NISE network™

NANOSCALE
INFORMAL
SCIENCE
EDUCATION

NISE Network Forum:
"Energy Challenges, Nanotech Solutions?"
Formative Evaluation

By Juli Goss and Elizabeth Kunz Kollmann

August 2011

Acknowledgements

Without the help of many people this evaluation would not have been possible.

Special thanks to:

- The NISE Network Forum Team, Larry Bell, Dave Chittenden, Veronica Garcia-Luis, Brad Herring, Marilyn Johnson, Troy Livingston, Jennifer Scott, David Sittenfeld, Sabrina Sutliff-Gross, and Amanda Thomas, for their help and support throughout the course of this evaluation; and

- Members of the NISE Network Evaluation Team, Marcie Bennie, Kirsten Ellenbogen, Scott Ewing, Amy Grack Nelson, and Christine Reich, for aiding in the data collection.

<div style="border:1px solid #555; padding:1em;">

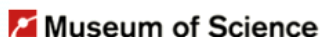**THIS IS A FORMATIVE EVALUATION REPORT**

Formative evaluation studies like this one often:

- **are conducted quickly**, which may mean
  - small sample sizes
  - expedited analyses
  - brief reports

- **look at an earlier version** of the exhibit/program, which may mean
  - a focus on problems and solutions, rather than successes
  - a change in form or title of the final exhibit/program

</div>

Research and Evaluation Department
Museum of Science
Science Park
Boston, MA 02114
researcheval at mos dot org
617.589.0302
© 2010

Table of Contents

Executive Summary

This study was conducted as a part of the formative evaluation of the NISE Network forum "Energy Challenges, Nanotech Solutions?" The purpose of the forum was to bring members of the public together to discuss how they would suggest that NSF distribute funding among three different energy-related research topics: nanotechnology-dependent energy, existing alternative energy, and conservation & energy efficiency.

During 2008, all five NISE Network Forum Team institutions (Exploratorium, Museum of Science, Museum of Life and Science, Science Museum of Minnesota, and Oregon Museum of Science and Industry) presented this forum at least once. As a part of the presentation of the forum, formative evaluation information was collected including registration surveys, participant documentation, pre/post exit surveys, observations, evaluator discussion debriefs, educator debriefs, video/audio tapes, and speaker follow-up emails. This information along with data collected through other sources was used to help the team modify and optimize the forum for participants and program educators. In addition, it was felt that the data collected could be used to help future forum educators and expert presenters understand the needs of potential forum audiences and gain advice from past forum educators.

Based on the results of the formative evaluation, advice to those presenting future "Energy Challenges, Nanotech Solutions?" forums includes the following:

- Balance the time allowed for the expert presentations and small group discussion because participants find both of these segments of the forum important.
- Make sure to use facilitation tools throughout the forum to keep the forum running on time and to ensure that participants keep on task.
- Make sure to explain the purpose of the forum and the different forum segments so that participants understand what they are being asked to do and feel that their involvement in the program is worthwhile.
- Make sure to work closely with speakers on their presentations to make it more likely that participants will learn from them.
- If at all possible, make sure the presentations cover the full range of content relevant to the discussion scenarios, including information about applications, risks & benefits, and research related to all three types of energy technologies (nanotechnology-based energy, existing alternative energies, and conservation & energy efficiencies).
- Make sure that participants encounter at least one nanotechnology-based energy discussion card during the small group discussion in order to encourage them to talk about nanotechnology.
- Make sure the participants clearly understand what they are expected to produce for the report-out so that they are not caught off-guard.

I. Introduction

About the Forum

The "Energy Challenges, Nanotech Solutions?" forum was created in 2008 by the NISE Network Forum Team. The professionals who comprise the NISE Net Forum Team represent the following institutions:

- Exploratorium, San Francisco, CA (Explo),
- Museum of Life and Science, Durham, NC (MLS),
- Museum of Science, Boston, MA (MOS),
- Science Museum of Minnesota, St. Paul, MN (SMM), and
- Oregon Museum of Science and Industry, Portland, OR (OMSI).

As a part of the creation of the forum, it was presented at each of the five forum institutions at least once between February and September 2008 (see Table A1 in Appendix A). The purpose of the forum was to generate discussion among members of the public about how they would suggest that NSF allocate funding between three categories: nanotechnology-dependent energy, existing alternative energies, or conservation & energy efficiency. These forums generally lasted two hours. During this time, participants learned about nanotechnology and its societal and ethical implications from experts, were able to ask the experts questions about their presentations, watched videotaped perspectives from three energy experts, discussed the pros and cons of allocating funding money to each of the three energy categories in a small group, and reported out to the larger group about their discussions including their final decision about how to allocate funding. The educational and programmatic goals for all NISE Network forums including "Energy Challenges, Nanotech Solutions?" are the following:

Overarching Goal: To provide experiences where adults and teenagers from a broad range of backgrounds can engage in discussion, dialogue, and deliberation by:

- Enhancing the participants' understanding of nanoscale science, technology and engineering and its potential impact on the participants' lives, society, and the environment.
- Strengthening the public's and scientists' acceptance of, and familiarity with, diverse points of view related to nanoscale science, technology, and engineering.
- Engaging participants in discussions and dialogues where they consider the positive and negative impacts of existing or potential nanotechnologies.
- Increasing the participants' confidence in participating in public discourse about nanotechnologies and/or the value they find in engaging in such activities.
- Attracting and engaging adult audiences in in-depth learning experiences.
- Increasing informal science educators' knowledge, skill, and interest in developing and conducting programs that engage the public in discussion, dialogue, and deliberation about societal and environmental issues raised by nanotechnology and other new and emerging technologies (NISE Network, 2007).

The materials needed to conduct this forum can be found at http://www.nisenet.org/. In addition, information about other NISE Network forums can be found on the website, in the *NISE Network Public Forums Manual* (NISE Network, 2007), and in the article "Fostering civic dialogue: A new role for science museums?" (Reich, Bell, Kollmann, & Chin, 2007).

About the Evaluation

As part of the creation of the "Energy Challenges, Nanotech Solutions?" forum, evaluators from the NISE Network Forum Team institutions (Museum of Science, Exploratorium, Science Museum of Minnesota, Museum of Life and Science, and Oregon Museum of Science and Industry) conducted a formative evaluation of the program under the direction of the Research and Evaluation Department at the Museum of Science. The purpose of the formative evaluation was to collect data from participants, forum educators, and forum speakers in order to understand what changes should be made to optimize the forum experience. Based on these findings, changes have been made which are reflected in the "Energy Challenges, Nanotech Solutions?" materials available on http://www.nisenet.org. Those changes included the following:

- The overarching question of the forum was modified so that it focused not just on nanotechnology-dependent energy but on all three funding categories (nanotechnology-dependent energy, existing alternative energies, and conservation & energy efficiency).
- The titles of the funding categories were changed so that participants could more easily understand the categories' corresponding technologies. For example, the category entitled "nanotechnology" was changed to "nanotechnology-dependent energy," the category entitled "non-nanotechnology dependent alternative energy" was changed to "existing alternative energies," and the category entitled "conservation, education, and improving existing conventional technologies" was changed to "conservation & energy efficiency."
- The discussion cards were distributed such that each table would be given at least one nanotechnology-based energy card during their small group discussion instead of distributing the cards randomly.
- The videotaped energy perspectives from the three energy experts were modified to include captioning.
- One of the videotaped energy perspectives was shortened to make it less repetitive.
- Additional information was provided about the background of NSF to facilitate the group discussion game. This was initially offered in a PowerPoint slide and later was delivered as a handout left on each table for the participants to share.

The other purpose of the evaluation was to create a program that could be easily disseminated to and used by museum professionals who had never conducted a forum program. The findings reported in this report reflect this second purpose of the formative evaluation. The analysis was conducted to help people who had never presented their own forum before to present the forum at their own institutions by presenting them with a description of experiences of the participants who came to the forums and the educators and speakers who presented the forums. This report provides information about why participants are likely to attend the forum, what reactions participants will likely have to the event, and what participants are likely to value and learn through their participation. The findings presented will also be useful to forum speakers who may want to understand the nanotechnology topics that are likely to interest participants as well as the level of information the participants need. Also included in this report is advice collected from the NISE Network Forum Team about how to run the "Energy Challenges, Nanotech Solutions?" forum. This information is presented to help program presenters understand what implementation techniques worked well for the forum educators as well as the challenges they encountered.

