and staff. The intent was to build a collaborative system for evaluating the impact of education programs that could be expanded into an ongoing system in the future to include other themes and program formats.

Collaboration Roles

This reciprocal collaboration offered the opportunity for staff from both divisions to develop new skills and continually learn from each other through this participatory approach to evaluation. The Evaluation & Visitor Studies staff acted as project managers and created timelines and other planning documents and tools to keep the evaluation project on track. The evaluators also helped guide intentional program planning during the development phase and provided expertise in data collection methods and analysis. They provided documentation of results with discussion and recommendations and led the reflection on what was learned through the process.

The education staff was heavily involved in the planning work to prepare for the evaluation. This included documenting the program's activities and intended outcomes and helping to develop the success indicators. They also provided input and feedback along the way through regular meetings, helped with data collection, and reflected and prepared to take action based on the evaluation findings.

Training Opportunities

The evaluators conducted trainings in addition to the participatory nature of the process as a whole to build evaluation capacity for educators. One aspect of the training was focused on the data collection protocol for each program in the sample. A one-hour training session was held before the data collection period for each program to train the educators that would be acting as data collectors to use the tools consistently to capture reliable data. A debrief meeting with those involved was held after each data collection period to understand the extent of the training's success and areas of opportunity. It also provided the opportunity to discuss the educators' and data collectors' observations and insights about the experience of the program to help further inform the data analysis and begin the process of reflection.

Another aspect of training was a one-hour session during the OMSI Educator Summit event in late February. This event is described in more detail in the next section. The session, about the collaborative evaluation process, was led by the lead evaluators with support from the educator who participated in the *Wind Power* evaluation. The objectives for the session, open to all OMSI educators and their managers, were to provide a snapshot of what evaluation is through describing the collaborative evaluation process, demonstrate how it could be useful for designing and delivering programs, and clarify what would be the expectations for the educator's role in the process. It is intended that this presentation will be offered again as needed to orient education staff involved in future program evaluation projects.

OMSI Educator Summit Evaluation

On February 28, 2011, the Science Education managers hosted a day-long professional development summit for OMSI educators. Sixty-four educators from museum education, outdoor education and camps, traveling programs, classes, camp-ins and sub-ins, planetarium, and the submarine were in attendance. The summit included an introduction, a group icebreaker activity, 11 sessions organized into three timeslots, and a final "educator death match" competition at the end of the day. Most sessions were related to informal science education topics such as inquiry, curriculum sharing, and Oregon state science standards. Two sessions in particular were directly related to the Energy and the Environment Program Evaluation project. The lead evaluators for the Energy and the Environment Program Evaluation led a session on the collaborative evaluation process. A draft version of the *Energy and the Environment Program Development Guide* was presented in another and the resulting discussion centered on collecting feedback to improve it. An evaluation of the entire event was conducted in order to measure the extent to which it achieved its outcome goals and to gather feedback to inform future summits and other professional development opportunities. A full version of the evaluation report of the event is included in Appendix E.

The intended outcome goals of the summit, as determined by the summit planning team, were:

- Participants will feel that the summit was relevant to their work
- Participants will feel prepared to use the information provided during the summit
- Participants will feel that the summit met their personal goals and expectations for the event
- Participants will be more familiar with the work of other OMSI educators and resources at OMSI relevant to their work
- Participants will have fun

<u>Evaluation Method</u>

Data was collected through a self-administered questionnaire handed out to each participant at the beginning of the summit. The instrument included open- and close-ended questions to be answered at the beginning of the summit, after each session, and at the end of the event. In total, 54 participants completed the questionnaire, with a response rate of 88%.

<u>Key Findings and Discussion</u>

1. The educator summit was highly successful

Evaluation results suggest that the educator summit successfully met the majority of its goals. Participants rated the summit particularly highly in terms of its relevance to their work at OMSI and how enjoyable the event was. They also indicated that the summit increased their familiarity with the work of other OMSI educators and relevant OMSI resources. Although still high, ratings were not as strong for how well participants felt that the summit met their goals and expectations and how prepared they felt to use the information provided during the event.

2. Educators desired more opportunities for dialogue and networking

Evaluation results suggest that future OMSI educator summits could be improved by providing more opportunities for dialogue, discussion, and networking among participants and between departments.

3. There is the potential to focus more on practice and skill building

One of the goals mentioned by almost half of the summit participants was to learn and practice new educational techniques. The theme was not mentioned, however, by any participant as a particularly successful aspect of the summit.

4. Many educators are still not very familiar with the work of other OMSI staff and relevant resources at OMSI

Although the majority of participants (64%) self-reported at the end of the summit that they were more familiar with the work of other OMSI educators and relevant resources at OMSI, there was still a relatively small proportion of staff (26%) who felt very familiar with OMSI at the end of the day. This is another potential focus of future OMSI summits.

Reporting

Data analysis was conducted and then discussed with the summit planning team to inform the final version of the evaluation report, included as Appendix E. A brown bag lunch session open to all OMSI staff was held in May 2011 to review the summit and examine the impact of this event on OMSI's education team.

Part 3: Developing Momentum and Continued Support for Program Evaluation

This project also contributed to the continued momentum and support for opportunities and new projects related to program evaluation at OMSI. During the fiscal year, the Evaluation & Visitor Studies division provided additional support in multiple ways for evaluation-related activities outside the scope of the Energy and the Environment Program Evaluation project. Those most closely related to this project are described below.

Outdoor Science School

There is a history of program evaluation related to OMSI's Outdoor Science School due to the grant requirements of two funders that support the ability of some of the school groups to participate. In planning for the 2011 Spring season of the program, a request was made to the Evaluation & Visitor Studies division to assist with a survey redesign in addition to conducting the data entry and analysis that was typical of previous years. Through this partnership, the evaluator and outdoor education staff worked together to develop a program logic model that incorporates Energy and the Environment program outcomes into its impact framework. The existing data collection tools were also redesigned to capture indicators of the newly clarified outcomes for the program and additional support was provided for monitoring data collection. This collaborative support for the Outdoor Science School evaluation is expected to continue in future seasons of the program.

ASTC Conference Session

Stemming directly from the work on the Energy and the Environment Program Evaluation, a cross-functional session proposal was created, submitted, and accepted for a national conference. Science Education manager, David Perry, and Research and Evaluation associate, Liz Rosino, co-developed and presented a session along with three other evaluators and educators from other institutions at the annual Association of Science-Technology Centers (ASTC) in October 2011. The topic of the session was on integrating evaluation in educational programs and examples from the Energy and the Environment Program Evaluation were used to illustrate how OMSI is currently conducting program evaluation.

Fiscal Year 2012

The collaboration system that was developed through the Energy and the Environment Program Evaluation project will be continued at least through the next fiscal year. Conversations among the cross-functional teams led to the decision that the next program evaluation project might be related to programs offered through school partnerships.

Conclusion

The Energy and the Environment Program Evaluation project was created out of a need to support OMSI's impact-driven business planning during the 2011 fiscal year and the new museum-wide strategic focus on energy and the environment, still in its early stages. The programs evaluated had many strengths and overall did have an impact on participants' knowledge and awareness, scientific reasoning skills, interest, and identity related to energy and the environment science concepts. It was found that in particular the new and innovative science and technologies presented during the *Nanotechnology* program were very exciting to the young participants. A number of students started clapping spontaneously when examples of potential future use of nano in renewable energy technologies were presented! Adding more innovative or potential future science and technology examples into programs could lead to an increased impact of a sense of wonder and excitement about many topics.

Another recommendation for improvement across all programs would be for educators to consider an outcomes-based planning approach that uses audience needs and desired results as the foundations for planning and developing programs. This could take the form of a more formal documentation of a program's curriculum that includes alignment to state education standards, internal standards and outcome frameworks, and desired learning outcomes and how these items match the planned activities and educational strategies. Intentional planning in this way would likely lead to an increased impact on participants, a more efficient evaluation process, and improved consistency both per program and institution-wide. The *Energy and the Environment Program Development Guide* in current development will be a good start to support to this type of work.

The cross-functional collaborative process of this project helped to set the stage for program evaluation to continue into the future. The tools created such as logic models, measures of success models, and data collection instruments can be used as reference for other projects. The education managers and staff that were involved in this project will bring their experience to the next and will continue to build their capacity for evaluation and reflective thinking about their work. The evaluators involved in the project learned a lot as well to bring to future projects, including more about the width and depth of OMSI programs, the opportunities and constraints of a collaborative and participatory evaluation approach, and the impressive content expertise and enthusiasm of the educators for the work they do.

Appendix Table of Contents

A: *Wind Power* and *From Pond Scum to Salmon Science* Reserved Labs Evaluation Report ..A1

a. *Wind Power* Lab—Quiz Tally Sheet
b. *Wind Power* Lab—Skills Observation Sheet
c. *Wind Power* Lab—Post-Survey
d. *From Pond Scum to Salmon Science* Lab—Stream Table Tally Sheet
e. *From Pond Scum to Salmon Science* Lab—Skills Tally Sheet
f. *From Pond Scum to Salmon Science* Lab—Post-Survey

B: *Nanotechnology* Classroom Program Evaluation Report B23

a. Embedded Assessment Tally Sheets
b. Post-Survey

C: Amazing Whales Classroom Program Status Report C34

a. OMSI Energy and the Environment Program Evaluation Logic Model
b. *Amazing Whales*—Embedded Assessment Tally Sheet
c. *Marine Biologist's Notebook* Grades K–2 and 3–6
d. Post-Survey
e. Redesigned *Amazing Whales* Program Outline

D: *Energy and the Environment Program Development Guide* Feedback Report D49

a. Draft Program Development Guide

E: OMSI Educator Summit Evaluation Report E57

a. Summit Agenda
b. Questionnaire
c. Coding for Personal Goals
d. Coding Categories for Summit Successes
e. Coding for Suggested Improvements

Appendix A. *Wind Power* and *From Pond Scum to Salmon Science* Reserved Labs Evaluation Report

By Liz Rosino, OMSI Research & Evaluation Associate

Introduction

Program Description

This evaluation was focused on two lab programs held during the 2010 Winter Break Class at OMSI. This lab evaluation is part of the larger OMSI Energy and the Environment Program Evaluation which includes a sample of programs presenting energy and environment-related topics during the 2011 fiscal year.

The class entitled *LEGO and the Museum Experience* was held for eight days during the last two weeks of December 2010 and was open to children in second and third grades. The classes ran from 9 a.m. to 4 p.m. each day and combined activities from the popular LEGO classes with the fun of a day at OMSI.

During two days of the *LEGO and the Museum Experience* class, participants attended a one-hour lab related to energy and/or the environment. Participants that attended the class on Tuesday, December 21, participated in the *Wind Power Lab* and those that attended class on Wednesday, December 22, participated in the *From Pond Scum to Salmon Science Lab*. Both labs were physically held in the Watershed Lab in the Earth Hall.

There were a total of 23 participants in the class each day. To provide a "small-group" lab experience to each participant, classes were split into two smaller groups. Group 1 attended the lab from 10–11 a.m. Group 2 attended the lab from 11–12 p.m.

Objective

- As part of the larger OMSI Energy and the Environment Program Evaluation, contribute to the understanding of the impact of current energy and the environment-related programming at OMSI in order to inform future programs.
- Understand in what ways each lab met or did not meet the intended outcomes of the program as set forth in the measures of success models (Charts 1 and 4) in order to evaluate its strengths and weaknesses and inform future versions of each lab.

Methods

Data was collected during both labs each day for all participants for a total of 46 subjects (23 in each lab) in this study. Participants could register for just one day or multiple days to attend class, so it is likely that the same subject could be in both labs. This information was not recorded. Data collection methods for both labs used similar methods such as embedded assessment and a post-survey, while the Wind Power Lab also used observations.

Embedded Assessment

Both labs used this method which involved the educator asking participants planned questions at specific points in the lab program. A data collector was nearby to record participant responses on simple tally sheets (Appendices a, d, and e).

This embedded assessment method served two purposes. One is that of a teaching tool for the educator to quickly assess participants' progress toward reaching the targeted outcome, thus providing immediate feedback for the educator to address gaps in understanding. The second purpose was to perform program evaluation, contributing to assessment of the lab's success (along with other methods) in meeting or exceeding intended outcomes.

Observation

During the *Wind Power Lab*, participants were observed while working in small groups (four groups of three) to complete tasks by engineering a wind turbine. A data collector was stationed near each group to observe and record the visual and audible use of engineering design process skills. He or she took notes about whether the specific task was solved by the group as well as recording other relevant activity by the group. The observation sheet is located in Appendix b.

Post-Survey

Directly following each lab, the participants were led to another area to individually complete a short written survey customized for each lab. All but one participant filled out a survey. These surveys, located in Appendices c and f, were designed to be appropriate for young children and asked questions about the participant's knowledge, attitude, and identity related to the intended lab outcomes.

Findings

Lab Participants

<u>Gender</u>

Across all of the participants, only four were female and 42 were male. The *Wind Power Lab* included three out of the four females.

<u>Location</u>

There were 24 children registered for class each day that labs were occurring, although only 23 participated in the labs. The child's home zip code information from their registration form was used to look at where participants live that chose to attend the OMSI Winter Break class, *LEGO and the Museum Experience.*

About 60% of registrations were from children that lived in the city of Portland (considered zip codes: 97201–97299). Out of the 40% that lived outside of Portland, all but three lived within Oregon. The three out-of-state registrations were all from Washington state, in the cities of Vancouver and Camas. About 83% of registered children lived within 20 miles of OMSI, and the furthest away was in Three Rivers (about 178 miles) and Salem (about 52 miles).

Wind Power Lab

Measures of Success

The chart below shows what the intended outcomes were for the lab, the indicators for what that outcome would look like if it occurred, the methods used to collect data, and finally what the actual result was. The actual results column can be used to compare against the indicators column to see how well the lab measured up against the intended outcomes and where the strengths and weaknesses are.

Chart 1. *Wind Power Lab* Measures of Success

Can't access the image to edit

Outcome Category	**Outcomes**		**Success Indicator**	**Evaluation Method**	**Actual Results**
	Energy and the Environment Programs	***Wind Power Lab***			
Knowledge	Participants will understand the big idea: Energy used in our daily lives comes from a variety of sources that have different impacts on the environment	Participants will understand the big ideas: 3. Wind is a good source of renewable energy 4. There are many factors that influence wind energy production	67% of respondents can identify that wind is a good source of energy because it can't run out.	Post-Survey	**Only 14% (3 out of 22) of responses mentioned wind being renewable.** 64% (14 out of 22) of legible survey responses identified valid reasons why wind is a good source of energy. Most were related to its use in creating electricity.
			67% of respondents can recall at least two important factors influencing energy production from wind (blade size, blade angle, wind speed, location).	Post-Survey/ Observation	**26% (6 out of 23) were able to name on the survey at least two of the important factors that influence energy production from wind.** Though in group presentations during the lab, all groups did mention at least two important factors.
			The majority of participants will answer all of the questions correctly about wind energy during the quiz.	Embedded Assessment	**The majority of participants answered each of the questions correctly about wind power**.
Skills	Participants will engage in scientific reasoning related to E&E science topics	Participants will problem solve using the engineering design process	All groups would be observed to use at least 67% (4 out of 6) of the engineering design process while completing tasks during the wind turbine activity.	Observation	**All but one group was observed to use all of the six engineering design process skills during the wind turbine activity.** One group used five because they were unable to implement the best solution.
Attitude	Participants will report a high level of interest in E&E science topics	Participants will report a high level of interest in learning more about wind energy	75% of respondents report a high level of interest (e.g., 4 or higher on a scale of 1–5) in learning more about wind power.	Post-Survey	**71% (15 out of 21) of respondents reported a high level of interest in learning more.** The average rating of interest was 4.19 out of 5.
Identity	Participants will report interest in a career related to E&E	Participants will report a high level of enjoyment in enacting the role of an engineer during the lab	75% of respondents report a high level of enjoyment (e.g., 4 or higher on a scale of 1–5) in enacting the role of an engineer during the lab.	Post-Survey	**76% (16 out of 21) of respondents reported a high level of enjoyment in enacting the role of an engineer during the lab.** The average enjoyment rating was 4.38 out of 5.

Knowledge Outcome

The intended knowledge outcome for the lab was that participants would understand the two main ideas: (1) Wind is a good source of renewable energy, and (2) there are many factors that influence wind energy production. This is related to the OMSI Energy and the Environment program knowledge outcome that participants would understand the big idea that "energy used in our daily lives comes from a variety of sources that have different impacts on the environment."

Renewable Energy

Participants were asked on the post-survey why wind is a good source of energy. The responses were grouped together into similar response themes and the frequency of each is shown below.

Table 1.

Why is wind a good source of energy?	# of responses
It is renewable	3
Can be used to create electricity	9
It can be efficient	2
Other:	
It blows things around	2
It creates energy	2
Helps life	1
Unrelated Answer	1
No Answer (blank)	2
Illegible Answer	1
Total	23

About 64% (14 out of 22) of legible survey responses identified reasons why wind is a good source of energy. These were related to it being renewable and efficient and its use in creating electricity. Twenty-three percent (5 out of 22) gave reasons that are valid but appear less complete in reasoning as to how or why it is good, such as "it creates energy" or "blows things around." One of the main ideas of the lab was that wind is a good source of energy because it is renewable and can't run out. Only 14% (3 out of 22) of responses mentioned it being renewable. Most responses focused on its use in creating electricity.

Influencing Factors for Energy Production

Participants were also asked on the post-survey to name three ways to get more energy from wind using a wind turbine. About 26% (6 out of 23) were able to name at least two of the important factors that influence energy production from wind and 52% (12 out of 23) could name at least one. Table 2 shows the frequency of the different responses to this question.

Table 2.

Factors named to influence energy production from wind	# of responses
Wind (presence of or speed)	7 (20%)
Turbine location	5 (14%)
Turbine blade angle	4 (11%)
Turbine blade shape	4 (11%)
Turbine size	1 (3%)
Incorrect	14 (40%)
Total	99%*

*Percent total does not add up to 100% due to rounding

About 60% (22 out of 25) of responses were correct. Most are about the need for wind. Some mentioned that in particular wind speed was important. About 40% (14 out of 35) of the responses were incorrect and included answers such as string, volts, and Christmas lights. These were items they used to complete their specific task during the wind turbine activity but were not factors that influence the energy production from the wind itself to complete the task.