Based on the results of the formative evaluation, advice to those presenting future "Energy Challenges, Nanotech Solutions?" forums includes the following:

- Balance the time allowed for the expert presentations and small group discussion because participants find both of these segments of the forum important.
- Make sure to use facilitation tools throughout the forum to keep the forum running on time and to ensure that participants keep on task.
- Make sure to explain the purpose of the forum and the different forum segments so that participants understand what they are being asked to do and feel that their involvement in the program is worthwhile.
- Make sure to work closely with speakers on their presentations to make it more likely that participants will learn from them.
- If at all possible, make sure the presentations cover the full range of content relevant to the discussion scenarios, including information about applications, risks & benefits, and research related to all three types of energy technologies (nanotechnology-based energy, existing alternative energies, and conservation & energy efficiencies).
- Make sure that participants encounter at least one nanotechnology-based energy discussion card during the small group discussion in order to encourage them to talk about nanotechnology.
- Make sure the participants clearly understand what they are expected to produce for the report-out so that participants are not caught off-guard.

These findings and recommendations are based on the formative evaluation of the "Energy Challenges, Nanotech Solutions?" forum as conducted at the five institutions cited above. One should keep in mind that these findings may not be applicable to all institutions that choose to host this forum in the future. These forums were marketed predominantly to people who are museum members or on a museum email list so the audiences present at these forums were generally similar. However, we found that much of the data were consistent across institutions making it likely that similar results will also be found at other science centers and museums, particularly if the program attracts museum members or frequent visitors.

II. Methods

Data were collected in 2008 during the "Energy Challenges, Nanotech Solutions?" forums conducted by the NISE Network Forum Team. The purpose of the formative evaluation was to generate data that could be used to make informed changes to the forums and provide advice to future forum presenters. Multiple methods of data collection were employed including registration surveys, pre/post exit surveys, participant documentation, observations, evaluator discussion debriefs, videotaping, education debriefs, and speaker follow-up emails. By using multiple data collection methods, the evaluators were able to develop a more complete picture of the forum experience for visitors and educators (Table 1). Data collection instruments which other museums can use to conduct their own forum formative evaluations can be found in the *NISE Network Public Forums Manual* (NISE Network, 2007).

Table 1. Methodology matrix.

Evaluation Questions	Data Collection Instruments							
	Registration survey	Pre/post exit survey	Participant documentation	Observations	Evaluator discussion debrief	Videotaping	Educator debriefs	Speaker follow-up emails
What marketing methods are effective, and not so effective, at attracting audiences to the NISE Net forum events?	X	X					X	
What aspects of the program are valued by the key stakeholders?		X		X	X	X	X	X
What aspects of the program appear to contribute to the program's ability to achieve its stated goals?		X	X	X	X	X	X	
What changes should be made to the program so that it becomes cheaper and easier for other museums to implement?				X			X	X
How can the programmatic model be refined so that it better meets its goals and objectives and better meets the needs of program stakeholders?	X	X	X	X	X	X	X	X

Selection of Study Forums

Over the course of 2008, each NISE Network Forum Team institution committed to presenting the "Energy Challenges, Nanotech Solutions?" forum at least once. This report contains the data collected from six of the seven 2008 "Energy Challenges, Nanotech Solutions?" forums that were chosen for inclusion because they retained the original forum purpose of giving participants a chance to discuss how they thought NSF should allocate funding among three potential energy sources: nanotechnology-dependent energy, existing alternative energies, or conservation and energy efficiency. In addition, these six forums were selected because they represent all of the NISE Network Forum Team institutions (Exploratorium, Museum of Science, Museum of Life and Science, Oregon Museum of Science and Industry, and Science Museum of Minnesota). The forum times and locations from which data were collected can be found in Appendix A (Table A1).

Data Collection Methods

Methods of data collection used for the "Energy Challenges, Nanotech Solutions?" forum included registration surveys, pre/post exit surveys, participant documentation, observations, evaluator discussion debriefs, videotaping, education debriefs, and speaker follow-up emails. Given that each NISE Network Forum Team institutions operated under a different set of constraints, the institutions did not always collect data using all these methods. At a minimum, all the institutions were asked to collect data through pre/post exit surveys, participant documentation, observations, evaluator discussion debrief, and educator debriefs, but they did not always collect data through other sources. The information sources considered in this report include the registration surveys, pre/post exit surveys, observations, videotaping, speaker follow-up emails, and educator debriefs. The forums at which each data collection method was used can be found in Appendix A (Table A2).

Registration survey: The registration survey primarily served as a registration tool for the NISE Net Forum Team so that educators at each of the institutional sites knew who was coming to the forum. This survey was also used by the Evaluation Team to learn the participants' relationship to the topic, how they learned about the forum (through what marketing methods), and if they had a disability. The registration surveys were collected for five of the evaluation forums. In total, 61 surveys were collected from approximately 116 participants (53% return rate). This return rate is a result of the nature of the online registration system in that some people registered more than just themselves. Additionally, another reason for the lower rate of return is the fact that drop-in participants did not register before arriving.

Participant documentation: Materials generated by the participants during the event served as a source of visitor-generated data that was analyzed by the Museum of Science Research and Evaluation staff to determine how visitors thought their money should be allocated between nanotechnology-dependent energy, existing alternative energies, or conservation and energy efficiency. These materials were collected from 21 small group discussion tables at all six of the study forums.

Pre/post exit survey: This method focused on capturing information about who attended the forum, what they learned from the forum, and what they perceived to be the most valuable aspects of the experience. The exit surveys were collected at all six of the evaluation forums. In total, 97 surveys were collected from approximately 116 participants (84% return rate). Participants were given the survey at the beginning of the forum. The first side of the survey contained questions that participants were expected to answer before the forum, and the back side of the survey contained post-forum questions. Survey questions addressed participants' interests and backgrounds, recommendations for improving the program, what they learned and valued about the experience, and the clarity of the information presented during the forum.

Observations: Observational data provided insights on the topics and concerns the participants were most interested in discussing during the event. These notes were collected at all six of the study forums. Data recorded included content discussed by the speakers during their presentations, questions asked by the participants during the forum, what participants talked about during their small group discussion, and what the groups said were the major summary points from their small group discussion during the report-out.

Evaluator discussion debrief: At five of the six evaluated forums, evaluators observed one to two small group discussions. After observing a small group discussion, evaluators completed a debrief form that summarized the content discussed by the participants. In addition,

evaluators recorded how the small group used the discussion scenarios and whether the small group incorporated the expert presentations into their discussion.

Videotaping: Videotape data revealed insights on the quality of the small group discussions and detailed the types of topics the visitors discussed during the small group activities. The discussion at one table was videotaped during five of the six study forums. Participants were asked to give consent to be videotaped when they signed in at the forum. Those who did not agree were told that they could still participate fully in the forum, but they should avoid sitting at the table with the camera. The videotape was used by the NISE Network Forum Team after the forum to discuss the positive and negative aspects of the small group discussion and how it could be improved.

Educator debrief: In the days following the forum, program staff were asked to gather together to discuss their forum experience. Debriefs were conducted following all of the six study forums. Staff were asked to talk about their thoughts on the success of the forum, how they felt about their preparation for the event, their thoughts on the structure and format of the forum, and what changes they would recommend for future implementations of the program.

Speaker follow-up email: Within a week following the forum, speakers were contacted and asked to fill out an email survey. A reminder email was sent out a week after the first email. Using these methods, follow-up emails were collected from the speakers at five of the six evaluated forums. The survey asked the speakers what value they found in participating, how the museum helped them prepare, and how the museum could have better helped him or her prepare for the forum.

Data Analysis

By collecting data in a variety of ways, the evaluation team was able to triangulate the data. The logic behind triangulation is that "no single method ever adequately solves the problem of rival causal factors" (Patton, 2002, p.247). Therefore, if data is collected through many sources, evaluators can avoid the problems of a one-method study, which is "vulnerable to errors linked to that particular method (e.g., loaded interview questions, biased or untrue responses)" (Patton, 2002, p.248). Studies that utilize multiple methods allow "cross-data validity tests" (Patton, 2002, p.248), and thus reduce the likelihood that the evaluator will draw a false conclusion based on the limits of any one instrument. In this case, data from registration surveys, pre/post exit surveys, observations, video/audio taping, speaker follow-up emails, and educator debriefs were compared whenever possible to ensure that findings are not susceptible to error, and to allow for an exploration of differences among data.