Embedded Assessment

This type of formative assessment occurred about half-way through the one-hour session. It took the form of a short interactive quiz that involved the educator displaying multiple choice questions as a large projected image and asked participants to answer by moving to one side of the room or the other to demonstrate their response. The majority of participants answered each of the questions correctly during the group quiz.

Table 3. Embedded assessment quiz questions and answers

Q1: What makes wind a renewable energy?	# of participants
1A: You need to burn fuel to make wind	0
1B: The wind will never run out (correct)	21
1C: I don't know	2

Q2: The faster the wind…	
2A: The more energy we get from the wind turbines (correct)	20
2B: The less energy we get from the wind turbines	2
2C: I don't know	1

Q3: What do engineers need to think about when designing a wind turbine to create more energy?	
3A: What color to paint it	0
3B: Shape of the blades (correct)	23
3C: I don't know	0

Q4: Who is ready to be an engineer?	
4A: Me	17
4B: Not me	3
4C: What's an engineer	3

Skills Outcome

During the second half of the lab, participants formed four small groups of three. They worked as teams to build small wind turbines and each team was assigned to solve a specific task such as light LED lights or lift a cup of weights. With each task, they were given different levels of increasing difficulty to solve. For example, with the cup task the beginner level was to simply lift the cup and at the master level it was to lift the cup with 12 weights in it. Groups were encouraged to try a harder level once completing the one before. A data collector was stationed near each group to observe and record the visual and audible use of engineering design process skills.

The intended skills outcome of the lab was that participants would problem solve using the engineering design process. This is related to the OMSI Energy and the Environment program skills outcome that participants would "engage in scientific reasoning related to Energy and the Environment science topics." All but one group was observed to use all of the six engineering design process skills at least once during the wind turbine activity. One group used only five because they were unable to implement the best solution before their presentation to the rest of the class.

Engineering Design Process Skills

The following describes each skill and what was typically observed for each.

Identify Problem

- Reading the group's task on the paper handout.
- Restating what they needed to do in their own words: "we're going to light this one now," "if we make it spin...it will unwind," or "let's try to get 5 volts."
- Asking staff for clarification: "what's a volt?" or "are we supposed to pump all the water into here?"
- Announcing specific actions they need to take to get started: "let's go get blades."

Brainstorm Solutions

- Making specific suggestions about what to change to achieve certain results, such as "take in more wind," "get them faster," or "to get more." Participants usually did not use the word energy but did seem to make the connection that the faster the blades turned the more likely it would do what it needed to do to solve their task.
- Variables mentioned: changing blade type, blade angle, adding or changing a light, etc.
- Often staff helped to prompt thinking on possible changes.

Design and Test

- Acting on suggestions made during the brainstorming to change different variables: blade type, blade angle, fan distance and angle, or fan speed.

Gather and Compare

- Evaluating the effects of the change in variable and deciding whether it solved the task or worked better or worse than before the change.
- Reverting back to brainstorm new possible solutions based on what they observed.
- Often staff helped to interpret results and guide what the group should try next.

Implement Best Solution

- All but one group was able to implement their best solution to at least the beginner level of the task.
- Once they solved the task at that level, they would move on to the next level.

Share Best Solution

- During their presentations at the end, all groups explained their process.
- They explained how certain blade shapes didn't work and how they had to change the blade angle and fan speed.
- One group never solved their task but still shared what they tried to do and staff continued unsuccessfully attempting to make it work during the other presentations.
- Two of the groups, after solving their task, had more time so they continued to change more variables. When it came time to present, their setup was not working because of the later changes and required staff help to revert it back to the original setup to explain their solution.

Task Levels Achieved

The table below demonstrates the highest task level that each group was able to solve for their task. Levels in order from lowest to highest: Beginner, Intermediate, Advanced, Master.

Table 4.

Task	Group	Process Skills used (out of 6)	Solved Task	Task Level Achieved
Light up LED Lights	10 a.m.	6	Y	Advanced
	11 a.m.	6	Y	Advanced
Lift a cup with weights	10 a.m.	6	Y	Master
	11 a.m.	6	Y	Master
Raise water level in X amount of seconds	10 a.m.	5	N	None
	11 a.m.	6	Y	Intermediate
Get the voltmeter to read X number of volts	10 a.m.	6	Y	Master
	11 a.m.	6	Y	Master

Groups were able to complete the cup with weights and voltmeter tasks up to the master level while the LED lights and water level tasks were harder for groups to complete at the higher levels. The water level task was the most difficult to solve as one group was unable to solve at the beginner level and the other group only reached the intermediate level.

Staff Facilitation

There were three staff persons available to help the four groups during the lab and there were varying levels of staff facilitation for each group. Typically, two of the staff people each stationed themselves next to a group and assisted them the whole time. The third staff person floated around to the two remaining groups as needed. The typical guiding questions offered by staff included, "Why doesn't it work?," "What if we change this?," or "What can we tell people we learned?"

The one group that was unable to solve the task had a staff person assisting them the entire time who helped to facilitate blade direction and fan distance. They also continued to troubleshoot while participants were observed to be distracted by other things in the room.

Activity Challenges

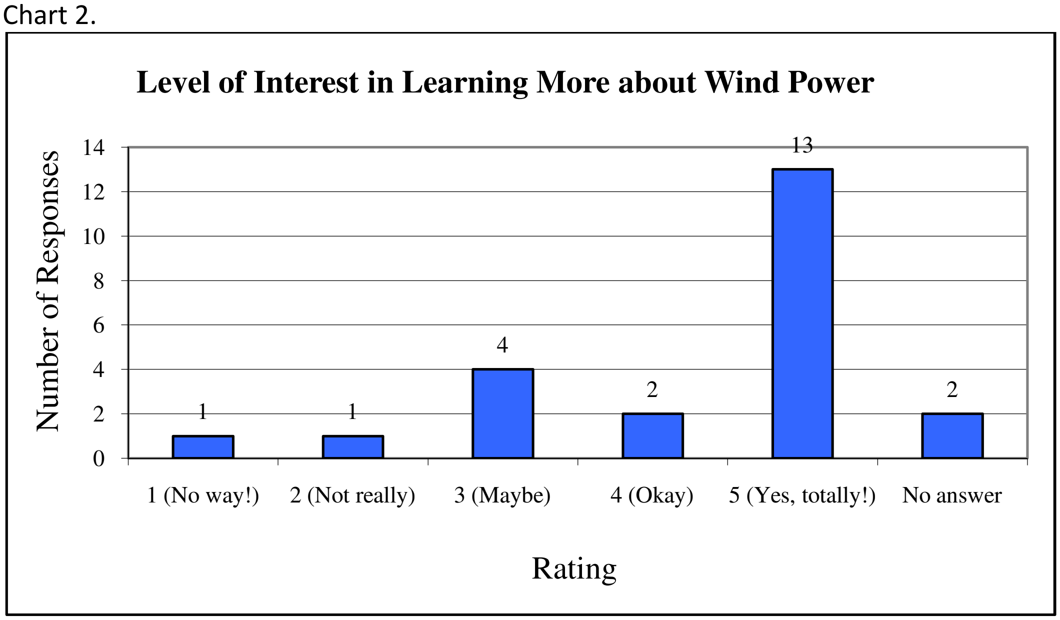
- It appeared that the biggest challenge of the wind turbine activity for participants was in getting the blade angle correct and having all of them at the same angle. This is a much more subtle yet important variable and was harder to keep track of for participants.
- The tasks that required wiring (voltmeter and LED light tasks) had some issues with needing to switch the polarity in order to make it work. Participants did not always know to try this.
- Some groups had trouble with physically manipulating and tightening the blades into the base and required staff assistance. This could be due to the dexterity and size of the young participants.
- In the water task, the water was difficult to see in the clear tube. Colored water could be considered to be able to see it more clearly.

<u>Attitude Outcome</u>

The intended attitude outcome for the lab was that participants would report a high level of interest in learning more about wind power. This is related to the OMSI Energy and the Environment program attitude outcome that participants would "report a high level of interest in Energy and the Environment science topics."

About 71% (15 out of 21) of respondents on the post-survey reported a high level of interest in learning more by rating a four or five on a five-point scale (1=No way! / 5=Yes, totally!). Most respondents gave a rating of 5 (Yes, totally!) and the mean rating of interest was 4.19 out of 5.
The chart below shows the distribution of ratings.

Chart 2.

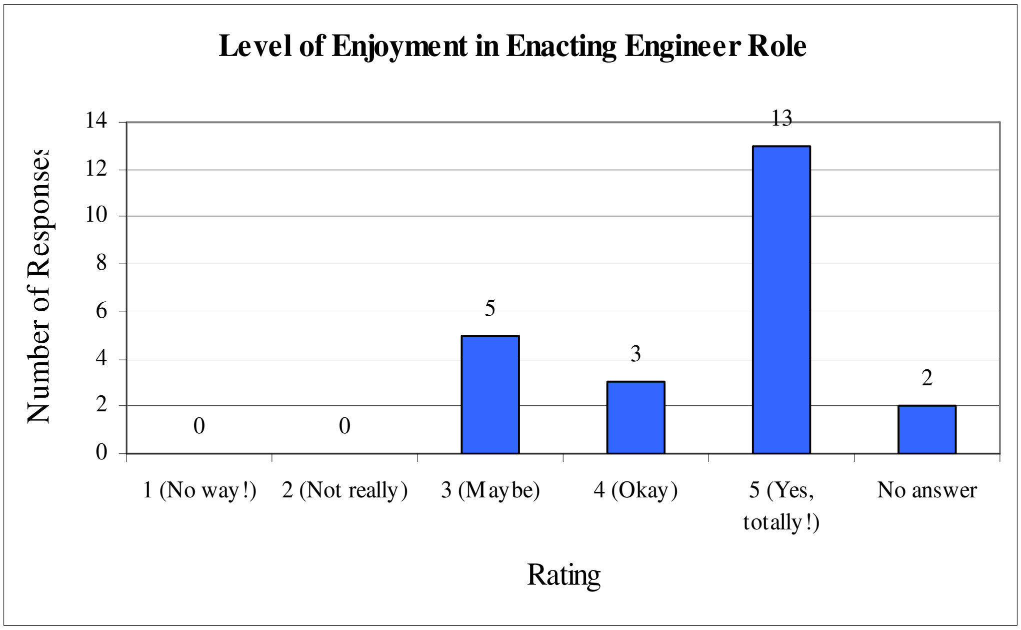


<u>Identity Outcome</u>

The intended identity outcome was that participants would report a high level of enjoyment in enacting the role of an engineer during the lab. This is related to the OMSI Energy and the Environment program identity outcome that participants would "report interest in a career related to Energy and the Environment."

In the beginning of the lab, the educator introduced the job of an engineer and instructed participants that they would all be acting as engineers to solve specific problems by designing a wind turbine. This role of an engineer was also mentioned again when the wind turbine activity was introduced. About 76% (16 out of 21) of respondents on the post-survey reported a high level of enjoyment in performing the role of an engineer during the lab, rating a four or five on a five-point scale (1=No way! / 5=Yes, totally!). Most respondents gave a rating of 5 (Yes, totally!) and the mean enjoyment rating was 4.38 out of 5. Chart 3 shows the distribution of ratings.

Chart 3.



From Pond Scum to Salmon Science Lab

Measures of Success

The chart below shows what the intended outcomes were for the lab, the indicators for what that outcome would look like if it occurred, the methods used to collect data, and finally what the actual result was. The actual results column can be used to compare against the indicators column to see how well the lab measured up against the intended outcomes and where the strengths and weaknesses are.

Chart 4. *From Pond Scum to Salmon Science Lab* Measures of Success

Outcome Category	Outcomes		Success Indicator	Evaluation Method	Actual Results
	Energy and the Environment Programs	***From Pond Scum to Salmon Science Lab***			
Knowledge	Participants will understand the big idea: The living environment results from the interdependent relationships between the Earth as a physical system, living systems, and human society	Participants will understand the big idea: Over their lifespan, salmon rely on certain living and non-living things in their environment to survive	67% of participants can identify one thing they did at the stream table that was helpful to salmon and why.	Embedded Assessment	**All participants were able to name something they did at the stream table that would be helpful to salmon.** 86% (24 out of 28) of the total responses were able to identify why.
			67% of respondents can recall at least two living or non-living things that salmon need in their environment to survive.	Post-Survey	**91% (21 out of 23) respondents could name at least two things salmon need to survive that they learned that day.** 70% (16 out of 23) could recall three.
Skills	Participants will engage in scientific reasoning related to E&E science topics	Participants will use a microscope to make accurate observations about pond water	67% of participants will be accurate during the majority of their observations at the microscope.	Embedded Assessment	**81% (17 out of 21) of questioned participants were accurate during the majority (2 out of 3) of their observations at the microscope.** 24% (5 out of 21) were accurate during all three of their observations.
Attitude	Participants will report a high level of interest in E&E science topics	Participants will report a high level of interest in learning more about salmon and their environment	75% of respondents will report a high level of interest (e.g., 4 or higher on scale of 1–5) in learning more about salmon and their environment.	Post-Survey	**61% (14 out of 23) of respondents reported a high level of interest in learning more**. The average rating of interest was 3.61 out of 5.
Identity	Participants will report interest to share their E&E science knowledge with others Participants will report interest in a career related to E&E	Participants will see themselves as someone who can affect their environment	75% of respondents can identify at least one thing we as humans can do to help salmon.	Post-Survey	**83% (19 out of 23) of respondents could identify something we as humans can do to help salmon.**

Knowledge Outcome

The intended knowledge outcome for the lab was that participants would understand the main idea that "over their lifespan, salmon rely on certain living and non-living things in their environment to survive." This is related to the OMSI Energy and the Environment program knowledge outcome that participants would understand the big idea that "the living environment results from the interdependent relationships between the Earth as a physical system, living systems, and human society."

One of the activities of the lab involved participants adding objects to a stream table with the goal of creating a salmon-safe river. Each addition to the table was facilitated by the educator and it was explained in what way it was helpful to salmon. At the end of the activity, the educator asked each participant to pick something they did at the table that was helpful to salmon. This was followed up with a question about how it was helpful. The responses are shown below.

Table 5.

What participants reported they did that would be helpful to salmon and why

Activity	Why it was helpful	# of complete responses (activity + why)	# of incomplete responses (activity + no reason why)
Created pools of water	Resting place	12	1
Placed trees	Oxygen, food, hiding	5	
Created a curvy shape to the stream	Slower water	3	
Pathway through dams and bridges	To get by	2	1
Put in other animals	Omnivore/herbivore balance	1	1
Put in rocks to create rapids	Oxygen	1	
Put in logs	Food source	0	1

All participants were able to name something they did at the stream table that would be helpful to salmon and four named more than one thing. The most common activity reported was that of creating pools for salmon to rest in. Four responses were incomplete in that they could not answer why what they did was helpful.

On the post-survey, participants were asked to name three things that salmon need in their habitat to survive that they learned that day. Table 6 shows the responses and their frequency.

Table 6.

Things that salmon need in their habitat to survive	# of responses
Food (bugs, shrimp)	15
Pools/ponds	11
Trees	10
Rapid/rocks	6
Water	6
Other animals	4
Oxygen	3
Logs	2
Slow water	1
Sense of smell	1
Incorrect (dams, bridges)	3
Unrelated answer	1
Total	**63**

About 91% (21 out of 23) of respondents could name at least two things living and non-living that salmon need to survive that they learned that day. About 70% (16 out of 23) could recall three. The most common responses were food, pools, and trees. This relates to what was also most commonly mentioned previously (pools and trees) when participants were asked what they did at the stream table and why. Some mentioned shrimp specifically as a food source on the survey. They would have learned this during the activity looking at pond water through a microscope rather than at the stream table.

There were three incorrect responses and they all mentioned simply dams or bridges. These were things that were talked about during the lab, but in the context of the need to provide a pathway through as to not block the salmon's travel. All three responses that mentioned dams or bridges were incomplete in that they did not mention it was the path that was needed and a dam or bridge itself is not helpful to salmon.

Skills Outcome

The intended skills outcome of the lab was that participants would use a microscope to make accurate observations about pond water. This is related to the OMSI Energy and the Environment program skills outcome that participants would "engage in scientific reasoning related to Energy and the Environment science topics."

One of the activities of the lab included participants using a microscope to make observations. They first learned how to focus their microscope and then retrieved a water sample to observe. While they were looking at their water samples, a data collector approached to ask each participant about what they saw. Depending upon their response (scud shrimp, duck weed, or snail), the data collector would next ask three standardized follow-up questions (see Appendix E).

When questioned as a group at the beginning of the activity, about 26% (6 out of 23) of participants reported that it was their first time using a microscope. About 81% (17 out of 21) of participants were accurate during the majority (2 out of 3) of their observations at the microscope during the questioning. About 24% (5 out of 21) were accurate during all three of their observations. Two participants did not make specific observations about what was in their water sample because they said they didn't see anything. Another participant was shy and did not want to answer.

Table 7.
Accuracy of microscope observations by specimen

Specimen	% of total observations	% that were accurate
Scud shrimp	37%	71%
Duck weed	16%	100%
Snail	47%	63%

The most observations were about the snail but these were also the least accurate. The snail was the largest to see in the water sample. The least number of observations were about the duck weed but these were the most accurate.

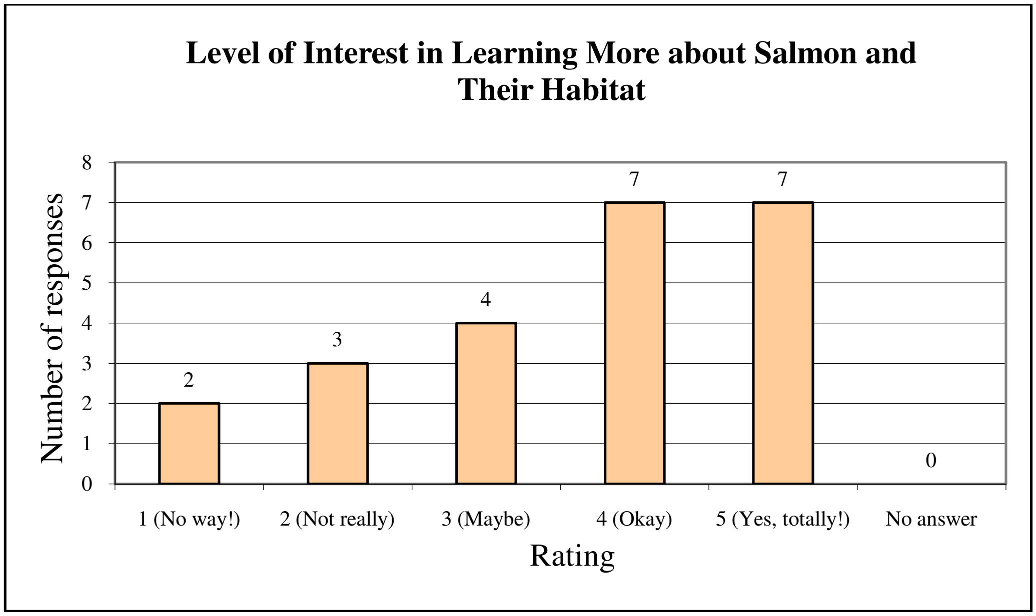
Activity Challenges
The interviewer reported that it was hard to keep participants focused on looking at their sample and that they were easily distracted by what else was in their field of view. It was also reported that a few students seemed to be making up answers rather than looking into the microscope to answer.