Data collected through the instruments were both qualitative and quantitative in nature. Quantitative data were analyzed through descriptive statistics such as percentages, counts, and means. Qualitative data were analyzed using inductive coding. Inductive coding analysis involves "immersion in the details and specifics of data to discover important patterns, themes, and interrelationships" and allowing the coding scheme to emerge from the data (Patton, 2002, p.41).

III. Results and Discussion

In order to describe the visitors' experiences, the evaluation data are split into the following sections:

1. Why participants came to the forum and what they knew before attending,
2. Questions participants asked during the forum,
3. Issues participants discussed during the forum,
4. Outcomes reported by participants after the forum,
5. What speakers thought about their forum experiences, and
6. Advice for conducting the forum based on learning from the educators.

1. Why participants came to the forum and what they knew before attending.

The data collected from visitors before their participation in the forum indicate the following:

1. Participants came to the forum because they were interested in the topic of nanotechnology and wanted to learn about it.

2. Participants knew less about and felt less comfortable discussing nanotechnology than energy technology before the forum.

1.1 Participants came to the forum because they were interested in the topic of nanotechnology and wanted to learn about it.

The evaluation sought to figure out why participants were coming to the forum by asking them on the registration survey about their relationship to the forum topic of nanotechnology. Participants were given nine options to choose from. Over half of the surveyed participants (56%) said their relationship to the topic of nanotechnology was personal interest. The second most common response was that attending registrants' relationship to the topic was museum membership (43%). This means that, for most participants, their relationship to the forum topic of nanotechnology was not that they were a researcher/student studying science (11%), community/advocacy interest group member (11%), museum volunteer/staff (10%), educator/teacher (10%), researcher/student studying nano or a related topic (8%), or a NISE Network affiliate (0%) (Table 2). Instead, it seemed to be the topic of nanotechnology and a prior relationship with the science museum that were most likely to be participants' links to the forum topic.

Table 2. Participant responses to the registration survey question: "Describe your relationship to the forum topic" (N=61).[1]

	Number of Registration Respondents	%
Personally interested	34	56%
Museum member	26	43%
Other	8	13%
Researcher/Student studying science	7	11%
Community/Advocacy interest group member	7	11%
Museum volunteer/staff	6	10%
Educator/Teacher	6	10%
Researcher/Student studying nano or a related topic	5	8%
No Answer	2	3%
NISE Network Affiliate	0	0%

Another way we learned why participants were attending the forums was to ask them about their reasons for deciding to attend on the pre/post exit survey. Surveyed participants most often responded that they decided to attend in order to learn about nanotechnology (84%). Over half of the survey respondents also indicated that they decided to attend in order to learn about energy technologies (56%). Less than half of the survey respondents reported that a key reason that they decided to attend was because the forum sounds like fun (43%) or to hear others' perspectives (41%). Fewer than a quarter of the survey respondents said that other reasons were key in their decision to attend (Table 3). Similar to the responses on the registration survey, these data indicate that learning about the topics of the forum (nanotechnology and energy technologies) drove attendance more than any other reason.

Table 3. Participant responses to the exit survey question: "What are the key reasons you decided to attend this event?" (N=97)[2]

	Number of Survey Respondents	%
To learn about nanotechnology	81	84%
To learn about energy technologies	54	56%
Sounds like fun	42	43%
To hear others' perspectives	40	41%
Professional networking	23	24%
To meet people, socialize	16	16%
To share my ideas with others	15	15%
To get involved at the Museum	14	14%
Other	6	6%
No Answer	0	0%

---

[1] Percentages add up to more than 100% because participants were allowed to choose multiple question options.
[2] Percentages add up to more than 100% because participants were allowed to choose more than one reason for attending.

Finally, participants were asked on the pre/post exit survey an open-ended question about their expectations for the experience. Through this question, we learned that participant expectations of the forum were varied. However, once more, the most common response from surveyed participants was about learning. Nearly half the survey respondents (41%) reported that they expected to learn from the forum (Table 4). One person at the Museum of Science, Boston expressed that he/she "hope[d] to learn about alt energy." Another survey respondent at the Museum of Life and Science expected "to be more informed about [energy] alternatives and...new thinking in saving our planet." The data from all of these questions indicate that participant attendance is driven by a desire to learn.

Table 4. Participant responses to the pre/post exit survey question: "What do you expect this experience will be like?" (N=97)[3]

	Number of Survey Respondents	%	Example Quotes
I will learn.	40	41%	"Classroom setting w/no quizzes." (SMM)
No Answer	20	21%	--
It will have science content.	15	15%	"Learning about the production and application of nanoparticles. " (OMSI)
It will be fun/interesting.	14	14%	"Interesting…" (Explo)
I have no idea.	14	14%	"No preconceived notions." (MLS)
It will have a discussion.	8	8%	"Good discussion of the issues…" (SMM)
It will include interaction.	7	7%	"...Interactive…" (Explo)
Other	6	6%	"We got what we expected." (OMSI)
It will have a presentation and discussion.	5	5%	"An informative presentation followed by group discussion and reflection on the topic." (MOS 3.2)
It will have a presentation.	4	4%	"An interesting presentation…" (Explo)
I will hear others' opinions.	4	4%	"...hearing points of views from all walks of life" (SMM)
It will be intellectually stimulating.	4	4%	"...intriguing discussion" (MOS 3.2)
It will be challenging/confusing.	3	3%	"...challenging" (SMM)
It will have societal impact content.	2	2%	"... pros and cons of it." (MOS 3.2)
Hear/learn about different perspectives	2	2%	"...well crafted perspectives." (MOS 3.1)
I've been to a forum/science pub before.	2	2%	"Much like the nanotech one I did before." (OMSI)
It will be good.	1	1%	"Good" (SMM)
I will meet new people.	1	1%	"To meet people, socialize" (Explo)
It will be open-ended.	1	1%	"...open-ended" (Explo Survey #17)
A friend/family member brought me	1	1%	"...came along with my sister who is working on alternative energy." (MOS 3.1)
Content was different	1	1%	"Did not expect alternative energy to be nuclear as though nuclear is only important alternative energy." (Explo)
It was different than expected.	1	1%	"A few more people…" (MOS 3.2)

---

[3] Percentages add up to more than 100% because participants' answers sometimes could be applied to more than one coding category.

1.2   Participants knew less about and felt less comfortable discussing nanotechnology than energy technology before the forum.

Before participating in the "Energy Challenges, Nanotech Solutions?" forum, participants were asked to rank their agreement with a series of statements on the pre/post exit survey about their understanding of and their comfort expressing opinions about nanotechnology and energy technologies. When asked to rank their agreement with the statement "I have a strong understanding of nanotechnology," just over one-third of the surveyed respondents (37%) either agreed or strongly agreed. In contrast, almost two-thirds (61%) of the survey respondents either agreed or strongly agreed that they had a strong understanding of energy technologies (Table 5). These data show that few participants felt they had much knowledge of nanotechnology before the forum, but that nearly twice as many participants felt they had a strong baseline of knowledge about energy technologies before the forum. This corresponds with the previously stated participant responses for reasons for attending the forum as more individuals were interested in learning about nanotechnology than about energy technologies (Table 3).

Participants were also asked to report their comfort discussing the program topics before the forum. When asked to rank their agreement with the statement "I feel comfortable expressing my opinions on nanotechnology" on the exit survey, almost half of the surveyed respondents (49%) either agreed or strongly agreed. However, over three-quarters (78%) of surveyed respondents either agreed or strongly agreed with the statement asking if they feel comfortable expressing their opinions on energy technologies (Table 5). Data from these statements show that survey respondents felt less comfortable discussing nanotechnology than other energy technologies. However, it is interesting to note that for both of these statements at least half the survey respondents reported that they would be comfortable expressing their opinions. Additionally, it should be noted that while only about one-third of participants felt they had a strong understanding of nanotechnology, nearly half reported that they felt comfortable expressing their opinions about nanotechnology. These findings suggest that a lack of knowledge about nanotechnology does not necessarily prevent participants from feeling comfortable expressing their opinions about this topic.

Table 5. Participant responses to the pre/post exit survey questions about their understanding of and comfort talking about the forum topics.[4]

	% of Question Respondents Choosing: "Agree" or "Strongly Agree"	% of Question Respondents Choosing: "Disagree" or "Strongly Disagree"
I have a strong understanding of nanotechnology. (n=95)	37%	63%
I have a strong understanding of energy technologies.(n=95)[5]	61%	39%
I feel comfortable expressing my opinions on nanotechnology. (n=93)	49%	51%
I feel comfortable expressing my opinions on energy technologies. (n=95)[6]	78%	22%

[4] Participants were asked to rank each statement as "strongly disagree" "disagree" "agree" or "strongly agree". The data reflect only the surveys on which the question was answered.
[5] On MoS 3.1 survey the statement referred to "alternative energy" instead of "energy technologies".
[6] On MoS 3.1 survey the statement referred to "alternative energy" instead of "energy technologies".

2. Questions participants asked during the forum.

The question and answer session occurred during the forum just after the speaker presentations and expert videos. This component of the program gave participants a chance to ask the speakers clarifying questions about their presentations and the videotaped perspectives from three energy experts. The following analysis examines the questions that participants posed to the experts at all six of the study forums. This analysis includes all the questions that participants had for the speakers that related specifically to the forum topic of energy. Questions posed by participants that related to general nanotechnology topics can be found in the *NISE Network Public Forums Manual* (NISE Net, 2007).

Upon examination of the questions from the "Energy Challenges, Nanotech Solutions?" forums, it was discovered that participants from different venues often asked similar questions. The types of energy-related questions that were most often asked during the "Energy Challenges, Nanotech Solutions?" forum included the following:

1. Participants asked the experts about nanotechnology risks.

2. Participants asked the experts about nanotechnology research.

3. Participants asked the experts about applications of nanotechnology-based energy and other energy technologies.

2.1 *Participants asked the experts about nanotechnology risks.*

The most common questions asked by participants during the question and answer sessions at the forums were about the risks of nanotechnology. These questions were asked at five of the six forums. Participants of the Exploratorium, Museum of Life and Science, Museum of Science, and Science Museum of Minnesota forums were interested in learning more about risks related to nanotechnology research from the experts. Examples of these questions include,

> *You mentioned potential toxicity [from nanotechnology research]. What protection do you have from lawsuits? (Explo)*

> *How much research is being done on sunscreen with nano getting into the water? (MLS)*

> *The last speaker talked about two hazards of nano to toxicity... Are those the big two in terms of problems? Is anyone measuring and predicting these two problems? (MOS 3.1)*

> *About the health effects, do you wear any sort of masks or use a screen or a ventilator [when conducting research]? (SMM)*

Participants at the Exploratorium, Museum of Life and Science, and Museum of Science forums were interested in learning more about the environmental risks of nanotechnology applications from the experts.

What about recycling? Can you make monotones from recycled materials or can you recycle them? (Explo)

Are nano-products – like a bumper on a car – recycle-able? Will they go back into nanoparticles? (MLS)

Perhaps nanotechnology may be split into two parts. First part – things like solar cells, won't necessarily create waste, unless you are disposing of them. Second part – perfume part, which could create waste more. What kind of nanotechnology is not dangerous? (MOS 3.2)

2.2   Participants asked the experts about nanotechnology research.

Participants from four of the six forums asked questions about nanotechnology-based energy research. At the Science Museum of Minnesota and Museum of Science forums, participants were interested in learning from the experts about careers in nanotechnology and locations where research on nanotechnology-based energy is taking place.

Where are the centers of [research] excellence in terms of nanotechnology, in your opinion? (MOS 3.1)

How strong is a mechanical engineering school going into nano, versus just being about physics? Is this only something with people with Master's degrees go into right now? (SMM)

Do you get money from the IREE [Initiative for Renewable Energy and the Environment] group? (SMM)

Questions that participants asked during the Museum of Life and Science, Museum of Science, and Science Museum of Minnesota forums focused on learning more about research processes and practices.

I understand to do nanotechnology you have to lower the temperatures dramatically, and you would have to use energy? (MLS)

Is there cooperation in these three areas [nanotechnology-dependent energy, existing alternative energy technologies, and conservation & energy efficiency] or is it competition? (MOS 3.1)

[What] matters is where the metal comes from [like] cell phones and the republic of Congo. Where do these resources [for nanotechnology-based energy research] come from? Where does the gold come from for your research? (SMM)

2.3   Participants asked the experts about applications of nanotechnology-based energy and other energy technologies.

Participants at three of the six forums raised questions regarding energy technology applications. At the Oregon Museum of Science and Industry and Science Museum of

Minnesota, participants were interested in learning more from the experts about how nanotechnology might impact energy applications.

Are they currently using any of these nanotechnologies for motors or anything like that? (SMM)

Currently nanotech photovoltaics have less output than the wafer that are currently used? So maybe in five or ten years they could apply these into the spray paint in the cars? (SMM)

Do you think nanotechnology will have an impact on alternative energy in the future? (OMSI)

Participants at the Museum of Science and Science Museum of Minnesota were interested in learning more from the experts about energy applications that did not involve nanotechnology.

What is the theoretical efficiency you can reach in solar cells 15 years? (SMM)

On the question of transmission of electricity are there statistics on the loss of electricity from point A to B? (MOS 3.1)

If you invest in [conservation & energy efficiency] you get a big bang for your buck straight up. Is there a ceiling on the amount of efficiency you can get from a building? (MOS 3.1)

3. Issues participants discussed during the forum.

During the "Energy Challenges, Nanotech Solutions?" forum small group discussion, participants were asked to imagine that they were a member of the board of the National Science Foundation (NSF) and that they had to decide how $100 million allocated for energy funding should be distributed between research on nanotechnology-dependent energy, existing alternative energy, and conservation & energy efficiency. After looking at the transcripts created from the videotaped small group discussions at five separate forums, it appears that there were similarities in the discussions and arguments made across the forums despite the differences in the locations of the events and the people present at the tables. The arguments most typically seen in the small group discussions were the following:

1. Participants felt that funding decisions need to be made based on the timeline of when technologies will have an impact on energy issues.

2. Participants felt that funding decisions need to be made based on the ability of technologies to provide solutions to our energy problems.

3. Participants felt that some energy funding money needs to be used to educate the public because they impact energy consumption and technology adoption.

4. Participants felt that funding decisions need to take into account the cost of a technology in relation to its impact on energy issues.

5. Participants felt that funding decisions need to be made based on the risks inherent to the technology.

3.1   Participants felt that funding decisions need to be made based on the timeline of when technologies will have an impact on energy issues.

One argument that participants repeated during all five of the videotaped discussions from the "Energy Challenges, Nanotech Solutions?" forums was the importance of thinking about when technologies will be available when making decisions about energy funding. Some members of the small groups felt that we need to focus on funding short-term solutions because immediate answers are needed for our energy problems. For these participants, it was important to provide funding for conservation & energy efficiency and existing alternative energy technologies because these technologies will be able to quickly impact the energy field.

> *And for the conservation piece, obviously there are existing methods... There's still very much existing technology that can be easily implemented given the resources that could make a big impact. (Explo)*

> *Well, I allocated nearly half on existing [alternative energies] because we're looking for an immediate solution ...to improve our current technologies. (SMM)*

Additionally, these participants discouraged funding nanotechnology-based energy because these technologies will not be able to impact the energy field quickly enough.

> *...I still look at [nanotechnology-based energy] as the longest term. And I [think] that we add more [money] in [for] the short term issues to solve. (MLS)*

> *And then the nanotech stuff I think is great, but it seems to have like a 20 year, 15 year time horizon before it really becomes effective. (Explo)*

Other members of the small groups disagreed with this point of view and advocated providing funding to nanotechnology-based energy because they felt these technologies could provide long-term solutions to our energy problems.

> *...I think you just have to put some money in some of these screwball things, which I'd call the nanotechnology. You've got to look at them. (MOS 3.1)*

> *...[Nanotechnology-dependent energy] needs to be developed anyway for long term. (MOS 3.2)*

A final set of the small group members argued for the need to fund both short-term and long-term energy solutions because we need to think about creating change in how energy works both now and in the future.