Attitude Outcome

The intended attitude outcome for the lab was that participants would report a high level of interest in learning more about salmon and their environment. This is related to the OMSI Energy and the Environment program attitude outcome that participants would "report a high level of interest in Energy and the Environment science topics."

About 61% (14 out of 23) of respondents reported a high level of interest in learning more by rating a four or five on a five-point scale (1=No way! / 5=Yes, totally!). The mean rating of interest was 3.61 out of 5.

Chart 5.



Identity Outcome

The intended identity outcome was that participants would see themselves as someone who can affect their environment. This is related to the OMSI Energy and the Environment program identity outcomes that participants would "report interest in a career related to Energy and the Environment" and "report interest to share their Energy and the Environment science knowledge with others."

About 83% (19 out of 23) of respondents on the post-survey could identify something we as humans can do to help salmon. The responses were grouped by theme and the frequency of each response theme is shown in Table 8 on the next page.

Table 8.

Activities reported by participants that humans can do to help salmon	# of Responses
Provide a way to get around or through dams or bridges	6
Environmentally friendly activities (don't pollute, use less water, build in safe place)	5
Don't kill/eat them	3
Create a nice habitat in general	2
Put in specific things (trees, rocks)	2
Feed them	1
Not a helpful response (eat them)	1
No answer (blank)	3
Total	23

The most common response as to what we as humans can do was to provide a way to get around or through dams or bridges. Some specific activities were mentioned such as using salmon ladders or giving them a boat ride. This is interesting because when identifying helpful things for salmon during the stream table activity and also on the survey, most participants were not able to explain what about bridges or dams would be helpful or not. But when put in terms of what humans can do, all of the six responses related to dams or bridges did explain that there needs to be way through for salmon. Environmentally friendly activities were also common, such as not polluting the water or building in a safe place.

Discussion and Recommendations

Both labs were successful in meeting or exceeding most of the success indicators set forth in their respective measures of success models. Comparing the success indicators with the actual results can reveal the strengths and weaknesses of each lab in order to inform future versions of the program.

The *Wind Power Lab*'s strength is in the skills, attitude, and identity outcomes. Participants solved problems using the engineering design process, reported a high level of interest in learning more, and enjoyed performing the role of an engineer. The knowledge outcome is where this lab was the weakest. The main idea that wind is renewable, which is why it is a good source of energy, was generally not understood by participants. The issue seems to be whether children that young can have an appreciation for what renewable energy is. Another related consideration is that there may not be enough time to focus on both accomplishing the engineering objective as well as learning about renewable energy. The engineering aspect seemed to have the most focus across the lab as a whole.

The *From Pond Scum to Salmon Science Lab*'s strength is in the knowledge, skills, and identity outcomes. Participants demonstrated they understood the big idea about salmon's habitat needs, used observations skills with a microscope, and could identify how they could help salmon. The attitude outcome of having a high level of interest in wanting to learn more about salmon and their environment was where the lab was weakest. During a debrief meeting, the lab's educator remarked that it is hard to make a program about such an "outdoor" topic as interesting when doing it indoors. It was observed that for a lab about salmon, there was very little to show what the real fish looks like or what their real habitat is like. New ways to bring real life examples of the "outdoors" in could be something to consider to potentially increase participants' interest in the topic.

It should also be mentioned that the intended outcomes and measures of success for these labs were originally designed to be appropriate for the age group that participated (2nd and 3rd grade). When offering these labs to older participants, it would be recommended to revisit the lab activities and desired outcomes to ensure that they are appropriate.

Appendix a. *Wind Power* Lab—Quiz Tally Sheet

Q1. What makes wind a renewable energy?

Answer		**#**
1A.	You need to burn fuel to make wind	
1B.	***The wind will never run out***	
1C.	I don't know	
	Total	

Q2. The faster the wind…

Answer		**#**
2A.	***The **more energy** we get from the wind turbines***	
2B.	The **less energy** we get from the wind turbines	
2C.	I don't know	
	Total	

Q3. What do engineers need to think about when designing a wind turbine to create more energy?

Answer		**#**
3A.	What color to paint it	
3B.	***Shape of the blades***	
3C.	I don't know	
	Total	

Q4. Who is ready to be an engineer?

Answer		**#**
4A.	* Me *	
4B.	Not me	
4C.	What's an engineer?	
	Total	

Date	
Lab Time (circle)	10am 11am
Total Participants	
Data Collector	
Educator	

Appendix b. *Wind Power* Lab—Skills Observation Sheet

Date	Lab Time	Group Size	Data Collector	Educator
	10am 11am			

Task:

Engineering Design Process

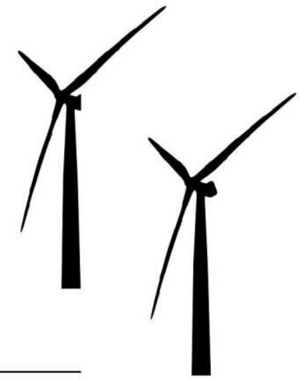
	occurred:	notes:
1. Identify problem observe question		
2. Brainstorm possible solutions hypothesize predict		
3. Design and test solutions create control variables		
4. Gather results and compare interpret evaluate		
5. Implement best solution final build		
6. Share best solution communicate present		

Did they solve the problem? Y N

Additional notes:

Appendix c. *Wind Power* Lab—Post-Survey

Wind Power Lab



1. Wind is a good source of energy because…

____

2. What are three ways to get <u>more</u> energy from wind using a wind turbine?

a. ____________________________________

b. ____________________________________

c. ____________________________________

3. Do you want to learn more about wind power?

circle your answer

1	2	3	4	5
No way!	Not really	Maybe	Okay	Yes, totally!

4. Did you like being an engineer today?

circle your answer

1	2	3	4	5
No way!	Not really	Maybe	Okay	Yes, totally!

5. I am a… Boy Girl

(circle one)

Appendix d. *From Pond Scum to Salmon Science* Lab—Stream Table Tally Sheet

Date

Lab Time
10am 11am

Data Collector

Educator

Q1: What did you do that was helpful to salmon? Q2: How is it helpful?

Subj	NA	Curvy shape	slower	Trees by river	shade oxygen erosion	Pools	resting	Rapids Waterfall	oxygen	Logs	food	Dam/ Bridge Path	to get by	Other Object	Other Reason
A1															
A2															
A3															
A4															
A5															
A6															
A7															

Notes:

Appendix e. *From Pond Scum to Salmon Science* Lab—Skills Tally Sheet

Date

Lab Time
10am 11am

Data Collector

Educator

First time?

Q: What do you see? (checkmark answer- fill in if 'other')

	Scud Shrimp						Duck Weed						Snail					
	a. how move?		**b. speed?**		**c. color?**		**a. move on own?**		**b. plant?**		**c. float?**		**a. texture?**		**b. in shell?**		**c. faster?**	
	swim, move legs	other	fast	slow	grey, white, stripe	other	no	yes	green leafy	other	float	sink	bumpy	smooth	correct	incorrect	shrimp	snail
A1																		
A2																		
A3																		
A4																		
A5																		
A6																		
A7																		

Notes:

Appendix f. *From Pond Scum to Salmon Science* Lab—Post-Survey

From Pond Scum to Salmon Science Lab

1. Name three things that salmon need in their habitat to survive that you learned today?

a. ________________________________

b. ________________________________

c. ________________________________

2. Name one thing we as humans can do to help salmon?

____

3.Do you want to learn more about salmon and their habitat?
Circle your answer

1	2	3	4	5
No way!	Not really	Maybe	Okay	Yes, totally!

4. I am a… Boy Girl
(circle one)

Appendix B: *Nanotechnology* Classroom Program Evaluation Report

By Nelda Reyes, OMSI Research & Evaluation Associate

Introduction

Program Description

This evaluation focused on two sessions of the *Nanotechnology Classroom Program* delivered by OMSI's outreach educators. It is part of the larger OMSI Energy and the Environment Program Evaluation which includes a sample of programs presenting energy and environment-related topics during the 2011 fiscal year.

The sessions were held on March 9, 2011, at Arch Bishop Howard Elementary School located in Portland, Oregon, a partner school with OMSI. There were a total of 50 participants between the two classes with 19 fourth graders in the first class and 31 fifth grade students in the second. The classes ran for one hour each and combined activities developed by OMSI Experience and Delivery staff and NISE Net, a consortium of informal science educators and researchers.

Participants were first introduced to nanoscale science with *What Is Nano?*, a slide show covering nanoscale, nano in nature, the unique characteristics of nanoscale materials, nanotechnology, and the risks of nanotechnology. Following the slide show and a short video, participants had 30 minutes to rotate between 11 activity stations. The class ended with a group activity in which students shared their ideas of new possible uses of nanotechnology, followed by a post-survey.

Objective

- As part of the larger OMSI Energy and the Environment Program Evaluation, contribute to the understanding of the impact of current energy and the environment-related programming at OMSI in order to inform future programs.
- Understand in what ways the class met or did not meet the intended outcomes of the program as set forth in the measures of success model (Chart 1) in order to evaluate its strengths and weaknesses and inform future versions of the class.

Methods

Data was collected during both classes using an embedded assessment quiz, an embedded assessment of student predictions, and post-surveys.

Embedded Assessment

Embedded assessment was used twice during the class with the educator asking participants planned questions at specific points in the classroom program. The first instance was a four-question quiz following the introductory slide show. In the second instance students were asked to make predictions about possible nano inventions in the future. A data collector was nearby to record participant responses on simple tally sheets in both instances (Appendix a).

This embedded assessment method served two purposes. One is that of a teaching tool for the educator to quickly assess participants' progress toward reaching the targeted outcome, thus providing immediate feedback for the educator to address gaps in understanding. The second purpose was to perform program evaluation, contributing to assessment of the classes' success (along with other methods) in meeting or exceeding intended outcomes.

Post-Survey

Directly following each class, the participants were asked to individually complete a short written survey. This survey, located in Appendix b, was designed to be age appropriate and asked questions about the participant's knowledge, attitude, and identity related to the intended program outcomes. School teachers returned the completed surveys by mail within one week of the program. The response rate was 90% (45 out of 50).

Findings

Class Participants

Participants were students at Arch Bishop Howard Elementary School. Gender data was self-reported by participants in the post-survey. Of those who responded on the survey, 27 were female and 16 were male. (Two participants did not record their gender.)

Measures of Success

Chart 1 shows what the intended outcomes were for the class, the indicators for what that outcome would look like if it occurred, the methods used to collect data, and finally what the actual result was. The actual results column can be used to compare against the indicators column to see how well the class measured up against the intended outcomes and where the strengths and weaknesses are.

Chart 1. *Nanotechnology Classroom Program* Measures of Success

Outcome Category	Outcomes		Indicators	Methods	Actual Results
	Energy and the Environment Programs	***Nanotechnology Classroom Program***			
Knowledge	Participants will understand the big idea: Energy used in our daily lives comes from a variety of sources that have different impacts on the environment	a. Participants will understand nanoscale science and engineering basic properties	65% of participants will respond correctly for each question about nano scale and properties during the embedded assessment quiz.	Embedded Assessment	**At least 86% (43 out of 50) of participants responded correctly for each question about nano scale and properties.** The mean percentage of correct answers per question is about 88%.
		b. Participants will conceptualize the current and potential applications of nanotechnology in renewable energy technologies	80% of participants will recall at least three current or potential applications of nano in renewable energy technologies.	Post-Survey	**42% (19 out of 45) of respondents named at least three current or potential applications in renewable energy technologies.** 82% named at least two. Most were about ways to harness solar energy.
Skills	Participants will engage in scientific reasoning related to E&E science topics	Participants will observe the properties of nanoscience and nanotechnology and make predictions about their use in the future.	65% of participants will be able to make at least one prediction about the use of nanotechnology in the future.	Embedded Assessment and Post-Survey	**During the embedded assessment, 87% (34 out of 39) made at least one prediction. On the survey, 100% (45 out of 45) made at least one prediction.** Most inventions were related to materials such as paper or textiles.
Attitude	Participants will report a high level of interest in E&E science topics	Participants will express a high level of interest in learning more about nanotechnology.	75% of participants will report a high level (e.g., 4 or higher on scale of 1–5) of interest in learning more about nanotechnology.	Post-Survey	**76% (34 out of 45) of respondents reported a high level of interest in learning more.** The average rating of interest was 4.18 out of 5.
Identity	Participants will report interest in a career related to E&E	Participants will report a high level of enjoyment in enacting the role of a nanoscientist.	75% of participants will report a high level of enjoyment (e.g., 4 or higher on scale of 1–5) in enacting the role of a nanoscientist.	Post-Survey	**82% (37 out of 45) of respondents reported a high level of enjoyment in enacting the role of a nano scientist.** The average enjoyment rating was 4.26 out of 5.

Knowledge Outcome

The intended knowledge outcomes for the class were (1) that participants will understand nanoscale science and engineering basic properties, and (2) that participants will conceptualize the current and potential application of nanotechnology in renewable energy technologies. This is related to the OMSI Energy and the Environment program knowledge outcome that participants would understand the big idea that “energy used in our daily lives comes from a variety of sources that have different impacts on the environment.”

Understanding Nanoscale Science and Basic Engineering Properties

Embedded Assessment

The first use of this type of formative assessment occurred at the end of the introductory slide show. It took the form of a short interactive quiz that involved the educator displaying multiple choice questions as a large projected image while asking participants to answer by raising their hands.

The measure of success indicator was that 65% of participants would respond correctly during the quiz. At least 86% (43 out of 50) of participants responded correctly for each question about nanoscale and properties. The mean percentage of correct answers per question is about 88%. The measure of success indicator was that 65% of participants would respond correctly during the quiz.

Table 1. Embedded assessment quiz questions and answers	**Percent of participants**
Q1: A red blood cell is found at the nanoscale.	
1A: True	8%
1B: False (correct answer)	92%
Q2: DNA is found at the nanoscale.	
2A: True (correct answer)	86%
2B: False	14%
Q3: Things on the nanoscale can be found all around us.	
3A: True (correct answer)	86%
3B: False	14%
Q4: Nanotechnology can affect the way we move and produce energy.	
4A: True (correct answer)	86%
4B: False	14%

Conceptualize the Current and Potential Application of Nanotechnology in Renewable Energy Technologies

Post-Survey

Participants were asked on the post-survey to name current or potential applications of nanotechnology in renewable energy technology. The measure of success was that 80% of participants would recall at least three current or potential applications.

About 42% (19 out of 45) of respondents were able to name at least three current or potential applications in renewable energy technologies on the survey. Eighty-two percent named at least two. Most of the responses (about 78%) were about harnessing solar energy through panels, windows, or paint.

Table 2 shows the types of energy-related responses overall. It combines the results of the first two questions on the post-survey. Q1 is from the knowledge category (What are three ways in which nanotechnology helps us produce energy?) and Q2 is from the skills category (If you were a nanoscientist in real life, which new things would you invent?).

Table 2. Current or potential energy-related applications of nanotechnology

# of responses		% of responses	
Q1	**Q2**	**%**	**Type of Application**
66	17	78%	**Harnessing renewable energy**, e.g., "Using solar panels to use the sun's energy to power it," "Solar powered windows," "Nano paint which is like solar panels."
16		15%	**Energy transmission**, e.g., "Not losing energy when transporting energy," "Electric nano wire instead of iron ones."
1	3	4%	**Energy Storage**, e.g., "Batteries."
4		4%	**Characteristics**, e.g., "It is very strong," "It is really small."
16			Not apparently nano related or energy related
103	20		Total

Skills Outcome

The intended skills outcome for the class was that participants would observe the properties of nanoscience and nanotechnology and make predictions about their use in the future. This is related to the OMSI Energy and the Environment program knowledge outcome that participants will "engage in scientific reasoning related to Energy and the Environment science topics."

Embedded Assessment

After rotating between 11 available activities, students were asked to make predictions about possible nano inventions in the future. The measure of success indicator was that 65% of the participants would be able to make at least one prediction about the use of nanotechnology in the future.

During the embedded assessment, 87% (34 out of 39) of participants were able to make at least one prediction about use of nano in the future. Four participants named more than one prediction. The largest percentage of predictions related to changing the characteristics of materials such as paper or textiles to make them stronger, lightweight, sticky, colorful, etc. Table 3 shows the distribution of responses by invention product type.

Table 3. Predictions of nano use in the future (from embedded assessment)

# of responses	% of responses	Invention Product Type
15	39%	**Paper/Textiles/Materials**, e.g., "Bulletproof shirt that is lightweight," "Paper that would never get wet," "Person crawling on the walls like gecko or spiderman."
7	18%	**Energy**, e.g., "Shirt to plug your Iphone into," "Shoes with solar panels."
5	13%	**Info/Communication**, e.g., "Robots that cost $5/month and you can program them to do things for you," "Phone on your glasses."
5	13%	**Cosmetics**, e.g., "Hair curlers (that work in the nanoscale)," "Waterproof hair so it doesn't get wet."
4	11%	**Chemistry**, "Chemical to put in water to clean it."
1	3%	**Medical**, e.g., "Prevent cancer and not become blue."
1	3%	**Not apparently nano related**

Post-Survey

On the survey, 100% (45 out of 45) of participants were able to make at least one prediction about the use of nano in the future. About 69% (31 out of 45) could make two predictions. Again, the largest percentages of inventions were related to materials (29%), but answers related to energy were a close second (24%).