> *So the nanotechnology world is kind of a pipe dream at this point. I think it's important to kind of keep those going while also cultivat[ing] the things that are going to be more [immediate]. (MOS 3.1)*

> *Let's make a short-term impact ...of conservation... Over time, shift more to nano but solve the short term problems [first]. (MLS)*

3.2 Participants felt that funding decisions need to be made based on the ability of technologies to provide solutions to our energy problems.

Another argument that came up during all of the videotaped small group discussions was that it is important to think about what impact the energy technologies will have on our energy problems when thinking about distributing energy funds. Some of these participants argued that it is important to focus funding efforts on technologies that have already shown some promise to provide solutions. These participants felt that nanotechnology-based energy should not be funded because it is still only theoretical.

> ...It's a little bit of a gamble to put everything into [nanotechnology-based energy]... (SMM)

> [Nanotechnology-based energy] may or may not work, and ...you need to keep moving it along... but you can't necessarily bet the farm on it. (MOS 3.1)

Instead, these participants felt that conservation & energy efficiency technologies as well as existing alternative energy technologies should be funded because these technologies are already available and could have a big impact on our energy problems.

> We found that conservation has its very important uses, and we want to focus a little bit more on the existing technologies to enhance solutions that are available right now. (MOS 3.2)

> ...I put $50 million in existing alternative energy category... because they have such good promises as a way to solve existing energy problems. We already know – they really have potential there. (Explo)

> I find the argument compelling that there is a great margin for progress in conservation & efficiency that we haven't tapped into. (MLS)

Another set of small group participants disagreed and argued that funding should be focused on new energy technologies because older technologies are not working to solve our energy issues. These participants felt that funding should be provided to nanotechnology-based energy because it has the potential to provide a breakthrough and is the evolution of past energy technologies.

> I loaded [funding] up on nanotechnology because I didn't see... the existing technologies as providing the kind of breakthrough that we're going to need in the next decade. (SMM)

> I think [nanotechnology-based energy] should be sufficiently funded, especially [since] we have the evolution of technology. (MOS 3.2)

Additionally, they felt that both conservation & energy efficiency and existing alternative energy technologies should not receive funding because they are obsolete and will only have a limited impact on energy problems.

> Like you were saying earlier...we already know a lot about conservation & energy efficiency...so it doesn't really need any more basic research. (Explo)

Well my problem with conservation is that conservation is – it's a very limited solution, because there's only so much you can consume. (MOS 3.2)

3.3 Participants felt that some energy funding money needs to be used to educate the public because they impact energy consumption and technology adoption.

During all the videotaped small group discussions, participants brought up that they felt that some energy funds need to be set aside to educate members of the public about energy issues. Some of these small group participants argued that the public needs to be educated about energy issues because they have the power to drive the adoption and use of energy technologies.

I put the most [money] in conservation and education because I think that the public is what's going to be driving this. And we need to get every – all of these ideas to the masses. And that's going to require a lot of education. (MOS 3.1)

I would put the five [million dollars] into conservation and education, because I think you now have to convince the public that joining forces with India [to build nano-based batteries] is a good thing. That could be a hard sell! (SMM)

Others felt that some money needs to be spent on educating the public about nanotechnology-based energy so that they embrace this new technology.

And that's where I think education comes in. That we have these technologies ready, but the public isn't necessarily ready to embrace them. (MOS 3.1)

...You need to show the public that you're making some progress with [nanotechnology-based energy]. And you're making real changes in peoples' lives to give the whole thing some momentum. (SMM)

Still other small group participants felt it is important to fund education about conservation & energy efficiency because changes in the publics' behaviors in regards to these topics can have an immediate impact on energy issues.

If we can – if a town as a society can teach their children to be consumers, we can also teach them to be conservationists as well, by alleviating ignorance. (Explo)

The thing about conservation I feel is, things like education... There's no group which is trying to tell us to insulate our house, for example, because that's so – in a way it's like technology which is not very fancy, it's sort of boring. But that's where I think education has the maximum value. (MOS 3.2)

3.4 Participants felt that funding decisions need to take into account the cost of a technology in relation to its impact on energy issues.

In addition to the previous topics, participants during all of the videotaped small group discussions argued that it is important to do a cost-benefit analysis when deciding how energy funding money should be divided. A few of these small group participants felt that it

is important to fund conservation & energy efficiency technologies because they will be cheap to implement and have a big impact on our energy problems.

> *So my thinking is that the biggest bang for the buck is the energy efficiency & conservation. I mean we're so inefficient out there that we could do a huge reduction of energy consumption and thus pollution by just taking a stab at that. (Explo)*

> *To implement an energy conservation plan [is] about essentially closing doors. It wasn't – it's not high tech... that's cheap too. (MLS)*

Others felt that funding needs to be provided to encourage the use of existing alternative energy technologies because they will off-set costs of energy produced using other technologies.

> *...I could see putting more money into the alternative technologies to accelerate ...the reduction in use of fossil fuels. (MLS)*

> *So it's an existing alternative technology that can help [if gasoline prices increase to $5/gallon]. (MOS 3.2)*

3.5   Participants felt that funding decisions need to be made based on the risks inherent to the technology.

Finally, during four of the five videotaped small group discussions, participants argued that it is important to think about the known and unknown risks of technologies when making energy funding decisions. All of these participants seemed to be most concerned about the potential risks related to nanotechnology-based energy. Some participants argued that some of the energy funding money needs to be used to study the environmental and health impacts of nanotechnology-based energy.

> *I would want to know about like materials handling and toxicity, confinement issues for nanotechnology. (Explo)*

> *I would argue whether it's friendly or not, those are – the arguments for it being non-friendly – that can justify more research, not less. (MLS)*

> *Well in one sense obviously if you look at this category of trying to encourage development of existing technologies, nuclear starts to go down in importance because of the accident [meltdown] when people were killed... (MOS 3.1)*

Other participants felt that independent of funding, nanotechnology-based energy needs to be under the oversight of a regulatory committee.

> *...There are some applications which...can be contained and there are overriding benefits, probably we should go with those first. Rather than letting anyone, at least in nanotechnology, [conduct research] without any regulation or oversight. (MOS 3.2)*

> *...Private industry has no impotence or motivation to actually deal with the long-term exposure issues. And I think that's where the government has to step in, to be able to handle that. (Explo)*

4. Outcomes reported by participants after the forum.

The data collected from visitors after their participation in the forum indicate the following:

1. Participants enjoyed their forum experience and valued the small group discussions.

2. Participants reported learning about nanotechnology through the forum.

3. Participants often suggested changing the forum in order to ensure that the nanotechnology content was clearer.

4.1 *Participants enjoyed their forum experience and valued the small group discussions.*

After the completion of the forum, participants were asked on the pre/post exit survey a series of open-ended and ranking questions about their experiences. Some of the ranking questions asked participants about their enjoyment during the forum. Almost all of the surveyed participants agreed that they enjoyed their experience (99%) and would recommend the forum to others (97%) (Table 6).

Table 6. Participant responses to the pre/post exit survey question: "Rate your agreement with the following statements about your experience at the forum."[7]

	% of Question Respondents Choosing: "Agree" or "Strongly Agree"	% of Question Respondents Choosing: "Disagree" or "Strongly Disagree"
I enjoyed the experience. (n=99)	99%	1%
I would recommend the forum to others. (n=86)	97%	3%

On an open-ended question on the pre/post exit survey, participants were asked what they valued most about their experience. The answers to this question showed that the small group discussion was the aspect of the forum most valued by the participants. The two most common responses that the surveyed participants gave were that they valued the diverse range of viewpoints (22% of survey respondents) and that they valued discussing with others (21% of survey respondents). One participant described this by saying that she valued, "talking with [her] group at [the] table…[as well as the] cross-section of participants" (MOS 3.1). Another participant at the Exploratorium said she valued "listening and sharing information with other participants." Fewer participants indicated that they valued the opportunity to learn (16% of survey respondents). One participant said, "[I valued the] education on nanotechnology" (MLS). Another said, "[I valued] the exposure to information about nanotechnology" (Explo). This indicates that, for the energy forum participants, the small group discussion was valued over the expert presentations (Table 7). This finding is similar to participants' responses to other forums (including "Risks, Benefits, and Who Decides?" and "Privacy. Civil Liberties. Nanotechnology.") in which more participants reported that they valued discussing with others and hearing a diverse range of viewpoints than the number of participants who said they valued the opportunity to learn (Kollmann & Goss, 2011; Kollmann, Reich, & Lindgren-Streicher, 2009).