Table 4. Predictions of nano use in the future (from post-survey)

# of responses	% of responses	Invention Product Type
24	29%	**Paper/Textiles/Materials**, e.g., "I will invent clothes that can kill all bacteria around," "Elevator to the moon," "I could make gloves that could climb on walls, windows, or just plain ceiling."
20	24%	**Energy**, e.g., "I would make a solar powered tent," "Make a painted wall that is a solar panel."
15	18%	**Cosmetics**, "A man who can swim without getting wet," "A contact that you could just drop the nano water in and your eye color changes."
7	8%	**Not apparently nano related**
6	7%	**Info/Communication**, "I could put nano thingies in my hand so my hand could be a hand ipad."
6	7%	**Medical**, e.g., "Use nanotechnology to detect cancer before it even starts and then prevent it," "I would make bacteria fighting nano-bots."
5	6%	**Chemistry**, e.g., "Water purifier device or chemical," "Paint that makes pictures."

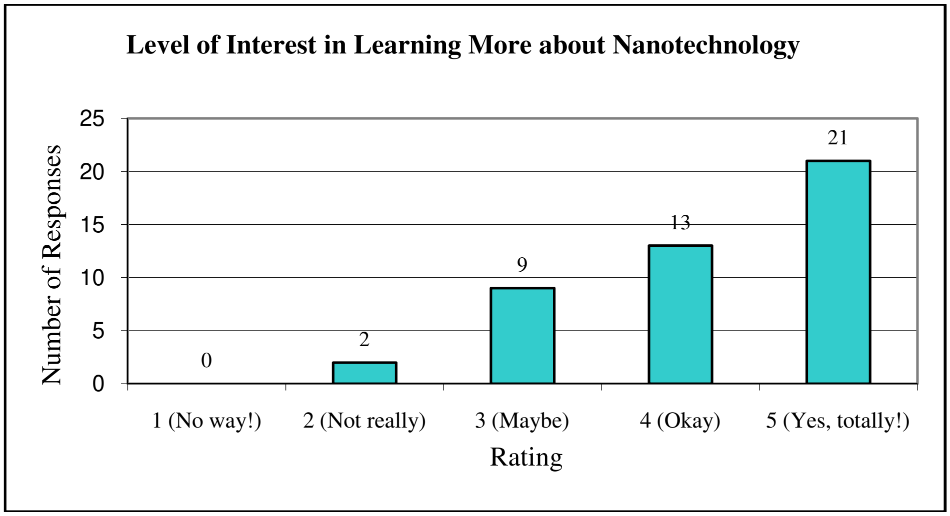
Attitude Outcome

The intended attitude outcome for the class was that participants would express a high level of interest in learning more about nanotechnology. This is related to the OMSI Energy and the Environment program attitude outcome that participants would "report a high level of interest in Energy and the Environment science topics."

Post-Survey

The intended attitude outcome was that 75% of the participants would report a high level (e.g., 4 or higher on a scale of 1–5) of interest in learning more about nanotechnology. On the survey, 76% (15 out of 21) of respondents reported a high level of interest in learning more by rating a four or five on a five-point scale (1=No way! / 5=Yes, totally!). More respondents gave a rating of 5 (Yes, totally!) than any other rating and the mean rating of interest was 4.19 out of 5. Chart 2 shows the distribution of ratings.

Chart 2.



Identity Outcome

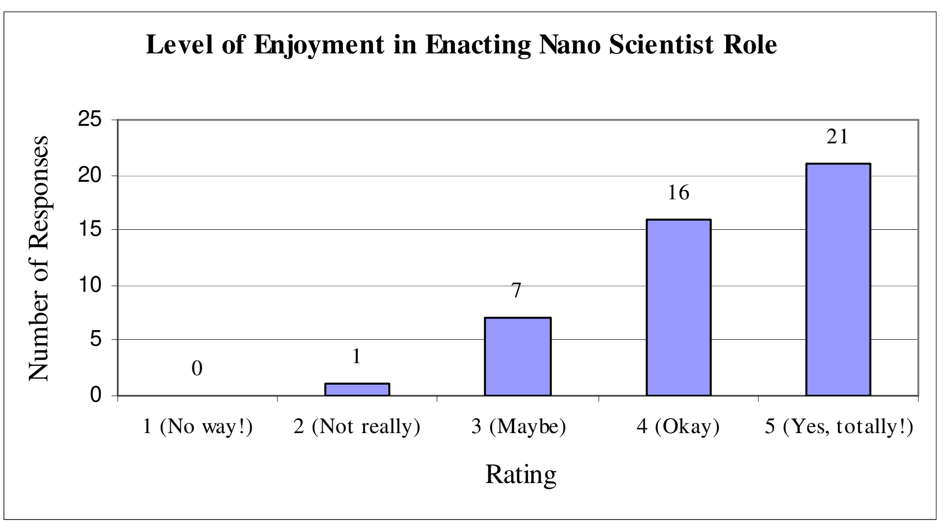
The intended identity outcome for the class was that participants would report a high level of enjoyment in enacting the role of a nanoscientist. This is related to the OMSI Energy and the Environment program identity outcome that participants would "report interest in a career related to Energy and the Environment."

Post-Survey

Participants were prompted to "think like nanoscientists" while engaging in the 11 activity stations (Appendix C) and when asked to predict what they would invent. The intended identity outcome was that 75% of participants would report a high level of enjoyment (e.g., 4 or higher on a scale of 1–5) in enacting the role of nanoscientist during the class.

About 82% (37 out of 45) of respondents on the post-survey reported a high level of enjoyment in performing the role of nanoscientist during the class, rating a four or five on a five-point scale (1=No way! / 5=Yes, totally!). More respondents gave a rating of 5 (Yes, totally!) than any other rating and the mean enjoyment rating was 4.38 out of 5. Chart 3 shows the distribution of ratings.

Chart 3.



Discussion and Recommendations

The *Nanotechnology Classroom Program* exceeded almost all of the success indicators set forth in its measures of success model in Chart 1. Its particular strengths were found to be in the skills, attitude, and identity outcomes. Participants understood and observed basic nanoscale properties and used this to make predictions about the use of nanotechnology in the future, often related to renewable energy technologies. Participants were also found to be interested in learning more and enjoyed enacting the role of a nanoscientist.

The knowledge component had two outcome indicators that each generated different results. For the embedded assessment quiz about basic nanoscale properties, the results far exceeded the measure of success indicator. The program met only half of the indicator developed for the second knowledge-related outcome. Only 40% were able to recall at least three current or potential applications of nano in renewable energy technologies on the post-survey.

This most likely resulted from an inconsistency between the indicator and the program's content. This measure of success was not an appropriate measure as only three renewable energy-related applications were mentioned in the program: solar panels, solar paint, and nano-tubes. Based on this, a more realistic success indicator would be to recall at least two, not three. If this new measure of success was used, this knowledge outcome would have been met as 82% of participants were able to recall at least two applications. Revision of this program's indicator and/or inclusion of more renewable energy-related examples would be recommended for future delivery or evaluation of the program.

Additional anecdotal observations made by the evaluator included that the fourth grade participants "loved the class" and that there was "lots of excitement and 'wow' expressions when [participants were] observing and experimenting with activities." During the fifth grade class, the "clapping of one kid was followed by others when [the educator] mentioned the possibility of powering a city with windows." There was also "clapping and overall verbalizing of excitement after the video finished."

Finally, there was a discussion between the teacher at the school and the educator about the possibility of offering this class for high schools and adults. The evaluator for this program recommends looking into this opportunity as the program has strong potential to educate older audiences regarding nanotechnology. In this case, the program would need some adaptations of the "stretch-ability" and "carbon-tube building" activities to be suitable for adults and teenagers.

Appendix a. Embedded Assessment Tally Sheets

Q1. A red blood cell is found at the nanoscale.

Answer		#
1A.	True	
1B.	False	

Date	
Grades	
Class time (circle)	9:30 am 10:40am
Total Participants	
Data Collector	
Educator	

Q2. DNA is found at the nanoscale.

Answer		#
2A.	True	
2B.	False	

Q3. Things on the nanoscale can be found all around us.

Answer		#
3A.	True	
3B.	False	

Q4. Nanotechnology can affect the way we move and produce energy.

Answer		#
4A.	True	
4B.	False	

If you were a nanoscientist, what would you invent (considering what you know about nanotechnology and nanoscience?)

Subj	**Made Prediction** (check if occurred)	**Invention**
1		
2		
3		
4		
5		
6		
7		
8		

Appendix b. Post-Survey

OMSI Nanotechnology Class

We hope you enjoyed the class!
Please respond to the following questions:

1. What are <u>three</u> ways in which nanotechnology helps us produce energy?

a.

---

b.

---

c

---

2. If you were a nanoscientist in real life, which NEW things would you invent?

	Invention
Example:	I would make shoes that could walk on walls or windows.

3. Do you want to learn more about nanotechnology?
circle your answer

1	2	3	4	5
No way!	Not really	Maybe	Okay	Yes, totally!

4. Did you like being a nanoscientist today?
circle your answer

1	2	3	4	5
No way!	Not really	Maybe	Okay	Yes, totally!

5. I am a… Boy Girl
(circle one)

Appendix C: *Amazing Whales* Classroom Program Status Report

By Nelda Reyes, OMSI Research & Evaluation Associate

Introduction

The *Amazing Whales* classroom program is an existing one-hour traveling program delivered by OMSI outreach educators in school classrooms. It is designed for students in kindergarten through fifth grade. This report focuses on the continued program development that occurred to align it to the OMSI Energy and the Environment program outcomes to prepare for its evaluation within the Energy and the Environment Program Evaluation project. This larger program evaluation initiative included a sample of programs presenting energy and environment-related topics during the 2011 fiscal year.

Similar to other programs in this sample, the intended evaluation process for this classroom program included the development of protocol, instruments, data collection, and presentation of results to understand its impact on participants and to inform improvements to the program as needed. During the period available for data collection, the program was not scheduled by local schools and for this reason the data collection phase along with analysis and results were not completed as intended.

This report focuses on the work completed to redesign and evaluate this program, setting up the precedents for an updated program and future evaluation efforts.

Classroom Program Redesign

In the course of collaboratively planning an evaluation for the *Amazing Whales* classroom program, the evaluator and the outreach educator leading the program realized that the content of the original classroom program did not relate directly to the OMSI Energy and the Environment program outcomes. These outcomes (see the Logic Model in Appendix a) were developed more recently through collaboration with education managers as the current, ideal, measurable outcomes for all OMSI programs related to energy and/or the environment-related topics. As a result, there was the need to make changes to the program in order to align it with those outcomes before the evaluation data collection phase began.

The evaluator worked with the educator one hour per week for six weeks; from the third week of January through the fourth week of February. In addition to these weekly meetings, the evaluator observed a session of the original classroom program delivered on January 28 at City View Charter School in Hillsboro, Oregon.

Several meetings were conducted that focused on the revision of the original *Amazing Whales* classroom program outline and activities through the use of the Energy and the Environment Program Evaluation Logic Model. After careful consideration, the team established the following set of outcomes specific to the redesigned program that also aligned with the Energy and the Environment outcomes:

1. (knowledge) Students will understand two main messages related to whales and the environment:
    a. Whales are amazingly adapted to survive in their ocean habitat
    b. Human actions can benefit or harm whales
2. (skills) Students will use scientific reasoning skills during program activities
3. (attitude) Students will demonstrate interest in learning more about whales and stewardship of whales
4. (identity)
    a. Students will enjoy playing the role of a marine biologist
    b. Students will understand that human actions can help whales

After establishing this new set of outcomes, the evaluator and educator redesigned the program by editing and adding content and establishing new educational strategies that would help improve the program's effectiveness in reaching the outcomes. The changes affected all three major sections of the program, namely the introduction, PowerPoint presentation, and the free-choice learning activities.

The most significant changes and strategies for each section are described below:

Introduction and PowerPoint Presentation

- One of the new overall strategies that is introduced at the beginning of the class consists of encouraging participants to undertake the role of marine biologists, giving them a role and a reason for learning, understanding, and caring about whales.

- While the original classroom program focused solely on the physical characteristic adaptations of whales and the variety of species, the new PowerPoint slide show introduces those original themes but incorporates environmental concepts such as "habitat," "endangered," "extinct," whale migration patterns across the globe, and the whale's life cycle. It also touches on stewardship and human efforts towards that end.

Free-Choice Learning Activities:

- The original program included several exploration stations. Most of these were adapted to the new outcomes and also further developed to be appropriate to two different age groups: grades K–3 and 3–6. Some of the original stations were taken out of the program as they proved not to be successful in supporting the new learning outcomes and others are in consideration for being redesigned in the future. (See Recommendations section for details.)

- The most significant change overall was the introduction of a *Marine Biologist's Notebook* (Appendix c). The notebook serves as a guiding document to help participants exercise their scientific skills and report their findings when going over the program's activities. They also serve as an evaluation assessment tool. There are two versions, one for grades K–2 and one for grades 3–6, and they are intended to be given to each of the participants before they start the activities and collected at the end of the program, if they will be serving as an evaluation tool.

All changes were recorded in the new program outline that can be found in Appendix e in this document.

Program Evaluation

The *Amazing Whales* program was originally planned to be evaluated as part of the larger Energy and the Environment Program Evaluation, which includes a sample of programs presenting energy and environment-related topics during the 2011 fiscal year. It was intended that this classroom program, like the others in the sample, would be held twice in a school, ideally a Title 1 partner school with approximately 25 participants per session. Due to scheduling issues, data was not collected to complete the evaluation, but the planned protocol is included here to inform future evaluation opportunities for this program.

Objective

- As part of the larger OMSI Energy and the Environment Program Evaluation, to contribute to the understanding of the impact of current energy and the environment-related programming at OMSI in order to inform future programs.

- Understand in what ways the program meets or does not meet the intended outcomes of the program as set forth in the measures of success model (Chart 1) in order to evaluate its strengths and weaknesses and inform future versions of the program.

Methods

Data collection methods designed for the *Amazing Whales* classroom program involves embedded assessment, the participant's *Marine Biologist's Notebook,* and a post-survey.

Chart 1. *Amazing Whales* Classroom Program Measures of Success

Outcome Category	Outcomes		Indicators	Methods
	Energy and the Environment Programs	***Whales***		
Knowledge	Participants will understand the big idea: "The living environment results from the interdependent relationships between the Earth as a physical system, living systems, and human society."	a. Participants will understand that whales are amazingly adapted to survive in their ocean habitat.	*(All grades)* 80% of the participants will be able to correctly respond to the quiz about adaptations. *(Grades 3–6)* 75% of participants will record at least two adaptations that would be necessary for humans to live in the water just like the whales do.	Embedded assessment *(all ages)* or post-survey *(grades 3–6)*
		b. Participants will learn about human actions and how some of them can harm whales.	*(Grades 3–6)* 80% of the participants will be able to identify human actions that harm whales.	Post-Survey
Skills	Participants will engage in scientific reasoning related to E&E science topics.	Participants will explore the activities and successfully record their findings in their Marine Biologist's Notebook.	*(All grades)* 80% of the participants will complete their Marine Biologist's Notebook assignments.	Marine Biologist's Notebook
			(Grades K–2) The average correct number of questions per participant will be 5 out of 7. *(Grades 3–6)* The average correct number of questions per participant will be 7 out of 11.	
Attitude	Participants will report a high level of interest in E&E science topics.	Participants will report a high level of interest in whales and the stewardship of whales.	*(Grades K–2)* 75% of the participants will report interest in learning more about whales and how to take care of them. *(Grades 3–6)* 75% of the participants will report a high level of interest (e.g., 4 or higher on a scale of 1–5) in learning more about whales and how to take care of them.	Embedded assessment *(grades K–2)* or post-survey *(grades 3–6)*
Identity	Participants will report interest in sharing their E&E science knowledge with others.	a. Participants will report a high level of enjoyment in enacting the role of a marine biologist.	*(Grades K–2)* 75% of the participants will report enjoyment in enacting the role of a marine biologist. *(Grades 3–6)* 75% of the participants will report a high level of enjoyment (e.g., 4 or higher on a scale of 1–5) in enacting the role of a marine biologist.	Embedded assessment *(grades K–2)* or post-survey *(grades 3–6)*
	Participants will report interest in a career related to E&E.	b. Participants will understand that human actions can help whales.	*(Grades 3–6)* 80% of the participants will be able to report one thing that humans can do to help whales.	Post-Survey

<u>Embedded Assessment</u>

This type of formative assessment is to be conducted by the educator twice during the classroom program. The first instance is a two-question quiz during the program's slide show. The second instance is part of the wrap-up activity inside the program's inflatable whale and consists of one question about the level of enjoyment participants had enacting the role of a marine biologist. A data collector would record participant responses on simple tally sheets in both instances (Appendix b).

Marine Biologist's Notebook
This notebook serves two purposes. The first is as a guiding document to help participants exercise their scientific skills and report their findings when participating in the program's hands-on activities. The second is as a tool to assess how successful the activities are in helping participants exercise these scientific skills. This notebook, located in Appendix c, asks specific questions related to key activities and is designed as an indicator along with other methods to evaluate how the program did to achieve its intended outcomes. It was designed to be appropriate for two specific target audience groups: K–2 and 3–6 grades.

Post-Survey
Directly following each class, the participants would be asked to individually complete a short written survey (Appendix d). This survey was designed to ask questions about the participant's knowledge, attitude, and identity related to the intended program outcomes. School teachers would need to distribute and collect the completed surveys and send them by mail within one week of the program. This survey was intended only for the participants in grades 3–6, and designed specifically for these age ranges.

Recommendations

There were additional changes planned for activities within the *Amazing Whales* program that were not carried out due to a shortage of resources. These include some editing for the "Whale Sounds" activity, updating the data in some of the graphs in the "Graph Station," and redesigning the "Whales Puzzle" in order to further facilitate learning and alignment to the new learning outcomes.

It would also be recommended to make the necessary efforts to familiarize other outreach educators with the new version of the program so its delivery is consistent among educators.

The program evaluation protocol and data collection tools are ready if there is an opportunity to conduct the evaluation in the future.

Appendix a. OMSI Energy and the Environment Program Evaluation Logic Model (v.4.28.11)

<table>
<tr><th>Evaluation Need</th><th>Audiences</th><th colspan="3">Impact Framework</th><th>Intended Program Outcomes</th><th>Evaluation Methods</th></tr>
<tr><td rowspan="4">To understand the impact of current Energy and the Environment-related programming to inform future E&E programs.</td><td rowspan="4">Experience and Delivery program participants</td><td>CLE Impacts[1]</td><td>OMSI Science Education Programs[2]</td><td>NRC Strands[3]</td><td rowspan="2">Knowledge
Participants will understand the big ideas: “The living environment results from the interdependent relationships between the Earth as a physical system, living systems, and human society” and/or “Energy used in our daily lives comes from a variety of sources that have different impacts on the environment.”

Skills
Participants will engage in scientific reasoning related to Energy and the Environment science topics.</td><td rowspan="4">Embedded Assessment

Observations

Survey</td></tr>
<tr><td>Foster informed citizens</td><td>Inspire Wonder
Science Literacy
• Knowledge development
• Decision-making skills
• Information evaluation skills</td><td>6. Developing interest in science
7. Understanding scientific knowledge
8. Engaging in scientific reasoning
9. Reflecting on science
10. Engaging in scientific practices</td></tr>
<tr><td>Reduce gaps in STEM participation and performance</td><td rowspan="2">Inspire Wonder
Science Identity
• Promote and support STEM careers</td><td rowspan="2">2. Developing interest in science
7. Engaging in scientific practices
8. Identifying with the scientific enterprise</td><td rowspan="2">Attitude
Participants will report a high level of interest in Energy and the Environment science topics.

Identity
c) Participants will see themselves as someone who can affect their environment.
d) Participants will report interest in a career related to Energy and the Environment.</td></tr>
<tr><td>Foster identities as Science learners</td></tr>
</table>

[1] OMSI Center for Learning Experiences Impact Logic Model, v. 12.15.09
[2] OMSI Internal Curriculum Standards: Energy and the Environment Initiative, v. 9.28.10
[3] National Research Council. (2009). *Learning science in informal environments: People, places, and pursuits.*Washington, D.C.: National Academies Press.

Appendix b. *Amazing Whales*—Embedded Assessment Tally Sheet

PP Quiz

Q1. Which adaptation helps the whale breathe?

Answer		#
1A.	**Baleen**	
1B.	**Blowhole (correct answer)**	

Q2. Which adaptation helps the whale steer right and left?

Answer		#
2A.	**Flipper (correct answer)**	
2B.	**Fluke**	

Date

Grades

Class time ______________

Total Participants

Data Collector

Educator

Wrap up question

Q3. Raise your hand if you think you would like to learn more about whales.

Answer		#
3A.	Yes	
3B.	No	

Q4. Raise your hand if you enjoyed being a Marine Biologist today.

Answer		#
4A.	Yes	
4B.	No	

School

Teacher

Contact Info

Phone:

E-mail: ____________________________

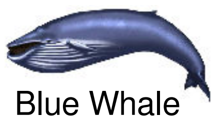
Appendix c. *Marine Biologist's Notebook* Grades K–2

4 **Use the graphs to find out more about whales!**

4.1 Which whale can hold its breath the longest? Circle it in Red.

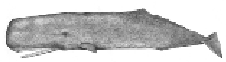
4.2 Which whale can dive the deepest? Circle it in Blue.

4.3 Which whale can swim the fastest? Circle it in Green.


Blue Whale


Orca


Grey Whale


Sperm Whale

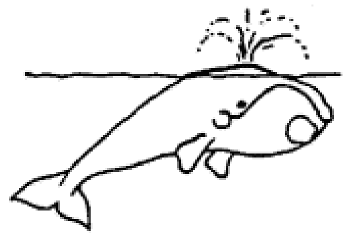

Bottlenose Dolphin

Narwhal

Amazing Whales

Marine Biologist Notebook

OMSI
OREGON MUSEUM OF SCIENCE AND INDUSTRY



Name: ______________

Grades K-2

1 **Touch Table**

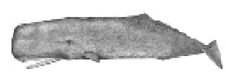
Draw something you saw or touched:

1.1 What is it? ______________________

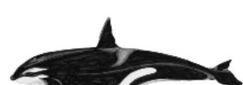
2 **How big are whales?**
Use the ropes to find out!

2.1 Circle the whale that is *longer*:


Blue Whale


Sperm Whale

2.2 Circle the whale that is *shorter*:


Orca


Dall's Porpoise

3 **Whale songs**
What do the whale songs remind you of? *Circle the pictures that match.*





Marine Biologist's Notebook Grades 3–6

4 **Use the graphs to find out more about whales!**

4.1 How many minutes can a Sperm whale hold its breath? __________

4.2 How many hours is that? _________

5 Which kind of whale is most endangered (fewest alive)?

____

5.1 Why do you think this whale could be endangered?

____

____

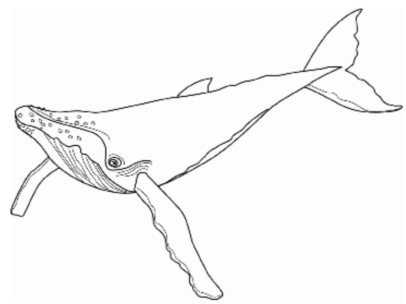
5.2 What is one thing people could do to help whales?

____

Amazing Whales

Marine Biologist Notebook

OMSI
OREGON MUSEUM OF SCIENCE AND INDUSTRY



Name: ______________

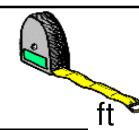
Grades 3-5

Touch Table

1 Draw something you saw or touched:

1.1 What is it? ______________________

2 **How big are whales? Use the ropes to find out!**

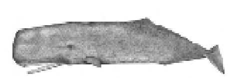


2.1 How long is a blue whale? ______ ft

2.2 How much longer is a blue whale than an orca? _______ ft

Circle the longest *toothed* whale:

Blue Whale



Sperm Whale

Orca

Dall's Porpoise

3 **Whale songs**

3.1 Which whale song is your favorite?

____

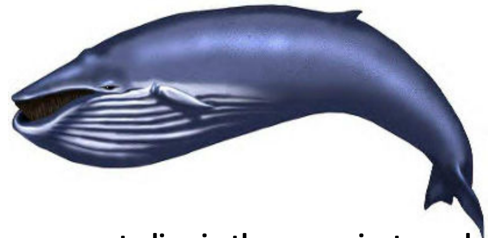
3.2 What does this whale song remind you of?

For example, a tuba or a squeaky door.

____

____

Appendix d. Post-Survey
OMSI Amazing Whales! class



We hope you enjoyed the class!
Please respond to the following questions:

1. **Write two ADAPTATIONS you would need to have if you were to live in the ocean just as whales do.**

    a.____

    b. ____

2. **Which of these human activities can harm whales?** circle your answers

Hunting too many whales

Buying dolphin-safe tuna

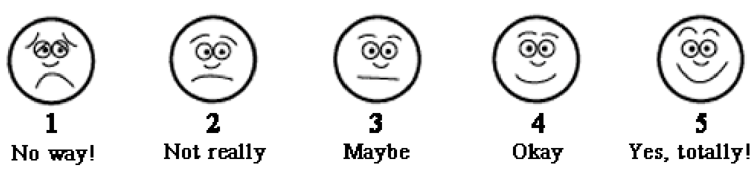
Dressing up as a whale for Halloween

Littering on the beach

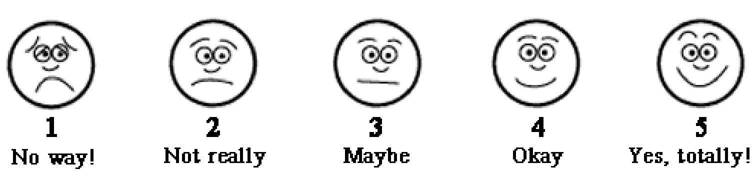
3. **Write ONE thing that we as humans can do to help whales?**

____

4. Do you want to learn more about whales and how to take care of them?
circle your answer



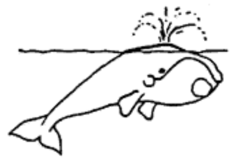
5. Did you like being a marine biologist today?
circle your answer



6. I am a… Boy Girl
(circle one)

Appendix e. Redesigned *Amazing Whales* Program Outline

OREGON MUSEUM OF SCIENCE AND INDUSTRY



Amazing Whales

Outline updated 3.31.2011

Purpose

This program was revised in April 2011 as part of OMSI's Energy and the Environment Initiative. In accordance with the initiative's overarching goals, the ideal outcomes for the revised Amazing Whales program are as follows:

- Students will understand two main messages related to whales and the environment:
  1) Whales are amazingly adapted to survive in their ocean habitat.
  2) Human actions can benefit or harm whales.
- Students will use scientific reasoning skills
- Students will play the role of a marine biologist
- Students will demonstrate interest in Energy and the Environment science topics

The revisions to Amazing whales included a framework for evaluating the outcomes of the class with regards to the Energy and Environment goals. The evaluation tools include:

- Verbal embedded assessment (instructor asks for a class response to a question and tallies correct/incorrect answers)
- Written embedded assessment (students fill out Marine Biologist Notebook which can be collected for evaluation)
- Post survey

For more specific information about program outcomes and evaluation, please see the Amazing Whales classroom program logic model.(Appendix b)

Overview

5 min	Situate students for slide show; introduce self, OMSI, expectations
20 min	Slide show - Whale dress-up - Embedded assessment
5 min	Introduce stations
20 min	Station Exploration and Marine Biologist Notebook - Touching and reading table - Size comparison ropes - Whale songs - Graph station - Memory game - Whale dress up - Whale pictures and fun facts slide show (playing in background)
5 min	Go into whale (including breath-holding experiment)
5 min	Wrap-up and goodbye

Room Set-Up:

You will need:

- Room large enough to inflate the whale (minimum of 60' or 40') – gym or cafeteria is best. (Set up the inflatable whale far from the stations and do not allow children in that area until it is time to blow it up. If you are in a smaller space, you may have to unroll the whale just before inflating it).
- Screen or white wall for slide show
- Ability to darken room

- Electrical outlets (for slide projector and fan)
- 5-6 small tables for stations (or 3 six-foot tables)

Intro

- Introduce self/expectations
- We are marine biologists (whale scientists). It is our job to learn as much as we can about whales and to take care of them so they can survive! As marine biologists, we can also teach other people about whales and tell them how they can help whales too.

Slide Show (Main Points – see slide show script below)

- Habitat = the place where an animal lives and finds food, water, and shelter. A whale's habitat is the ocean.
- Mammal = an animal that gives live birth, is warm blooded, and breathes air. Whales are mammals.
- Adaptation = a body part that helps an animal survive in its habitat. **(Insert whale dress-up and embedded assessment)**
- Endangered = when there are not many left of a certain plant or animal, and that plant or animal is at risk of going extinct (gone forever). Some whales are endangered because of human actions.
- Stewardship = taking care of living creatures and their habitat so that they can survive.

Stations - Students have marine biologist notebook guiding them through stations. They have to answer questions for each station in their notebook.

- Instructor: Now you're going to have the opportunity to be marine biologists and study whales. Your Marine Biologist Notebook is the place for you to record the information you find about whales. All the questions can be answered by visiting the different stations set up around the room.
- **Touch table** – Students touch and observe biofacts including whale bones, fossils, dried krill, and seal fur. They must draw and identify one item in their notebook.
- **Size comparison ropes** – Students unroll ropes to see how long different whales are and answer one size comparison question in their notebook.
- **Whale songs –** Students listen on headphones to three different kinds of whale songs, then respond to a question in their notebook.
- **Graph station** – Students interpret the graphs to answer questions in their notebooks.
- **Memory game** – Students play memory to learn about different whale species.
- **Dress-up station** – (Optional to set up). Students try on whale adaptations.
- **Whale pictures and fun facts slide show** – Play slide show in background while students visit stations.

Going in the whale

- While inflating have students identify adaptations
- A few minutes of free play inside the whale
- Gather students together inside the whale, sitting down. Then as a group, do breath holding experiment.
  - For younger students – Hold up the clock so students can see the second hand, then have them hold their breath. How long could you hold your breath for? Is that as long as a whale? Why can whales hold their breath longer than us?
  - For older students – Whales have a special adaptation that allows them to hold their breath for an extended period of time. When a whale dives underwater (holding its breath) its heart rate slows down to conserve oxygen. Some drop from 120 bmp to 4-6 bpm! Have students take their pulse for 30 seconds (multiply by 2). Then, have them take their pulse for another 30 seconds, this time while holding their breath (multiply by 2 again). Did your pulse increase, decrease, or stay the same while holding your breath? Why do you think that is?

Wrap-up

- What did you learn? What was your favorite part?
- ***(If evaluating class)*** Collect Marine Bio Notebooks (assure students and teachers that they will be returned after looking at them for evaluation purposes). Give teacher post-survey and ask him/her to give it to students and return to OMSI.

Powerpoint Outline

1. Today, we are going to be *marine biologists*. Does anybody know what a marine biologist does? (Learns about living things in the ocean and helps take care of them). Today we're specifically going to study whales: what makes them so cool, how they survive in their ocean environment, and how we as people can help take care of them.

2. Whales live in every ocean on earth – from the Pacific to the Atlantic, to the Indian, Arctic, and Antarctic. Many whales even travel thousands of miles every year, visiting several different oceans to find food or have their young. Marine biologists have a name for the place an animal lives; does anybody know it? *Habitat*. What is *your* habitat?

3. Whales share their habitat with lots of other marine animals, from salmon to squid to sharks. But whales are different, because like us, they are *mammals*.
Let's look carefully at what makes a mammal a mammal.

4. What is this whale doing? Breathing! Like all mammals, whales breathe air. When they come to the surface, they blow out the old air and take a fresh breath. How do fish breathe?
Whales breathe voluntarily, not involuntarily like we do. When the whale is not breathing, its blowhole remains shut. If a whale is trapped underwater (like in a net) it will suffocate because it will not breathe if it is underwater.
Experienced whale watchers can identify a whale by the size, shape and direction of its blow. The whale in this picture is a gray whale.

5. Whales, like (almost) all mammals give birth to live young and feed their babies milk. The babies are called calves. This is a mother humpback whale and her calf.
The mother must escort the calf to the surface for its first breath.
Calves must grow quickly in order to develop the layer of blubber that will keep them warm.
Whale milk is VERY rich – 50-53% fat (compare this to drinking nonfat, 1% or 2% or 3% regular mile). A newborn baby blue whale can drink 65 gallons of milk and gain 200 pounds a day.
Female whales usually have one calf every 2 to 5 years. Twins are rate

6. Whales are also warm blooded. That means they maintain a consistently high body temperature. They do this by eating; food goes in the belly and the process of digestion actually creates heat, just like putting wood in the fireplace. In the ocean it's really cold, so this orca has to eat a lot to stay warm! Fortunately, it also has a thick layer of blubber that helps keep him warm.

7. All animals, including whales, have *adaptations,* special body parts that help them survive in their habitat.

- Students, what is your habitat? (House, city, classroom, etc). In this habitat, we have certain adaptations—lungs to breathe air, thumbs to open doors—that help us get around. Can you think of any other adaptations people have?
- Okay now let's imagine we are whales. What is a whale's habitat? (The ocean). Do you think that a whale living in the ocean will have some different adaptations from people living in the city?

- I need two volunteers to model these adaptations for the rest of the class. One of my volunteers is going to demonstrate the adaptations on a *baleen whale*. The other volunteer is going to model adaptations on a *toothed whale*.
  - **Life Jackets** – Whales have blubber (a thick layer of fat) to help them keep warm in cold water and provide buoyancy
  - **Dorsal Fins** (wrap around lower torso) – Help whales stay balanced and keep from rolling in the water.
  - **Flippers** (pull on hands) – Help whales steer.
  - **Flukes** (strap around legs) – Provide the thrust necessary to move whales through the water.
  - **Blowholes** (put nose on top of head) – Blowholes are on the top of the head so the whale doesn't have to lift their whole head out of the water to breathe. Baleen whales have two openings in their blowholes, toothed whales have one.
  - **Combs** (optional- give to baleen whale only) – Baleen whales have sieve-like plates in their mouths that allow them to strain food out of the water (point out that toothed whales have teeth just like we do).
  - **Balloon** (optional- give to baleen whale only) – Many baleen whales grunt, squeal and moan to communicate with each other. They do not have vocal cords, but make noises by squeezing pouches of air near their blowhole, which creates vibrations (the whistles of toothed whales are produced in the same way). Demonstrate this by blowing up a balloon and letting the air escape slowly through a small opening in the neck.
  - **Clickers** (optional- give to toothed whale only) – Use the clickers to model echolocation. Have a second pair of clickers for yourself and stand several feet away from the student. Ask them to click their clickers a few times and then stop. Repeat the clicks with your clickers in the same pattern as the students. Explain that in the ocean, the return sound is not made by another whale, but by the original sound waves bouncing off objects in front of them. Whales "listen" for these echoes through a special reception system in their head and jawbone. ***You might omit this with very young children.***

Dismiss volunteers to their seats.

8. Let's see how much you know about whale adaptations! One of these adaptations helps the whale breathe air at the surface of the ocean. If you think it's baleen, raise your hand. If you think it's a blowhole, raise your hand. *(Instructor quickly counts correct responses to assess student understanding).*
If you guessed *blowhole*, you're right!

9. Both of these adaptations help the whale swim, but one of them is especially for steering. Which adaptation helps the whale turn right and left? If you think flipper, raise your hand. If you think fluke, raise your hand. (Count).
If you guessed flipper, you're right! The fluke goes up and down, pushing the whale forward through the water, but the flippers are for steering.

10. The two kinds of whales, toothed whales and baleen whales, are adapted to eat different things.
Toothed whales have teeth shaped like pegs—good for snatching food and swallowing it whole, or in a few small pieces. Toothed whales will fish, crab, and even other whales! *(click to show pic)*
Baleen whales, like this right whale do not have teeth. What do they have instead? (Baleen).
(Show real-life example. It's made of keratin, the same stuff that our fingernails are made of**)** It acts like a giant strainer in their mouth. The whale gulps up a huge mouthful of seawater and then pushes it back out through gaps in the baleen plates. But all the little shrimp, fish, and tiny sea creatures get stuck in the bristles of the baleen. Then the whales licks them off the baleen with its

giant tongue. Baleen whales are big – even bigger than many toothed whales, but they eat some of the tiniest creatures in the sea! *(Click to show pic).* They will travel long distances—thousands of miles—to find food.

11. Some adaptations are special body parts, like fins and blowholes. Other adaptations are special behaviors or abilities that help the whale survive.
These humpback whales are doing something really cool. They are working together to trap krill and small fish. All the whales swim in circles around the fish, while blowing lots of tiny bubbles. The bubbles surround the fish like a net, then the whales swim through and gobble them up. This behavior is an adaptation that helps them get food.
This sperm whale has a different way of getting food. It dives way down deep to find large prey, like this giant squid. While it hunts, the sperm whale can hold its breath underwater for up to two hours!