---

[7] Participants were asked to rank each statement on a scale of "strongly disagree," "disagree," "agree," or "strongly agree." The data in this table reflect only the surveys on which the question was answered.

Table 7. Participant responses to the pre/post exit survey question: "What did you value most about this experience?" (N=97)[8]

	Number of Survey Respondents	%	Quotes
No answer	32	33%	--
Diverse range of viewpoints	21	22%	"I really enjoyed hearing other people's perspectives on issues that are very important to me." (OMSI)
Discussing with others	20	21%	"...Group interactions on allocating funding." (MLS)
Opportunity to learn/access to information	16	16%	"What I learned and intro to nanotechnology. Learning the pros and cons of nanotechnology…" (MOS 3.2)
Listening/access to experts	11	11%	"The information from experts…" (OMSI)
The topic of nanotechnology	7	7%	"...nanotech." (SMM)
Societal/ethical issues discussed	4	4%	"...discussing science and policy implications with other people in an informal setting…" (MLS)
The small group discussion and the experts	3	3%	"...a comfortable format to bring together community members to discuss topics & learn about them…" (Explo)
Other	3	3%	"Recommend the forum" (MOS 3.2)
The videotaped perspectives	3	3%	"...Hearing three speaker's perspectives." (MOS 3.2)
The game format	2	2%	"...game format is engaging and non-threatening." (MOS 3.1)
The opportunity for networking	2	2%	"Getting 'plugged in' to the alternative energy & nanotech community" (Explo)
The topic of energy/alternative energy	2	2%	"...on technology and energy." (MOS 3.2)
Meeting other participants	1	1%	"...interesting, intelligent community members…" (Explo)
The format	1	1%	"... a comfortable format…" (Explo)
Everything	1	1%	"Everything" (Explo)

4.2   Participants reported learning about nanotechnology through the forum.

The two learning goals that the NISE Network Forum Team had for the "Energy Challenges, Nanotech Solutions?" forum were the following: 1) participants would have an increased understanding of nanoscale science, technology, and engineering; and 2) participants would gain an understanding of its potential impact on the participants' lives, society, and the environment.

---

[8] Percentages add up to more than 100% because the answers participants gave sometimes fit into more than one coding category.

Across the six events included in this report, participants reported that they learned during the forum – specifically about nanotechnology. After the completion of the forum, participants were asked to rank their agreement with the statement "I feel more informed about nanotechnology." Most surveyed participants (92%) either agreed or strongly agreed with this statement. Additionally, three-quarters of the question respondents (75%) either agreed or strongly agreed that they felt more informed about the risks and benefits of nanotechnology-dependent energy due to the forum. However, fewer question respondents (64%) either agreed or strongly agreed that they felt more informed about energy technologies after the forum (Table 8).

Table 8. Participant ratings to pre/post exit survey question: "Rate your agreement with the following statements about your experience at the forum."[9]

	% of Question Respondents Choosing: "Agree" or "Strongly Agree"	% of Question Respondents Choosing: "Disagree" or "Strongly Disagree"
I feel more informed about nanotechnology. (n=88)	92%	8%
I feel more informed about energy technologies. (n=87)[10]	64%	36%
I feel more informed about the risks and benefits of nanotechnology-dependent energy. (n=88)	75%	25%

In order to gain more information about what participants learned, they were asked an open-ended question about what they learned from the forum that they did not know before. When added together, the responses about nanotechnology total 20% of all the responses to the open-ended learning question – more than any other topic. Looking at individual topics that visitors said they learned about, it was discovered that the most common response (12%) that surveyed respondents gave was that they learned about science and technology at the nanoscale at the forum. One participant said, "[I learned] some aspects of nanotechnology, specifically current developments and applications" (Explo). Another participant said that he "learned about the exact size of a nanometer, more about nanomedicine and nanotechnology in alternative energy" (OMSI). Other surveyed participants (11%) said they learned about the uses and applications of nanotechnology during the program. One of these participants said, "[Through the forum, I learned about the] pipeline of existing nanotechnologies" (MOS 3.1). Another described this saying, "[I learned about] nano-solar technology" (Explo). Other nanotechnology topics that visitors said they learned about included its risks, benefits, funding, regulation, and future directions (Table 9). This large portion of responses mentioning nanotechnology combined with the fact that the majority of participants feel more informed about nanotechnology indicates that the forum led participants to become more informed about nanoscale science and technology. The data also indicate that the program made visitors aware of the societal and ethical impacts of nanotechnology, although possibly to a lesser extent.

[9] Participants were asked to rank each statement as "strongly disagree," "disagree," "agree," or "strongly agree." The data reflect only the surveys on which the question was answered.
[10] On MOS 3.1 survey the statement referred to "alternative energy" instead of "energy technologies".

Table 9. Participant responses to the exit survey question: "What, if anything, did you learn from this forum that you didn't know before?" (N=97)[11]

	Number of Survey Respondents	%	Quotes
No answer	44	45%	--
About science/technology of nano	12	12%	"...some details of the technology, but less technical than I hoped." (SMM)
Uses of nanotechnology	11	11%	"...more about nano-medicine and nanotechnology in alternative energy." (OMSI)
About the risks of nano	10	10%	"...environmental and health concerns" (Explo)
What others are thinking	6	6%	"People view toward nanotechnology." (MOS 3.2)
About alternative energy or conservation	6	6%	"...J. Drake Hamilton had an intriguing perspective emphasizing conservation." (OMSI)
Lots of information	4	4%	"Many things…" (MOS 3.1)
Other	4	4%	"How nanotechnology should be a part of the solution" (Explo)
About current research	4	4%	"Status of some aspects of research." (SMM)
Societal aspects of nano	3	3%	"...Potential + and -." (MOS 3.2)
About the benefits of nano	3	3%	"More about the opportunities... nanotech & biotech offer and pose" (Explo)
Funding of nanotechnology	2	2%	"Lack of venture-capital motivation in basic nanotechnology research…" (MLS)
Regulations and policies of nanotechnology	1	1%	"...The need to refine the questions and scenarios to create institutions (like the orginal FNMA) to magnify the available money for research. The need to democratize scenarios as in Ontario energy policy." (Explo)
Future directions of nano	1	1%	"What hopefully will be a better future with nanotechnology." (OMSI)
Very little	1	1%	"Little." (OMSI)
Nothing	1	1%	"Nothing." (OMSI)
Advancement in science and technology	1	1%	"How rapid advance is headed." (SMM)
That I didn't know much about nano before	1	1%	"didn't know about nano" (Explo)
About the complexity of the issue	1	1%	"How complex energy is." (Explo)

---

[11] Percentages add up to more than 100% because the answers participants gave sometimes fit into more than one coding category.

4.3 Participants often suggested changing the forum in order to ensure that the nanotechnology content was clearer.

In order to learn what changes participants would suggest for the forum, they were asked an open-ended question. Looking at these responses, it was found that even though most participants reported that they learned about nanotechnology during the forum, they were most likely to suggest changing the content or topic of the forum (12% of survey respondents) (Table 10). One participant said, "[I suggest that the forum] needs more detail about production and application of nanoparticles from the live speaker and/or the video presentations" (OMSI). Another participant said, "[I suggest that the forum include] more detailed information on nanotechnology, higher level. [It needs] more technical description of actual applications" (Explo). Other surveyed participants (10%) suggested that the amount of time spent on different segments of the program should be changed. Of these ten responses related to time, eight mentioned adding more time for discussion while only two suggested adding more time for lecture. One participant said, "[I suggest] more time to discuss topics and options" (MOS 3.2). Another participant said, "[I suggest] more time for the first allocation discussion before getting to scenarios" (MLS).