12. Whales are amazing creatures! Unfortunately, some human actions have hurt whales.
For many years, people of all cultures have hunted whales for food and to use their bones, baleen, and oil. During the 1700s though, hunting whales became even more popular. So many whales were hunted and killed that some whales, like this right whale, became *endangered*.
When a certain kind of animal is *endangered* it means there aren't very many of them left. Today there are only about 350 right whales alive in the world. If they were to all die, they would become *extinct*, gone forever.

13. Other human actions can hurt whales too.
Some fishermen, when fishing for tuna or other fish, use nets called drift nets. Whales can get tangled in these nets by mistake, then they can't get to the surface to breathe.
Other times, whales get hurt by human garbage in the ocean. They can get tangled or choke.

14. The good news is that human actions can also HELP whales! Stewardship means taking care of living creatures and their habitats so that they can survive.
In the 1940s world leaders got together and signed an agreement limiting the number of whales they could hunt and kill. Since people have stopped hunting them so much, many whale populations have been able to recover.
Here are some other people being stewards of whales:
This scuba diver is trying to help untangle the netting from this whale's fluke.
These volunteers just picked up trash from the beach, preventing it from hurting whales and other marine animals.

15. Can you give me any other ideas of ways people can practice *stewardship*, how they can help whales?

Appendix. Additional Info and FAQ:

How can a whale can hold its breath so long?

Whales have special adaptations that allow them to hold their breath for a long time.

- When whales breathe in, air fills in almost all of their lungs (when we breathe deeply, air only fills about ¼ of our lungs). They use the air in their lungs more slowly because their heartbeat gets slower when they dive.
- Whales' lungs are able to collapse when they go on a deep dive. Air is compressed in air ducts and nasal passages where there is no gas exchange with the blood. This prevents them from getting the bends and nitrogen narcosis, conditions which human divers have to contend with.
- Carrying oxygen: Marine mammals have a high concentration of oxygen-carrying cells in their muscles and blood.
- More blood equals more oxygen: Marine mammals have two to three times more blood than a human. Other adaptations also include a network of spiral blood vessels that act as reservoirs for oxygen rich blood. And, seals and sea lions store oxygenated blood in their extra-large spleen (which can be 45% of their body weight).
- Reticulating the blood: For extended dives the blood is shunted or recirculated to only the most essential organs, like the heart, lungs, and brain. How long a marine mammal stays underwater depends on the species, where it lives, and what it eats.

Why do whales sing?

Male humpbacks sing during the breeding season. Scientists believe that their singing serves a reproductive function, perhaps to attract mates, to establish dominance among males or to maintain distance between males. Other species do not sing songs like humpbacks and less is known about the meaning of the sounds that they do make. The noises of Right whales are probably used to communicate messages like "Her I am" and "Danger". The deep calls of Blue whales (they are sped up on the tape to make them audible to human ears) may allow them to communicate with each other across ocean basins. Today, shipping noise may be interfering with this ability.

Do whales sleep?

Whales do not sleep deeply like humans. This is because they have to think about breathing. Whales rest at the surface, bobbing up and down to breathe periodically. Scientists think whales and dolphins can rest one half of the brain at a time. Sometimes, whales are observed resting with just one eye open.

Do whales have ears?

Whales do not have external ears like humans. They have holes in their head, which lead to the internal ear. Their ears allow them to hear sounds that are much higher and lower than the human ear can pick up.

What do whales drink?

They cannot drink seawater because it is too salty. They get all of the fresh water they need as a byproduct of burning fat.

Are whales smart?

Many whales have complex social behaviors, such as cooperation, which suggests that they are very intelligent.

Appendix D: *Energy and the Environment Program Development Guide* Feedback Report

By Scott Pattison, OMSI Research & Evaluation Associate

As part of the Energy and the Environment (E&E) initiative, OMSI is creating a program development guide to inform the work of the program developers and educators throughout the Center for Learning Experiences (CLE). The goal of the guide is to describe the E&E initiative and provide OMSI educators and developers guidance and key steps for developing programming related to energy and the environment. OMSI's Energy and the Environment Coordinator has led the development of the guide, in collaboration with museum educators, evaluators, and program development staff. To inform this process, we collected feedback from staff on a draft of the guide during the 2011 Educator Summit and facilitated a debrief session after the summit to summarize participants' feedback. This report documents results from both the summit and the debrief meeting. A draft of the development guide is attached in Appendix a.

Methods

During the 2011 OMSI Educator Summit, a draft of the guide was presented to educators at one of the concurrent sessions. We asked participants of this session to complete a short feedback form, in addition to the session feedback on the summit questionnaire. Participants provided written responses to two questions: (1) what about the guide will be most useful for your work at OMSI and (2) what are some ways the guide can be improved. A project evaluator also took notes during the session to capture additional comments and feedback. So that the project team could respond more quickly to feedback, responses from the Energy and the Environment Program Development Guide session were provided directly to the project team. Session participants were aware that their comments would be available to other staff members. During the debrief meeting, the project team, including two project evaluators, the program developer who had presented during the concurrent session, and the Energy and the Environment coordinator, reviewed session notes and participant feedback and developed a list of suggested changes to the guide.

Results

In total, 11 participants provided feedback about what would be most useful about the program development guide. Ten participants also suggested ways that the guide could be improved. Few consistent themes emerged from participants' responses to what about the guide would be most useful for their work at OMSI. Four respondents discussed how the guide would help them align programs with OMSI's broader goals and with other programs developed across departments. Two respondents indicated that the guide would help make OMSI's larger goals and expectations clear. The complete set of responses is listed below:

- *It is a topic that is very important to me as an educator. I think as an educator it's important to keep in mind what people already know. Educators like examples and things that can be directly translated into what they do. In order to be most useful it should be directly applicable.*
- *This guide will not likely cross paths with my responsibilities as an on-call educator. It would be nice to be involved in program development, but it doesn't happen.*
- *The aligning with standards section will be the most useful for my work with camps.*
- *Networking resources with others in OMSI and outside partners.*
- *It would be starting point on how I would go about to develop a new program putting forth OMSI's expectations and goals while aligning new curriculum/or a new program with the public is important.*

- *The focus on how to develop programs for different audiences. All my previous teaching experience has used pre-existing programs so I don't have experience developing programs for specific groups.*
- *The key considerations for planning programs and the setting goals for programs and experiences will be the most helpful with planning curriculum.*
- *A clearer picture about what OMSI has in mind when it comes to education. With everyone on board and under similar guidelines it will be easier to transmit information.*
- *It will help guide me to create programs that are similar to the rest of the education dept.*
- *It seems like the first step towards more consistent and intentional program planning.*
- *The knowledge about the organization, collaboration across the museum in this area—resources available, ways to contribute from my own area.*

Responses were more consistent when participants discussed ways the guide could be improved. Seven of the 10 respondents suggested providing more examples, including example programs and projects and examples of OMSI partnerships through the Energy and the Environment initiative. The complete set of responses is listed below:

- *The guide could be more interactive, most people buy into pro environment, I would love to see models of integration of materials between different programs.*
- *At the moment the guide is very dense—the format could be changed so it's not just blocks of writing—it makes it a bit visually exhausting.*
- *Run through each section with example program/project. Simplifying network + integration ability.*
- *The guide can have some of the internal resources readily available to create/design new programs and access to previous (or current) programs/exhibits.*
- *More examples of specific topics/activities/programs.*
- *Adding more specific examples of OMSI's partnerships with E+E. Great ideas for field trips for classes.*
- *Just making sure the guide is clear on its goals.*
- *More detail on curriculum development.*
- *More examples/case studies, maybe in the appendix.*
- *More examples of what we are doing and plan to do—cooperation with industry, the Silicon Forest, other museums, etc.*

Discussion

The program development guide represents an important first step in OMSI's effort to increase the quality of the educational experiences it provides and align the goals of programs developed across CLE. The debrief meeting helped the team identify the strengths of the guide and possible ways it could be improved. Overall, the team felt that educators were interested in the guide. In particular, many educators recognized that the guide would help to align programs and activities developed throughout CLE with OMSI's strategic vision and goals. To support this, the Energy and the Environment coordinator mentioned that OMSI is developing a narrative around the E&E initiative. The team confirmed that the final guide would include a clear articulation of the goals, priorities, and core values for OMSI's E&E initiative.

Educators also seemed to value information about the content standards in the guide and suggestions on how to align their programs with those standards. Session participants had a number of questions and suggestions related to information about national standards; the importance of including specific examples in the guide; guide formatting, distribution, and sharing; and creating a list of partners OMSI has worked with for the energy and environment initiative.

Reviewing participant feedback also motivated the team to discuss several issues not specifically mentioned by educators. We discussed how different types of goals might be appropriate for different types of programs and experiences and that the guide should help educators choose appropriate goals. We also discussed how logic models might be introduced in the guide. During the concurrent session, the idea of logic models seemed to be new to most participants. Finally, the team highlighted the importance of communicating the process of program development in the guide, including the iterative nature of development and the importance of peer review.

Based on these discussions, the group identified several possible revisions to the draft guide.

- Include plenty of specific examples throughout the guide. The *Framework for Evaluating Impacts of Informal Science Education Projects*[1] provides an example of how this could be done.
- Include information about national standards in addition to Oregon state standards.
- Continue to look for ways to make the format of the program development guide more approachable and user friendly, including decreasing the amount of text.
- Consider including several examples of logic models in the guide, including an example tailored specifically towards program development rather than program evaluation. Use accessible language when presenting logic models.
- Provide both electronic and hardcopy versions of the final guide. Consider how the guide might become part of new staff orientation or ongoing professional development.
- Reference a list of partners that OMSI has worked with for the E&E initiative. Because this list would need to be frequently updated, it should be a separate document.
- Consider providing guidance to educators on how to select goals that are appropriate for different types of programs and experiences.
- Consider summarizing the development process and other take away messages in the guide as succinct sound bites (e.g., program development should be “iterative, collaborative, and based on best practices”).

[1] Friedman, A.J. (February 27, 2008). *Framework for evaluation impacts of informal science education projects: Report from a national science foundation workshop*. (Prepared under contract GS-10F-0482P). Arlington, VA: The National Science Foundation.

Appendix a. Draft Program Development Guide

DRAFT: Energy and the Environment Program Development Guide—v. 2.6.11

Introduction—How you can use this guide

This guide is intended to help OMSI educators—paid and volunteer—in planning, developing, and delivering a wide variety of programs, both in and outside of the museum. It's designed to be a quick reference that can be used by those with limited time and resources to spend creating new programs. For almost everything touched on here, more detailed information is available, and resources that can be used to access additional information are included in the appendix. While this guide is focused on OMSI's *Energy and the Environment* content, the information presented may be useful for creating programs on any topic.

OMSI's Focus on *Energy and the Environment*

OMSI has had a longstanding commitment to basing educational and business activities on a "triple bottom line" that takes into account environmental impacts, financial considerations, and social responsibility. These values have been influential in OMSI's effort to reduce the impact of the museum's operations (composting paper towels, purchasing part of our electricity from renewable sources) and to expand access to our educational programs (through programs like *$2 Days* and bilingual exhibits).

With our new strategic focus on *Energy and the Environment*, OMSI is building on this past experience with the "triple bottom line," taking our commitment to these ideas further**.** With *Energy and the Environment*, OMSI's goal is to become a leader in education on sustainability, renewable energy, and environmental science, reaching a broad audience and helping to foster the next generation of innovators in sustainable technologies.

We have also set a goal to play an active role in regional leadership on these topics, furthering our community's focus on sustainability while serving as an essential resource to help the public understand the science and technology underlying issues such as energy use and climate change. As we develop these new educational experiences, we will also continue our commitment to increase participation of Hispanic audiences through bilingual (Spanish-English)/bicultural educational opportunities and outreach.

Educational Goals and Key Messages

Through *Energy and the Environment* OMSI will provide unique opportunities for hands-on learning to audiences both inside and outside the museum. Our goals are to help people understand dynamic Earth systems, deliver experiences that spark people's imagination around topics such as renewable energy, and to help the public navigate the social, economic, and environmental considerations that are at the core of discussions about energy and sustainability.

The education we provide can

- Encourage informed decision making by increasing understanding of science-based issues
- Catalyze citizen action by providing tools and knowledge
- Help build skills and promote workforce development, including in renewable energy and other areas that are particularly relevant to the Northwest

With those in mind, *Energy and the Environment* topics include Earth sciences, the science behind environmental issues, and sustainable technologies. A number of *Energy and the Environment*-related projects at OMSI have already developed main messages (sometimes called "Big Ideas") that create a central theme. The Big Idea approach helps focus an exhibit or program by providing a filter that can be applied to each piece of content or experience by asking "does it support the Big Idea?"

Some examples of *Energy and the Environment* Big Ideas that have been created to date:

- "Renewable energy technology can convert energy from wind, water, and the sun into electricity that supports our daily lives." (Big Idea for the Renewable Energy permanent exhibit)
- "The living environment results from the interdependent relationships between the Earth as a physical system, humans, and their societies." (Classes programs)
- "Energy used in our daily lives comes from a variety of sources that have different impacts on the environment." (Museum programs)
- "We can cultivate a more sustainable community by building skills and making decisions that maximize positive impacts." (*Sustainability* project)

Aligning with Standards

In addition to supporting the work of classroom educators, there are a number of benefits OMSI programs can realize by aligning with accepted state and national education standards. By reinforcing the work of formal education and teachers, we can connect our programs with what learners may already know to create more effective programs while still providing a unique OMSI experience. Building those connections to students' prior knowledge is good educational practice. Standards developed by professional educators are also a good indicator of what is appropriate content for a given age, so consulting them can provide valuable feedback on what concepts a specific program should focus on and how they can best be presented.

- Relevant Oregon State Science Standards/National Science Standards
- American Association for the Advancement of Science strands
- The Oregon Environmental Literacy Plan

Key Considerations for Planning Programs

As you plan a new program, there are a number of key factors which will influence how you design the activities, the content you include, and the learning goals you establish. Not all of these considerations will play an important role in shaping each program, but they are worth taking time to think about.

- **Audiences**. Think about who your participants will be, including:
  - **Age range**. Will they all be the same age or will there be a mix of ages? The age of the audience will help determine what would be appropriate content and shape how you discuss the concepts at hand.
  - **Background**. Do the people you're trying to reach come from the same geographic area or from a variety of socio-economic situations? Try to create a program that is inclusive and targets your program's specific audience.
  - **Motivations**. Are participants taking part in the program because they are interested in the subject or because they want a specific experience?
  - **Prior knowledge**. Does your audience already have some information about the subject at hand? Are there key questions they hope to have answered or knowledge gaps they are hoping to fill?
- **Format and environment**. These are important considerations that will influence the tone you establish and the number of activities you can include. What you can effectively cover in a 10-minute demonstration will be very different from what can be included in an hour-long experience or a week of classes. It's also worth considering what other constraints you have—are there limited materials, limited space, a noisy environment?

- **Audience expectations**. Are they expecting to be entertained? To what extent do they expect to be active participants? (Most OMSI experiences engage the people who take part in a very hands-on way). It's worth considering what your audience may expect in terms of the experience.

Settings Goals for the Program or Experience

One of the most useful things you can do in planning a new program is to map out your specific goal for that particular experience: what specific knowledge or skill do you want your audience members to walk away with? It may be that you want the participants to better understand the fundamental science behind climate change (how CO_2 causes the Earth's atmosphere to warm) or encourage them to experiment with why some locations are excellent spots to put wind turbines and others aren't. For many programs, setting one or two goals is enough.

Once you have a general goal in mind, it can also be helpful to put it in terms of the learning impact you want to make. There are many ways to think about the learning impacts of your program. One system, described by the National Research Council, breaks science learning impacts down into six basic categories:

1. Developing interest in science (wanting to learn more)
2. Understanding science knowledge (e.g., grasping the big concepts)
3. Engaging in scientific reasoning (e.g., taking part in an inquiry-based process)
4. Reflecting on science (e.g., increasing understanding of how science results in knowledge)
5. Engaging in scientific practices (e.g., participating in the scientific process)
6. Identifying with the scientific enterprise (e.g., thinking of yourself as a scientist)

The idea of defining the learning results you want to achieve are a key part of using a logic model, a more formal way of organizing your thinking for an educational program. A logic model is a useful tool for walking through the process of planning a program and also provides a handy visual aid to refer back to as you move ahead with developing your ideas. A sample logic model is included in the appendix to this guide.

Best practices for Developing Programs

Identifying key strategies that make for effective educational programs is an active field of research. While there is no universally accepted set of "best practices," there are a number of research-based findings that can be helpful for planning and conducting programs. Here are a few key practices to consider.

Engage prior knowledge, interests, and abilities. Try to create your program in such a way that it helps people who participate make connections between what they learn with you and what they've learned in the past. This may mean trying to find out what students have studied in the classroom so you can build off of it or taking advantage of students' interests to help introduce new ideas.

Make programs interactive. This may seem like it goes without saying for an OMSI experience, but it serves as a good reminder that many people learn better when they're fully engaged in an activity. Creating opportunities for hands-on learning and for open-ended inquiry have been shown to be effective program strategies.

Create experiences that are welcoming to a diverse set of participants. Try to create programs that are accessible to a broad audience, including those with different abilities and backgrounds. Programs can be designed to be relevant to the target audience, but there are also tweaks to the delivery that can help build a stronger connection with a specific audience. Including a diversity of perspectives can also help programs have broad appeal.

Provide conceptual frameworks and big ideas, then provide multiple ways for participants to connect with these concepts. For most participants, facts will become more meaningful, and more memorable, if they are connected to an overarching concept. Understanding relationships between ideas and facts generally can lead to better learning.

<u>Taking Advantage of Other Resources</u>

OMSI has two divisions—the Research and Development division, which includes exhibit and program developers, and the Evaluation & Visitor Studies division—devoted primarily to creating and assessing learning experiences such as exhibits and programs. The staff in these two areas specializes in creating clear educational content that successfully engages the target audiences, has a focused message, and has a measurable effect on learning. They work closely together to plan, research, and assess the resulting learning outcomes.

Staff from these or other departments may be available for a quick review of content, and having their input can be helpful. Beyond these colleagues, any type of peer review, whether it comes from an educator, volunteer, or another staff person, can provide input that is valuable when developing and testing a new program.

Outside experts can also serve as a valuable resource for any project by reviewing the science content for accuracy, providing suggestions for activities, or relevant science to highlight. Many researchers, educators, and others are happy to provide their input for OMSI projects, and many have done so in the past. Contact the Energy and the Environment coordinator or an R&D staff person for help with identifying appropriate advisors and making those connections.

<u>Catalyzing Action, Handling Controversy</u>

With our new strategic plan, OMSI has set goals to provide education for informed decision making and to become a catalyst for actions that lead to a healthier, more sustainable world. Our impact in this area can come through providing tools and knowledge that enable visitors and program participants to take action on key issues. Some key considerations to keep in mind:

- Science (and science education) always takes place in a social, ethical, and political context.
- Trade-offs are a key part of many discussions about sustainability and environmental impacts (e.g., mercury in CFLs).
- It's not our goal to confront people or convert people to a certain way of thinking. As informal educators, we want to be engaging and serve those who are interested.
- Seek out advice or additional input for working with the public on topics you feel are sensitive. You should feel entirely comfortable with the subject matter of your programs.

While it's an area of ongoing research, many studies have shown that confronting people about the environmental impact of their behaviors or painting a portrait of "gloom and doom" are ineffective ways to reach people when it comes to environmental issues. Presenting environmental topics in this way can backfire, with people becoming more entrenched in their positions and shutting out new information and ideas.

In contrast, approaches that meet people where they're at—for instance, by engaging their curiosity, expanding their understanding of an environmental process, or helping them develop skills that they would need to adopt a new behavior—seem to yield better results. Research seems to show that many people are more receptive when large, complex issues are broken down into concrete segments or, in the case of behaviors, concrete steps that they can envision taking.

Appendix—Resources

- Specific citations for research on program practices
- Networks for professional development
- Websites for E&E-relevant information
- Universal Design/Accessibility research
- Resources: ASTC, ISEN, Informalscience.org, Exhibitfiles.org

Appendix E: OMSI Educator Summit Evaluation Report

By Scott Pattison, OMSI Research & Evaluation Associate

On February 28, 2011, the Science Education managers hosted a professional development summit for OMSI educators. The summit included an introduction, a group icebreaker activity, three concurrent sessions with three to four sessions offered during each timeslot, and an "educator death match" at the end of the day (see Appendix a for final summit agenda). As part of the Energy and the Environment initiative, we conducted an evaluation of the event in order to measure the extent to which it achieved its outcome goals and to gather feedback to inform future summits and other CLE professional development opportunities. The intended outcome goals of the summit, as determined by the summit planning team, were:

- Participants will feel that the summit was relevant to their work
- Participants will feel prepared to use the information provided during the summit
- Participants will feel that the summit met their personal goals and expectations for the event
- Participants will be more familiar with the work of other OMSI educators and resources at OMSI relevant to their work
- Participants will have fun

This report describes the results of the educator summit evaluation. Table 1 summarizes the key evaluation outcomes relevant to each summit goal. In general, the evaluation results suggest that the summit was highly successful. Other findings include: (1) educators desired more opportunities for dialogue and networking, (2) there is the potential to focus more on practice and skill-building during future summits, and (3) many educators are still not very familiar with other staff at OMSI and relevant OMSI resources. We describe these evaluation findings in more detail at the end of the report.

Table 1. Summary of evaluation outcomes, by summit goal

Summit goal	**Evaluation outcomes**
Participants will feel that the summit was relevant to their work.	• 64% of participants rated the summit overall as very relevant and 30% rated it as somewhat relevant. Ratings for individual sessions were similar.
Participants will feel prepared to use the information provided during the summit.	• 41% of participants felt very well prepared at the end of the event and 50% felt somewhat prepared. Ratings for individual sessions were similar.
Participants will feel that the summit met their personal goals and expectations for the event.	• 59% of participants felt the summit met their goals very well and 36% felt it met their goal somewhat well. • The majority of participants mentioned "meeting people" as both a personal goal for the summit and a success of the event. • Few participants mentioned collaborating with other staff members or learning education techniques as successes of the event, although these were described as personal summit goals by at least 40% of participants.
Participants will be more familiar with the work of other OMSI educators and resources at OMSI relevant to their work.	• 64% of staff reported an increase in familiarity with OMSI. • At the end of the summit, 26% of participants were very familiar with OMSI and 68% were somewhat familiar.
Participants will have fun.	• 70% of participants rated the summit overall as very enjoyable and 30% rated it as somewhat enjoyable.

Methods

We collected data through a self-administered questionnaire handed out at the beginning of the summit. The instrument included open- and close-ended questions to be answered at the beginning of the summit, after each session, and at the end of the event. A copy of the questionnaire is provided in Appendix b. In total, 54 participants completed the questionnaire, with a response rate of 88%[i].

Data Analysis

Data from summit questionnaires were entered into Excel, cleaned[ii], and exported to SPSS for analysis. We analyzed close-ended responses using descriptive statistics. For open-ended questions, we reviewed all responses and categorized them based on common, emergent themes[iii]. To protect the anonymity of participants, findings are presented in aggregate form only and direct quotes from open-ended responses are not included. Although division information was matched with survey responses, staff outside the evaluation division did not have access to the non-aggregated data. We described all of these confidentiality procedures to participants at the beginning of the summit.

Results

Overall Participation

Based on the sign-in sheet that was available at the beginning of the summit, 64 OMSI staff members attended the event. Of these, 54 participants completed and turned in the questionnaire. The largest group of these was from museum education (30%), followed by outdoor education/camps (28%), traveling programs (13%), and camp-ins/sub-ins (11%) (Table 2). Only one participant was not from a division listed on the questionnaire.

Table 2. Number of summit participants, by OMSI division.

OMSI division	No. participants	Frequency (n = 54)
Museum education	16	29.6%
Outdoor education/camps	15	27.8%
Traveling programs	7	13.0%
Camp-ins/sub-ins	6	11.1%
Planetarium	3	5.6%
Classes	2	3.7%
Submarine	2	3.7%
Evaluation	1	1.9%
R&D	1	1.9%
Other	1	1.9%

Educator Goals and Expectations

At the beginning of the event, educators were asked to write down their personal goals for the summit related to their work at OMSI. Table 3 shows the frequency of the themes that emerged from the responses. Almost two-thirds (65%) of participants discussed being interested in meeting and getting to know other OMSI staff. At a deeper level, many participants (41%) were interested in collaborating, sharing, supporting, and networking with other staff and other departments. Almost half of participants (43%) had goals related to learning education techniques, such as practicing new teaching strategies, becoming better educators, or getting ideas for new activities or teaching approaches. Just over a third of participants were interested in increasing their familiarity with other departments and OMSI in general. Complete descriptions of the response themes are included in Appendix c.

Table 3. Frequency of coded themes for educators' summit goals

Category	Frequency (n = 54)
Meeting people	64.8%
Learning education techniques	42.6%
Collaborating	40.7%
Increasing familiarity with OMSI	35.2%
Learning new things	9.3%
Standards	5.6%
Getting inspired	5.6%
Energy and environment	3.7%
Having fun	3.7%

Note. Participant responses could be coded for multiple code categories. All responses that were coded as "collaborating" were also coded as "meeting people."

Overall Session Feedback

At the end of the session, participants responded to a series of close-ended questions. They were asked to rate how relevant the summit was to their work, how prepared they felt to use the information provided during the summit, how well the summit met their personal goals and expectations, and how enjoyable the summit was. They were also asked to compare how familiar they were with the work of other OMSI educators and resources at OMSI relevant to their work before and after the event. Participants responded to these questions using a five-point rating scale, with one indicating a positive response and five indicating a negative response (e.g., "very relevant" through "not at all relevant").

Table 4 shows the frequency of responses for each of these questions. Overall, the summit was rated very highly across all the questions. Ratings were highest for how enjoyable the summit was. Seventy percent of participants said the summit was very enjoyable. Ratings were somewhat lower for how well participants felt prepared to use the information provided during the event. Less than half (41%) of participants felt very prepared and a small number of participants (9%) felt that they were not sure or not very well prepared to use the information.

Table 4. Frequency of participant ratings of summit overall

	Very	Somewhat	Not sure	Not very	Not at all	M	n
Relevant to work	64.2%	30.2%	3.8%	1.9%	0.0%	1.43	53
Prepared to use info	40.7%	50.0%	7.4%	1.9%	0.0%	1.70	54
Met goals	58.5%	35.8%	3.8%	1.9%	0.0%	1.49	53
Familiar with OMSI (before)	7.5%	41.5%	5.7%	39.6%	5.7%	2.94	53
Familiar with OMSI (after)	26.4%	67.9%	5.7%	0.0%	0.0%	1.79	53
Enjoyable	69.8%	30.2%	0.0%	0.0%	0.0%	1.30	53

Note. The wording of each question is provided in Appendix c. M = mean. n = sample size by question.

Based on participants' self reports, the summit clearly helped staff become more familiar with the work of other OMSI educators and relevant resources at OMSI. About half (49%) of participants felt they were very or somewhat familiar with OMSI before the summit, compared to 94% at the end of the event. Comparing these two questions by individual, 64% of participants indicated they had increased their familiarity with OMSI, while 35% indicated no change and 2% indicated they were less familiar with OMSI at the end of the event (Table 5). Because participants responded to both these questions at the end of the summit, these results represent educators' own perceptions of their change in familiarity.

Table 5. Change in familiarity with OMSI before and after summit

Change in familiarity	**Frequency (n = 52)**
More familiar	63.5%
No change	34.6%
Less familiar	1.9%

Note. Change in familiarity was determined by comparing how participants at the end of the event rated their familiarity with OMSI before and at the end of the summit.

Participants also provided open-ended feedback on what they were felt were particular successful aspects of the summit and on ways that future OMSI educators' summits could be improved. Tables 6 and 7 show the frequencies of common themes that emerged from responses to these questions. Aligned with their goals for the event, almost two-thirds of participants (62%) indicated that having a chance to meet and talk with other OMSI educators was an important success of the summit. Many participants (19%) also felt that having the chance to collaborate with other staff, including sharing, connecting, developing synergies, and networking, was a success, although the number was lower than for those who indicated collaborating was an important goal of the summit (see Table 2). Other successes included increasing familiarity with OMSI (19%) and appreciating the large group activities and opportunities for team building (15%). Notably, educators did not indicate that learning new educational techniques was a success of the event. Complete descriptions of the response themes are included in Appendix d.

Table 6. Frequency of coded themes for summit successes

Category	**Frequency (n = 52)**
Meeting people	61.5%
Collaborating	19.2%
Increasing familiarity with OMSI	19.2%
Group activities	15.4%
Specific sessions (curriculum sharing)	11.5%
Session information (general)	11.5%
Food	11.5%
Specific sessions (Cheryl)	7.7%
Session variety	7.7%
Format (general)	5.8%
Specific sessions (other)	1.9%

Note. Participant responses could be coded for multiple code categories. All responses that were coded as "collaborating" were also coded as "meeting people."

Participants also suggested ways that future OMSI educators' summits could be improved (Table 7). The most common suggestion (34%) was providing more opportunities for fostering dialogue among staff members and departments. Participants indicated a desire for more discussion opportunities during the summit, more time to interact and work with other staff, and more small group discussions. Many participants (32%) also had specific format suggestions, such as increasing the length of the summit or bringing in outside speakers (see Appendix e for the complete list of format suggestions). No single formatting idea was suggested by more than one or two respondents. Other common suggestions included making the sessions more relevant to educators' work (15%), such as by focusing on application or providing opportunities to practice new strategies or techniques, and encouraging more mixing of staff from different departments during the event (12%). Complete descriptions of the response themes are included in Appendix e.

Table 7. Frequency of coded themes for suggested improvements

Category	Frequency (n = 41)
Fostering dialogue	34.1%
Other format ideas	31.7%
More relevant	14.6%
Mixing departments	12.2%
Specific topic suggestions	12.2%
Problem with concurrent sessions	9.8%
Healthier food options	7.3%
More frequent summits	7.3%
More hands-on	7.3%

Note. Participant responses could be coded for multiple code categories.

Session Feedback

For each session that they attended, participants were asked to rate how relevant the session was to their work at OMSI and how well prepared they felt to use the information presented. In general, the sessions were rated highly (Table 8). Across all the sessions[iv], 61% of the ratings were "very relevant" and 29% were "somewhat relevant." Ratings were slightly lower for how well prepared participants felt to use the information. Across all the sessions, 44% of the ratings were "very prepared" and 41% were "somewhat prepared."

Table 8. Participant ratings of concurrent sessions

	Very	Somewhat	Not sure	Not very	Not at all	M	N
Relevant to work	60.53%	28.95%	7.24%	1.97%	1.32%	1.55	152
Prepared to use info	43.71%	41.06%	9.93%	1.99%	1.99%	1.74	151

Note. M = mean. n = sample size by question.

Comparing the ratings across the different sessions provides some idea of why participants rated particular sessions higher than others. Table 9 shows the average relevance ratings for all the sessions, organized from most relevant to lease relevant. The second *Oregon science standards* session was rated the most relevant, followed by *curriculum sharing*, *group dynamics*, and *inquiry*. Even those sessions at the bottom of the list had an average relevance rating less than three (i.e., participants were likely to provide ratings of "somewhat relevant" or higher).

Table 9. Relative ratings of individual sessions, organized by relevance to their work at OMSI

Session title	Relevant	
	M	n
Oregon science standards (2)[1]	1.18	11
Curriculum sharing	1.20	15
Group dynamics	1.24	21
Inquiry	1.25	12
Oregon science standards (3)	1.29	14
Nature of science	1.35	20
Engineering design	1.41	17
Energy and environment	1.88	8
Cultural competency	2.18	11
Planetarium sampler	2.33	15
Integrating evaluation	2.50	8

Note. 1 = very, 2 = somewhat, 3 = not sure, 4 = not very, 5 = not at all. M = mean. n = sample size. [1] The Oregon science standards session was offered twice. Numbers in parentheses indicate the concurrent session timeslot.

Table 10 shows the average preparedness ratings for each session, organized from most prepared to least prepared. The *nature of science* was rated the most highly according to this question, followed by *inquiry* and *engineering design*. The majority of sessions that were rated highly for relevance were also rated highly for preparedness. The top three sessions all included hands-on activities. Again, even the sessions at the bottom of the table were rated relatively highly.

Table 10. Relative ratings of individual sessions, organized by preparedness to use info presented

Session title	Prepared	
	M	n
Nature of science	1.35	20
Inquiry	1.55	11
Engineering design	1.62	16
Oregon science standards (2)[1]	1.64	11
Oregon science standards (3)	1.64	14
Curriculum sharing	1.71	14
Group dynamics	1.76	21
Planetarium sampler	1.87	15
Integrating evaluation	2.13	8
Cultural competency	2.27	11
Energy and environment	2.50	8

Note. 1 = very, 2 = somewhat, 3 = not sure, 4 = not very, 5 = not at all. M = mean. n = sample size. [1] The Oregon science standards session was offered twice. Numbers in parentheses indicate the concurrent session timeslot.

Results by OMSI Division

To explore differences by division, we grouped staff responses based on the recommendations of education managers. First, we compared "on-site" staff, including museum education, planetarium, submarine, evaluation, R&D, and other, and "off-site" staff, including camp-ins/sub-ins, classes, outdoor education/camps, and traveling programs. The sizes of these two groups were comparable. Of the 54 participants, 44% were classified as "on-site" and 56% as "off-site." We also looked at differences between the two largest groups of staff at the summit—museum education and outdoor education/camps. Museum education represented 30% of summit participants and outdoor education/camps represented 28%.

Overall, differences among these groups in their responses to questions 12 through 17 were small[v]. The largest difference was in how familiar participants from museum education and outdoor education/camps where with OMSI before the summit (Table 11). Over half of museum education staff indicated they were very familiar or somewhat familiar with OMSI, compared to 21% of outdoor education/camps.

Table 11. How familiar participants were with OMSI before the summit, by OMSI division

	Very	Somewhat	Not sure	Not very	Not at all	n
Museum education	0%	56.3%	12.5%	31.3%	0%	16
Outdoor education/camps	0%	21.4%	0%	57.1%	21.4%	14
Other	17.4%	43.5%	4.3%	34.8%	0%	23

Note. "Other" included all other participants not in museum education or outdoor education/camps. Cramer's V = 0.429.

There was also a difference in how enjoyable participants from museum education and outdoor education/camps rated the event (Table 12). Interestingly, "other" divisions rated the event as much more enjoyable than either museum education staff or outdoor education/camps staff.

Table 12. How enjoyable participants rated the summit, by OMSI division

	Very	Somewhat	Not sure	Not very	Not at all	n
Museum education	56.3%	43.8%	0%	0%	0%	16
Outdoor education/camps	53.3%	46.7%	0%	0%	0%	15
Other	90.9%	9.1%	0%	0%	0%	22

Note. "Other" included all other participants not in museum education or outdoor education/camps. Cramer's V = 0.388.

Discussion

Below we discuss key findings from the summit evaluation and potential ways that future OMSI educator summits could be improved.

1. The educator summit was highly successful

Evaluation results suggest that the educator summit successfully met the majority of its goals. Table 13 summarizes the key evaluation outcomes for each goal. Participants rated the summit particularly highly in terms of its relevance to their work at OMSI and how enjoyable the event was. Almost all of participants (94%) indicated that the summit was very relevant or somewhat relevant to their work at OMSI. All participants (100%) felt that the summit was either very enjoyable or somewhat enjoyable and the vast majority (70%) felt it was very enjoyable. Participants also indicated that the summit increased their familiarity with the work of other OMSI educators and relevant OMSI resources. Two-thirds of staff participants (64%) self-reported that they increased their familiarity with OMSI from before the summit.

Table 13. Summary of evaluation outcomes, by summit goal.

Summit goal	Evaluation outcomes
Participants will feel that the summit was relevant to their work.	• 64% of participants rated the summit overall as very relevant and 30% rated it as somewhat relevant. Ratings for individual sessions were similar.
Participants will feel prepared to use the information provided during the summit.	• 41% of participants felt very well prepared at the end of the event and 50% felt somewhat prepared. Ratings for individual sessions were similar.
Participants will feel that the summit met their personal goals and expectations for the event.	• 59% of participants felt the summit met their goals very well and 36% felt it met their goal somewhat well. • The majority of participants mentioned “meeting people” as both a personal goal for the summit and a success of the event. • Few participants mentioned collaborating with other staff members or learning education techniques as successes of the event, although these were described as personal summit goals by at least 40% of participants.
Participants will be more familiar with the work of other OMSI educators and resources at OMSI relevant to their work.	• 64% of staff reported an increase in familiarity with OMSI. • At the end of the summit, 26% of participants were very familiar with OMSI and 68% were somewhat familiar.
Participants will have fun.	• 70% of participants rated the summit overall as very enjoyable and 30% rated it as somewhat enjoyable.