Table 10. Participant responses to the exit survey question: "How could we improve the next forum?" (N=97)[12]

	Number of Survey Respondents	%	Quotes
No Answer	45	46%	--
Change the content/topic	12	12%	"More lecture on exactly what nanotechnology is. (more specific on how nanotech could be used and implemented.)" (Explo)
Change the amount of time spent on different segments of the program	10	10%	"...have more time for one speaker." (OMSI)
Change small group discussion scenarios	8	8%	"Make the purpose of the discussion/decision exercise more clear; perhaps more technical details…" (SMM)
Change the videotaped perspectives	7	7%	"...(3) For a tech topic, the video interviews/info was too bland and noninformative rather than provocative. " (MOS 3.2)
Change the discussion cards	6	6%	"...give us a card that instead of giving a new scenario, give us new identities as venture capitalists, etc…" (MLS)
Change the moderated discussion	5	5%	"Vary the experimental cards to see what happens & how far you can go with varied groups." (Explo)
Don't change a thing	4	4%	"It is very good as it is." (OMSI)
Provide information to the participants	3	3%	"When we registered, perhaps you could have suggested a website for us to view ahead of time to inform us in a simple way about what nanotechnology is…" (MLS)
Increase the number of participants	3	3%	"More people." (SMM)
Change the food service	3	3%	"Savory food along with sweet treats." (Explo)
Invite a broader range of/or different experts	2	2%	"It would be great to have more speakers…" (OMSI)
Other	2	2%	"Do it again practice makes perfect…" (Explo)
Change the format	2	2%	"Questions directly after Tim's presentation…" (MOS 3.1)
Provide more organizational structure	2	2%	"…Give more CONTEXT at beginning, and then visuals on screen of the steps of the overall process…" (MLS)
Change the audience to provide more balance or greater range	2	2%	"(1) Suggest seeding the forum with industry/academic professions…" (MOS 3.2)
Increase the marketing	2	2%	"Publicize" (MOS 3.2)
Provide other programming on nano or another topic	1	1%	"Do it again.. on other topics relevant to current issues & solutions." (Explo)
I'm not sure what to change	1	1%	"?" (OMSI)

[12] Percentages add up to more than 100% because the answers participants gave sometimes fit into more than one coding category.

Another way evaluators investigated possible recommendations for a successful forum was to ask participants to rank the clarity of different aspects of the forum (Table 11). Overall, participants thought the forum was clear with aspects of the small group discussion including discussion ground rules (91%) and questions to be answered (90%) seeming to be some of the clearer forum components. There is some modest room for improvement with the fewest number of respondents (73%) choosing either "clear" or "very clear" regarding the nanotechnology content. This supports the findings from the previous question which showed that participants wanted changes made to the nanotechnology content. These data together seem to indicate that part of the problem that participants had with the forum content was the clarity of the presentation of the nanotechnology content. In addition to the nanotechnology content, a relatively low number of question respondents also indicated that the purpose of the forum (75%) and purpose of the report out (85%) were "clear" or "very clear." The Forum Team has since addressed these recommendations for improvement in the forum's content as posted on the NISE Network website.

Table 11. Participant responses to the pre/post exit survey question: "How clear was the presentation of the following information?"

	% of Question Respondents Choosing: "Clear" or "Very Clear"	% of Question Respondents Choosing: "Somewhat Clear" or "Not at all Clear"
The purpose of the Forum (n=64)	75%	25%
The nanotechnology content (n=64)	73%	27%
The ground rules for discussing with others (n=64)	91%	9%
The question to be answered during the small group discussion (n=63)	90%	10%
The funding allocation game instructions (n=63)	87%	13%
The purpose of the report-out (n=62)	85%	15%

5. What speakers thought about their forum experiences.

Following the forum, the expert speakers were asked to complete an email survey about their experiences as presenters during the "Energy Challenges, Nanotech Solutions?" forum. The following analysis examines why the speakers felt it was important to participate in the forum and what the speakers valued about their experiences. Data include surveys collected at the Exploratorium, Museum of Life and Science, Science Museum of Minnesota, and two Museum of Science forums. The speakers, who answered these surveys, were both museum educators and scientists at local research institutions. While there were some differences in the speakers' forum experiences, it was discovered that there were commonalities in both why these speakers decided to participate and what they ended up valuing about the experience. Those commonalities included following:

1. Forum speakers decided to do presentations because they thought it was important to educate the public.

2. Forum speakers valued that the forum provided them with the opportunity to interact with the public.

5.1 Forum speakers decided to do presentations because they thought it was important to educate the public.

When asked why they felt it was important to participate in the forum, most of the speakers reported that they felt they needed to participate in order to educate the public. Speakers at the Exploratorium, Museum of Life and Science, and Science Museum of Minnesota felt they had an obligation to educate the public because of their status as "experts" and researchers.

I see a public obligation associated with the grants I have received. (MLS)

As a scientist who is informed about some 'hot' topics in R&D, I feel that it's part of my duty to the public to help get [the public] interested and informed about current technologies. (SMM)

As a scientist, I value the communication of the work conducted at research level in the lab to the general public. Since most of the funding we receive is from the federal government agencies, and ultimately the taxpayer, I strongly feel that involving the general public is of central importance. (Explo)

Speakers at the Museum of Science and Science Museum of Minnesota forums felt an obligation to participate to provide information that could help create a better informed public.

I think it's important for interested members of the public to have a chance to hear about frontiers in current science and technology research, and how the efforts underway at various research facilities may impact issues that matter to them. (MOS 3.1)

One of the most important components of building scientific advancements into everyday life is an informed and educated public. (SMM)

The forum program is a great way for members of the community to have a voice in scientific decision making and understand the challenges that science policy makers face in making such decisions. (MOS 3.2)

5.2 Forum speakers valued that the forum provided them with the opportunity to interact with the public.

When asked what they valued about their forum experiences, most of the speakers reported that they appreciated the opportunity to interact with the public. Speakers from the Museum of Life and Science, Museum of Science, and Science Museum of Minnesota found it valuable to be able to hear the participants' viewpoints and concerns.

I enjoyed speaking with people who were older and more varied than the student fare I get as a professor. (MLS)

[I valued] hearing the different points of view of the variety of people that were present. There were many different backgrounds and levels of prior knowledge [among the participants]. (MOS 3.2)

[Participating in the forum] makes me think about the real impact of scientific research, and understand what the public values, how they feel about what science has done (or failed to do) in their lives. (MOS 3.1)

Answering questions during the forum... helped illuminate [the participants] concerns and shed some light on how my field is being represented in the media-- as it turns out, there are mythical AND truthful components to the representation. (SMM)

Speakers from the Exploratorium and Science Museum of Minnesota valued interacting with the public so that they could help shape their understandings of the forum topic.

Answering questions during the forum... helped me to shape the understanding of the people present... (SMM)

[I valued] the speaker - public interaction. People have questions but not necessarily a place or a person to ask these questions to. Even in the age of Internet, a real person explaining a technology is really effective. In addition to this, having an interaction among the general audience as well, provides a great discussion that ultimately should give a better understanding of the matter. (Explo)

6. Advice for conducting the forum based on learning from the educators.

In the course of the evaluation, members of the NISE Network Forum Team were asked to discuss their experiences presenting the forums and provide advice about how they would suggest others present the "Energy Challenges, Nanotech Solutions?" forum. Included in this summary are the thoughts expressed by the Forum Team members and evaluators. Other information and advice from forum educators can be found in the *NISE Network Forum Manual* (NISE Net, 2007). While there were some differences in the experiences and advice of the Forum Team members, many similarities were discovered between the institutions. The data collected from programmatic staff about the forum indicated the following:

1. Targeted marketing assisted in lessening forum attrition rates.
2. The use of an agenda, timers, and discussion ground rules assisted the facilitation of the forum.
3. Working closely with the forum speaker before the forum increases the probability of a good expert presentation.

6.1   Targeted marketing assisted in lessening forum attrition rates.

Forum Team educators have often expressed their frustration that people sign-up for the forum and then do not attend the program. The energy forums at the Science Museum of Minnesota and Exploratorium had the lowest attrition rates of the six forums included in this report. In both cases, educators found that targeted calls and a follow-up email to interested individuals resulted in more registrants actually attending the forum.

With the lower attendance and the probability of low turn-out, [a staff member] called or emailed and tried to reach [the participants] personally to assess their commitment and encourage them to come...We find that calling helps. That is an issue of a free event. (SMM)

We did two different things to the marketing part. We added the targeted [marketing] in addition to what we usually do. I went back and sent the email to people [who attended past forums] who said they wanted [to be alerted about future programming]. (Explo)

6.2   The use of an agenda, timers, and discussion ground rules assisted the facilitation of the forum.

Forum Team members have found that including an agenda and facilitation aids are vital to keeping a forum program running smoothly. Educators from the Museum of Science and Science Museum of Minnesota reported the creation of a facilitator agenda helped them to keep the forum going according to plan. The educator at the Museum of Science found that it was helpful to have an agenda, even though it was time consuming to create it.