Although still high, ratings were not as strong for how well participants felt that the summit met their goals and expectations and how prepared they felt to use the information provided during the event. Although 91% of staff felt very well prepared or somewhat prepared to use information, the proportion of staff that felt “very prepared” (41%) was lower compared to the proportion that felt the summit was “very relevant” (64%). The majority of staff (59%) did indicate that the summit met their goals and expectations very well. Based on the open-ended comments, the majority of summit participants discussed meeting and talking with other staff members as both a personal goal and a success of the event. However, only a few staff members mentioned collaborating with other staff members or learning education techniques as successes, although both these were described as personal summit goals by at least 40% of participants. Because the project team did not identify specific indicators for achieving the summit goals, these evaluation results can serve as a baseline for measuring the success of future educator summits and other OMSI staff professional development opportunities.

2. Educators desired more opportunities for dialogue and networking

Evaluation results suggest that future OMSI educator summits could be improved by providing more opportunities for dialogue, discussion, and networking among participants and between departments. When asked at the beginning of the summit what their personal goals for the event were related to their work at OMSI, almost half of participants (41%) discussed the importance of going beyond meeting other staff members and fostering more collaboration, sharing, integration, and networking within the OMSI education department. At the end of the summit, however, only 19% of participants felt that this was a success of the event. Fostering dialogue, including creating more opportunities for discussion among participants, was the most common suggestion for how future OMSI educator summits could be improved. During a project team debrief in April 2011, several team members suggested that this could be an important goal of future summits but that it would take more than a yearly, one-day workshop to foster collaboration and networking within and across departments.

3. There is the potential to focus more on practice and skill building

Another important goal of summit participants was to learn and practice new educational techniques, including becoming a better educator or teacher, getting ideas for new activities or teaching approaches, or learning about new resources related to teaching and education. This theme was discussed by almost half (43%) of participants. The theme was not mentioned, however, by any participant as a particularly successful aspect of the summit. Ratings for how well prepared participants felt to use the information provided during the summit, both in relation to the summit overall and individual sessions, were lower compared to responses to other questions. This suggests that participants may be looking for more practical information directly related to their work and more opportunities to practice using that information during the sessions. Notably, the sessions that were rated most highly for preparedness by participants (*nature of science*, *inquiry*, and *engineering design*) were all focused on educational approaches and included hands-on activities. Several participants (15%) specifically mentioned that they would like future summits to be more relevant to their work and more focused on application, practice, and teaching techniques.

During the April 2011 project team debrief, team members discussed whether skill building was a realistic goal for a one-day workshop. As several team members suggested, the workshop may be an opportunity to introduce new skills and techniques that educators continue to practice during their work and through other ongoing professional development activities throughout the year. The project team may also want to consider the relative importance of different summit goals, such as fostering collaboration and supporting skill building.

4. Many educators are still not very familiar with the work of other OMSI staff and relevant resources at OMSI

Although the majority of participants (64%) self-reported at the end of the summit that they were more familiar with the work of other OMSI educators and relevant resources at OMSI, there was still a relatively small proportion of staff (26%) who felt very familiar with OMSI at the end of the day. This is another potential focus of future OMSI summits. In addition, the project team could talk to educators about what it means to "be familiar with OMSI" and learn more about the types of information that would be most helpful to staff members. During the debrief meeting, the project team pointed out that the summit was the first day at work for several staff members in outdoor education and camps.

Acknowledgments
Special thanks to all the staff members that participated in the study and contributed to this report, including Elias Cohen and Liz Rosino.

Technical notes

[i] 64 total participants were registered by summit organizers as attending the event. This number excluded the two volunteers who came to observe parts of the event to determine whether or not it would be useful to invite volunteers in the future. Excluding the summit organizer (Randall Fastabend) and the summit evaluator (Scott Pattison), the total number of participants was 62. Based on this, the questionnaire response rate was 87.1% (54 ÷ 62 = 0.871).

[ii] During data cleaning, responses entered into Excel were double checked against the original questionnaires. Any handwritten responses that were not clear were reviewed by a second evaluator. We also randomly selected 11 (20%) of the questionnaires (every fifth questionnaire, starting on a randomly generated number between one and five) and double checked the data entry for those participants against the original questionnaires. During this process, only four small changes were made to the open-ended questions data and no changes were made to the close-ended questions data.

[iii] To analyze open-ended responses, one evaluator reviewed all participant feedback for each question and inductively developed codes and code descriptions focused on the manifest content of the responses. This process was similar to “initial coding” from grounded theory (Charmaz, 2006). A second evaluator than reviewed all the codes and responses to check that they adequately represented the data. The second evaluator did not feel that any changes needed to be made to the codes. The first evaluator then coded all the responses in SPSS. Each participant response could be assigned multiple codes.

[iv] Frequencies were calculated by summing the total number of ratings in each category (very, somewhat, etc.) for all the sessions combined. The unit of analysis, therefore, was the session response, rather than the participant, since each staff member provided ratings for multiple sessions.

[v] The strength of the relationships between participant responses and OMSI division categories were determined by calculating Cramer’s V effect sizes for contingency tables (Field, 2009). Only medium effect sizes are reported (Cramer’s V values less than or equal to 0.3, [Huck, 2008]).

References

Charmaz, K. (2006). *Constructing grounded theory: A practical guide to qualitative analysis*. Los Angeles, CA: Sage Publications.

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.) Los Angeles, CA: Sage Publications.

Huck, S. (2008). *Reading statistics and research* (5th ed.). Boston, M.A.: Pearson Education.

Appendix a. Summit Agenda

OMSI Educator Summit Agenda
Monday, February 28, 2011
OMSI Auditorium, Classroom 1, Classroom 2, Parker Room, Kendall Planetarium

8:15-9:00 All Attendees Sign In & Mingle Bingo
All educators are urged to volunteer for the Death Match.
Auditorium

9:00-9:45 Team Initiatives
Anne Armstrong, *Auditorium*

9:45 Summit Evaluation
Scott Pattison, *Auditorium*

9:50 Welcome
Nancy Stueber/Ray Vandiver, *Auditorium*

9:55 Introduction of Cheryl Kleckner, ODE Science Specialist
Marilyn Johnson, *Auditorium*

10:00-11:15 Concurrent Sessions 1
Curriculum Sharing
Randall Fastabend with Natalie Reynolds & Amanda Fisher, *Classroom 2*
How can we share best practices, establish common values, and support each other and retain our specializations? This session will start with a discussion of the commonalities of curricula and morph to tackle the greater topics of goals, approaches and values. This session will follow a freestyle methodology with a goal to establish connections and methods for sharing after the Summit.

Group Dynamics
Brian Berry and Anne Armstrong, *Parker Room*
Discuss the personality factors that influence the dynamics of a group learning session. Explore different OMSI-related situations to learn how you, the Educator, can positively influence your teaching experience. We are open to talking about classroom settings, lab settings, and beyond!

Engineering Design
Cheryl Kleckner, ODE and David Perry, *Auditorium*
The new Oregon Science Standards now include engineering design. This session will give you an opportunity to engage in an engineering design activity in the context of the Oregon science standards. Come prepared to participate in the engineering design process and have fun!

11:15-1:00 Working Lunch in Auditorium

12:15 Educator Death Match Teams Announced
Randall Fastabend, *Auditorium*

12:30 Zoom Whole Group Activity
Marilyn Johnson, *Auditorium*

1:00-2:15 Concurrent Sessions 2
Integrating Evaluation into Educational Programming
Liz Rosino, Nelda Reyes, and Sean Rooney, *Parker Room*

This session will introduce educators to evaluation and its value. The discussion will be focused around the collaborative evaluation process used in the recent evaluation of two energy and the environment-related reserved lab programs.

Cultural Competency
Marilyn Johnson and Kirsten Goldman, *Classroom 1*
This session will explore factors of gender, socio-economic status and multicultural dynamics at work in interactions among peers, museum audiences, educators and students. Addressing these dynamics can help us improve our communication and outreach to individuals underrepresented in STEM. Please come prepared to explore how these factors affect our own lives, even the hidden-in-plain sight culture of science.

Nature of Science
Annie Douglass and Elizabeth Dannen, *Classroom 2*
We are science educators, but what exactly is science and how do we investigate it? Using activities from the Lawrence Hall of Science's "Reflecting on Practice" professional development program, we'll investigate the process of science, how it works, and what it means to be "doing science."

OR State Science Standards
Cheryl Kleckner-ODE, *Auditorium*
Oregon has new diploma requirements and new science standards. This session will provide an overview of the new requirements and give you the opportunity to engage with these new requirements in the context of your work with Oregon students and teachers.

<u>2:15-2:30 Break</u>

<u>2:30-3:45: Concurrent Sessions 3</u>
Science Inquiry
David Perry and Steve Tritz, *Classroom 1*
Discuss some of the different types of the scientific inquiry and ways to integrate it into what we do at OMSI. Also learn about the ODE Inquiry process standards, including student work-samples, and brainstorm ways we can support formal education through our programs.

Planetarium Sampler
Jim Todd, *Kendall Planetarium*
Within the Center for Learning Experience, the Harry C. Kendall Planetarium provides unique educational planetarium shows to visitors. Integrated within the mission of OMSI, the Planetarium offers a variety of educational and entertaining multi-media presentations on astronomy, space science, and laser programs. These can also be expanded into development of community programs such as public star parties, special interests groups, astronomy clubs, and educational programs.

Energy & the Environment Program Development
Nate Lesiuk, *Parker Room*
Learn more about *Energy and the Environment*, a new focus area for OMSI's education programs, and contribute your thoughts to a guide intended to help education staff develop new E&E programs. This session will help jumpstart your thinking on how to engage your audiences with highly relevant science topics such as renewable energy and environmental sciences and help you connect to other projects happening across the museum.

OR State Science Standards
Cheryl Kleckner-ODE, *Auditorium*
Oregon has new diploma requirements and new science standards. This session will provide an overview of the new requirements and give you the opportunity to engage with these new requirements in the context of your work with Oregon students and teachers.

3:45-4:00 Break

4:00 Scott Pattison with evaluation wrap up
Auditorium

4:05-5:00 Educator Death Match – Doors Open, All staff invited
Auditorium

5:00 Closing Remarks
Nancy Stueber/Ray Vandiver
Auditorium

Appendix b. Questionnaire

February 2011 OMSI Educator Summit

PRE-SUMMIT QUESTIONS

1. In which OMSI division do you currently work the majority of the time (circle one)?

Camp-ins/sub-ins	Classes	Evaluation & visitor studies	Museum education
Outdoor education/camps	Planetarium	R&D	Submarine
Traveling programs	Volunteer services	Other:________________	

2. What are your personal goals for this educator summit related to your work at OMSI?

____

____

____

SESSION FEEDBACK

SESSION 1 Title:______________________________ Presenter:____________________

3. How relevant was this session to your work at OMSI (circle one)?

1. Very relevant 2. Somewhat relevant 3. Not sure 4. Not very relevant 5. Not at all relevant

4. How well prepared do you feel to use the information presented in this session (circle one)?

1. Very prepared 2. Somewhat prepared 3. Not sure 4. Not very prepared 5. Not at all prepared

5. Comments and suggestions: ______________________________________

____

____

SESSION 2 Title:______________________________ Presenter:____________________

6. How relevant was this session to your work at OMSI (circle one)?

1. Very relevant 2. Somewhat relevant 3. Not sure 4. Not very relevant 5. Not at all relevant

7. How well prepared do you feel to use the information presented in this session (circle one)?

1. Very prepared 2. Somewhat prepared 3. Not sure 4. Not very prepared 5. Not at all prepared

8. Comments and suggestions: ______________________________________

____

____

SESSION 3 Title:______________________________ Presenter:____________________

9. How relevant was this session to your work at OMSI (circle one)?

1. Very relevant 2. Somewhat relevant 3. Not sure 4. Not very relevant 5. Not at all relevant

10. How well prepared do you feel to use the information presented in this session (circle one)?

1. Very prepared 2. Somewhat prepared 3. Not sure 4. Not very prepared 5. Not at all prepared

11. Comments and suggestions: ______________________________________

____

____

Page 1 of 2

February 2011 OMSI Educator Summit

POST-SUMMIT QUESTIONS

Please answer the following questions in response to the summit overall.

12. How relevant was this summit to your work at OMSI (circle one)?

1. Very relevant 2. Somewhat relevant 3. Not sure 4. Not very relevant 5. Not at all relevant

13. How well prepared do you feel to use the information provided during the summit (circle one)?

1. Very prepared 2. Somewhat prepared 3. Not sure 4. Not very prepared 5. Not at all prepared

14. How well do you feel the summit met your goals and expectations for the event (circle one)?

1. Very well 2. Somewhat 3. Not sure 4. Not very well 5. Not at all

15. Before the summit, how familiar were you with the work of other OMSI educators and resources at OMSI relevant to your work (circle one)?

1. Very familiar 2. Somewhat familiar 3. Not sure 4. Not very familiar 5. Not at all familiar

16. At the end of the summit, how familiar are you with the work of other OMSI educators and resources at OMSI relevant to your work (circle one)?

1. Very familiar 2. Somewhat familiar 3. Not sure 4. Not very familiar 5. Not at all familiar

17. How enjoyable was the summit (circle one)?

1. Very enjoyable 2. Somewhat enjoyable 3. Not sure 4. Not very enjoyable 5. Not at all enjoyable

18. What do you think were some particularly successful aspects of the summit?

____

____

____

____

19. What are some ways that future OMSI educator summits could be improved?

____

____

____

____

Thank you for your help! Please return your questionnaire to Scott Pattison, ext. 4673.

Page 2 of 2

Appendix c. Coding for personal goals

Categories were developed from participants' responses to the question: What are your personal goals for this educator summit related to your work at OMSI?

Table D1. Coding categories and category descriptions for educator personal goals

Category	**Description**
Meeting people	Meeting and getting to know other OMSI staff.
Collaborating	Going beyond simply meeting other staff, as indicated by words such as collaborating, sharing, connecting, bonding, supporting, integrating, learning from, and networking. Implies response also coded as "meeting people."
Learning new things	In general, learning new things, finding out about new resources, engaging in professional development. Not coded if respondent indicated a more specific learning goal.
Learning education techniques	Learning and practicing new teaching strategies and techniques, becoming a better educator or teacher; getting ideas for new activities or teaching approaches; learning about resources related to teaching or education; learning about developing and evaluating programs.
Increasing familiarity with OMSI	Learning more about other departments, programs, OMSI and OMSI culture in general; becoming more aware of or familiar with the work of other departments and other staff at OMSI; understanding OMSI's broader education goals.
Standards	Learning specifically about using state or national standards. Implies that response also coded as "learning education techniques" if it was discussed related to teaching techniques or approaches or developing curriculum.
Energy and environment	Learning specifically about the topic of energy and the environment. Response also coded as "learning education techniques" if respondent discussed the topic of energy in the environment context of education.
Getting inspired	Becoming inspired to be a better educator; getting excited about working as an educator.
Having fun	Having fun, laughing, specifically during the summit.

Appendix d. Coding categories for summit successes

Categories were developed from participants' responses to the question: What do you think were some particularly successful aspects of the summit?

Table E1. Codes and code category descriptions for summit successes

Category	**Description**
Meeting people	Meeting other OMSI staff; getting staff together; talking, socializing, interacting, and mingling with other educators.
Collaborating	Going beyond simply meeting other staff, as indicated by words such as collaborating, sharing, connecting, integrating, developing synergies, discussing OMSI issues and mutual needs, and networking. Implies response also coded as "meeting people."
Increasing familiarity with OMSI	Learning more about other departments, programs, OMSI in general; becoming more aware of or familiar with the work of other departments and other staff at OMSI; understanding their role at OMSI; understanding OMSI's broader education goals; being able to explore the museum.
Specific sessions (Cheryl)	Specifically appreciating the presentations by Cheryl, including Engineering Design and Oregon State Standards.
Specific sessions (curriculum sharing)	Specifically appreciating the curriculum sharing session, either referred to directly or indirectly, such as roundtable discussion or curriculum info.
Specific sessions (other)	Appreciating specific sessions other than those presented by Cheryl.
Session information (general)	Appreciating the sessions in general, without indicating a specific session or topic. Not coded if respondent was more specific. "Format (general)" code used if respondent discussed the session length.
Food	Appreciating the food, including donuts and lunch.
Session variety	Appreciating the variety of sessions and the freedom to choose different sessions.
Group activities	Appreciating the large group activities and opportunities for team building, including icebreakers.
Format (general)	General appreciation of the summit format, including mix of format types and length of activities and sessions.
Other	Focus on application, people's attitudes, inspiration; teaching techniques; theoretical frameworks; timing; location.

Note: questionnaires were collected before the educator death match.

Appendix e. Coding for suggested improvements

Code categories were developed from participant responses to the question: What are some ways that future OMSI educator summits could be improved? Coding also included any suggestions from question #18.

Table F1. Code categories and category descriptions for suggested improvements

Category	Description
Fostering dialogue	A desire for more discussion opportunities among participants; more time to discuss, interact, and work with other staff; more small group discussions.
Mixing departments	More encouragement and opportunities for participants to meet and interact with staff in other departments, such as through longer breaks, more discussion time during sessions, mixing up staff at tables in auditorium, or small group discussions.
More relevant	Need to make the sessions more relevant to educators' work, focused on application, practice, and teaching techniques, tailored to staff needs; make sure sessions are relevant and updated in the future.
Specific topic suggestions	Ideas for specific session topics, such as Montessori, improving informal education for short programs (less than two hours), how the OMNIMAX and submarine work, how exhibits are created, how museum educators can contribute to R&D, improving OMSI in general.
Healthier food options	A desire for healthier food options, such as fruits and vegetables, protein.
More frequent summits	This event should be repeated; educator summits should be held more frequently in the future.
Problem with concurrent sessions	The possibility of attending all or more of the offered sessions, rather than having to choose during each timeslot.
More hands-on	Sessions and activities should be more hands-on and interactive; less lecture-based; use diverse presentation methods.
Other format ideas	For example, different location, two-day summit, outside speakers, longer sessions, more specific session summaries; map of museum, program demonstrations, more or fewer icebreakers, not taking the time to introduce the whole group. Coded for ideas that were represented by no more than one or two respondents.