[The agenda] really helped [me] to spec out what would be happening when...the forum definitely felt calm. (MOS 3.1)

The educator at the Science Museum of Minnesota found that the agenda not only helped her to keep the forum running on schedule, but that it also helped her to remember what she needed to tell the forum participants during the course of the forum.

[I] put those cues on a separate card that lists what you say during the different parts of the forum. (SMM)

The NISE Net Forum Team members also used a number of other methods to help them facilitate the small group discussion without requiring a facilitator at each table. Educators at OMSI and the Museum of Science found that these facilitation aids were successful at making the small group discussion run smoothly.

Things [the educator] did that could work for others is putting pictures on the screens— showed the instructions [for the small group discussion] visually. I would encourage everyone to use [this method]. (OMSI)

I feel [having the small group discussion cards] enlivens the discussion and sort of acts as a facilitator that brings [the discussion] back to the main point. (MOS 3.2)

Some of the educators reported that they had success using a timer embedded within a PowerPoint to let the participants know how much time they had for each small group discussion section.

Using an electronic way of allowing the discussion to go forward worked well. [The PowerPoint] facilitated whole forum without needing facilitators. It helped to moderate activities without having to think about moderating them. (MOS 3.1)

NISE Network "Energy Challenges, Nanotech Solutions?" Forum Formative

Other educators reported that they felt frustrated that it seemed that participants did not read the instructions or aid materials that they left on the tables to provide facilitation to the small group discussion.

> "[The educator] put an ice-breaker note on the table, but no one used it. [We need to] instruct people to start by saying your name and why you are here." (SMM)

> What I tried to do yesterday [for] the wandering table [that was having trouble staying on task]... I asked them to write down [their funding allocation decisions] two times and after that I let it go. (Explo)

6.3   Working closely with the forum speaker before the forum increases the probability of a good expert presentation.

Forum Team members reported that it is sometimes difficult to make sure that speakers cover appropriate and desired content, but that working closely with the speakers on their presentations makes it more likely that the presentations will meet expectations. The individuals who served as forum speakers during the six study forums included both researchers from local universities and museum educators from the hosting institution.

According to debriefs conducted with the Forum Team, it is important to consider the following information when choosing your forum speaker and planning for their presentation. When choosing a forum speaker:

- Consider working with someone with whom you have worked before. This continued working relationship will allow you to know the speaker's style and possibly become more comfortable in offering advice.
- Whether choosing an outside speaker or coordinating with your in-house staff, provide background information and guidance to ensure that the speaker is prepared and able to include content that you deem important.

IV. Conclusion

The data presented in this report describes the experiences of the participants, speakers, and programmatic staff who participated in the "Energy Challenges, Nanotech Solutions?" forums. The original purpose of this formative evaluation was to provide the Forum Team with data that could be used to make informed changes to the forum. Between forum runs, the Forum Team made many modifications to "Energy Challenges, Nanotech Solutions?" based on the evaluation findings in order to optimize the forum for educators and participants including the following:

- The overarching question of the forum was modified so that it focused not just on nanotechnology-dependent energy but on all three funding categories (nanotechnology-dependent energy, existing alternative energies, and conservation & energy efficiency).
- The titles of the funding categories were changed so that participants could more easily understand the technologies they were referring to. The category entitled "nanotechnology" was changed to "nanotechnology-dependent energy," the category entitled "non-nanotechnology dependent alternative energy" was changed to "existing alternative energies," and the category entitled "conservation, education, and improving existing conventional technologies" was changed to "conservation & energy efficiency."
- The discussion cards were distributed such that each table would have to react to at least one nanotechnology-based energy card during their small group discussion instead of being distributed randomly.
- The videotaped energy perspectives from the three energy experts were modified to include captioning.
- One of the videotaped energy perspectives was shortened to make it less repetitive.
- Additional information was provided about the background of NSF to facilitate the group discussion game. This was initially offered in a PowerPoint slide and later was delivered as a handout left on each table for the participants to share.

The NISE Network Forum Team realized that much of the data generated could also be helpful to other programmatic staff who have not yet produced a forum at their own institution. The purpose of this report was to discuss the data results in a way that is helpful to these new forum presenters. Therefore, the data discusses the forum participants: what they know before the forum, why they decide to attend, what questions they ask the speakers, what they discuss in their small groups, what they learn from the forum, and what they value about the experience. The data also discusses the experiences of the expert speakers: why they decided to participate in the forum, and what they valued about their experiences. Finally the report discusses the experiences of the programmatic staff: how they felt about the marketing for the event, the expert presenters, and the small group discussion, and their advice for the presentation of future forums. Based on the data presented here, there are a number of things that programmatic staff, who have never presented a forum program before, should consider before presenting their own forum.

- Expect that most participants will come to the forum because they want to learn about nanotechnology.
    - Give the expert presentations and question and answer session just under half the forum time so that participants can optimize their learning.
    - Make sure to leave enough time for the small group discussion because this forum segment is also important to the achievement of forum goals and valued by participants.

- Whenever possible, cover content during the forum that is not just about nanotechnology but all of the energy topics covered in the small group discussion scenarios (nanotechnology-based energy, existing alternative energy, and conservation & energy efficiency).
  - o Participants are most interested in learning about nanoscale science, engineering, and technology, but they are also interested in learning about other energy technologies during the forum.
  - o For all of the energy technologies, participants are interested in learning about research efforts, current and potential applications, and their risks & benefits.
- During the discussion, participants tend to argue that energy funding decisions need to be made based on when and the extent to which the field/technology will impact energy issues.
  - o Make sure that participants understand the purpose of the small group discussion and report-out so that participants feel that their involvement in the forum is worthwhile.
  - o Because the main purpose of the forum is to have a discussion about nanotechnology, make sure that each small group is exposed to at least one nanotechnology discussion card.
- Most of the participants leave the forum having learned about nanotechnology and having valued their chance to participate in the small group discussion.
  - o Make sure to work closely with speakers on their presentations to make it more likely that participants will learn from them.
  - o Make sure to use facilitation tools throughout the forum to keep the forum running on time and to ensure that participants keep on task.

References

Kollmann, E. K., & Goss, J. (2011). *NISE Network forum: "Privacy. civil liberties. nanotechnology*." formative evaluation: NISE Network.

Kollmann, E. K., Reich, C., & Lindgren-Streicher, A. (2009). *NISE Network forum: "Risks, benefits, and who decides?" formative evaluation*: NISE Network.

NISE Network. (2007). *NISE Network Public Forums Manual.* Durham, NC: Museum of Life and Science.

Patton, M. Q. (2002). *Qualitative research and evaluation methods.* Thousand Oaks, CA: Sage Publications, Inc.

Reich, C., Bell, L., Kollmann, E.K., & Chin, E. (2007). Fostering civic dialogue: A new role for science museums? *Museums & Social Issues, 2,* 207 – 220.

Appendix A: Other Information about the Forums

Table A1. Dates and locations of the forums included in this evaluation.

Forum	Location Where Forum Took Place	Date
MOS 3.1	Museum of Science	2/12/2008
OMSI 3.1	Oregon Museum of Science and Industry	4/2/2008
MOS 3.2	Northeastern University, Boston, MA	4/3/2008
MLS 3.1	Museum of Life and Science	4/3/2008
SMM 3.1	Science Museum of Minnesota	5/21/2008
Explo 3.4	Exploratorium	9/18/2008

Table A2. Data collection instruments used at each of the study forums.

	Registration Surveys	Pre/Post Exit Surveys	Participant Documentation	Observations	Evaluator Discussion Debriefs	Video / Audio Taping	Educator Debriefs	Speaker Follow-up Email
MOS 3.1	X	X	X	X	X	X	X	X
OMSI 3.1		X	X	X	X		X	
MOS 3.2	X	X	X	X	X	X	X	X
MLS 3.1	X	X	X	X	X	X	X	X
SMM 3.1	X	X	X	X		X	X	X
Explo 3.4	X	X	X	X	X	X	X	X