NISE network™
NANOSCALE INFORMAL SCIENCE EDUCATION

Summative Study of the *Nano* Mini-exhibition

Summative Evaluation

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Executive Summary

In the spring of 2012, the Nanoscale Informal Science Education Network (NISE Net) Public Impacts evaluation team conducted a summative study of the *Nano* mini-exhibition: a 400-square foot, modular exhibition that will be replicated and installed at over 70 partner institutions. The Network's goals for *Nano* led to the following summative evaluation questions:

1. What is the projected reach of the *Nano* mini-exhibition?
2. Is *Nano* successful in providing visitors with an engaging experience and promoting visitor learning of nano concepts?
3. Is *Nano* successful in these ways for different types of contexts and for different types of audiences, including Hispanic visitors and visitors with disabilities?
4. Does *Nano* catalyze new or expanded public programming around nano at the host institutions?

These questions were answered through a range of methods, including a counting study, visitor observations, surveys, interviews, and questions asked to Network partners who currently had the mini-exhibition on display in January, 2013.

Findings

1. The estimated reach of the Nano mini-exhibition is sizeable and broad.

Conservatively speaking, an estimated 7.1 million people will come into contact with the mini-exhibition annually, assuming that a) all available copies are out on the floor, and b) all copies are displayed for an entire year, as required by the contract that all recipients sign.

2. *Nano* is successful in providing visitors with an engaging experience and in promoting visitor learning of nano concepts.

Visitor data across all study sites demonstrates that the mini-exhibition was successful across all of the indicators defined by the *Nano* design team, including sustained use, interest and enjoyment, social interaction, broad age range, further exploration, and learning about nano content.

3. *Nano* is successful within different types of institutions.

Examining the data by institution type reveals that *Nano* was successful in engaging visitors and promoting learning of nano concepts both in the science center context as well as the children's museum context.

4. *Nano* shows promise for being successful for Hispanic visitors and visitors with disabilities.

Small exploratory studies conducted at four institutions provide insight into the experiences of visitors from these audience groups within their local contexts. While broad generalizations should not be made from this data, *Nano* did appear to be successful with the specific visitors who participated in these studies.

5. Network partners say *Nano* is catalyzing new and enhanced programming.

The vast majority of partners who responded reported implementing new or expanded programming as a result of the mini-exhibition.

Introduction to the Summative Study of *Nano*

In the spring of 2012, the Nanoscale Informal Science Education Network (NISE Net) Public Impacts Evaluation group embarked on a three-year study to explore the public impacts of the most resource-intensive educational products developed by the Network. During this first year of the study, the Public Impacts Evaluation focused on conducting a summative evaluation of the *Nano* mini-exhibition, a 400-square foot, modular exhibition that will be replicated and installed at approximately 70 partner institutions. The Network established three broad goals for the mini-exhibition:

1. *Nano* will reach tens of millions of visitors during the life of exhibition copies.

2. *Nano* will create an environment that encourages engagement and learning for a broad public audience.

3. *Nano* will complement other nano learning experiences, including NanoDays.

By committing to the small footprint design and national distribution plans of *Nano*, the NISE Network took several risks. First, in order to achieve the desired reach numbers for the mini-exhibition, it had to be something that Network partners wanted to put out and keep on public display. Second, the mini-exhibition needed to be successful in a wide range of institutions that each drew an even wider range of visitors. Lastly, the mini-exhibition needed to effectively and efficiently communicate key messages about nano to visitors within a compact space. Together, the goals and risks of *Nano* led to the articulation of the following evaluation questions for the summative study:

1. What is the projected reach of the *Nano* mini-exhibition?

2. Is *Nano* successful in providing visitors with an engaging experience and promoting visitor learning of nano concepts?

3. Is *Nano* successful in these ways for different types of contexts and for different types of audiences, including Hispanic visitors and visitors with disabilities?

4. Does *Nano* catalyze new or expanded public programming around nano at the host institutions?

These questions were answered through a range of methods. A counting study, where data from counting tallies were combined with annual attendance records to project visitor contact with *Nano*, was performed during the summer of 2012 at seven initial host sites[1] in order to answer the first evaluation question and estimate the reach of the mini-exhibition. These initial host organizations – which are spread geographically across five NISE Network regions and include a range of institution types and sizes – were

[1] The seven sites included in the study were Arizona Science Center (Phoenix, AZ), Duluth Children's Museum (Duluth, MN), Oregon Museum of Science and Industry (Portland, OR), Port Discovery Children's Museum (Baltimore, MD), Sciencenter (Ithaca, NY), Science Museum of Minnesota (St. Paul, MN), and Science Spectrum (Lubbock, TX).

thoughtfully chosen by the Network Leadership in consultation with the NISE Network evaluation team in order to create a varied sample for the summative study. Further projections for the total number of visitors reached through all of the distributed *Nano* copies are based on the counting data collected at the original seven sites.

In order to answer the second and third questions, observations, surveys, and interviews were conducted during the summer of 2012 at five of the seven initial host sites in order to gather information about visitor use and learning. These instruments were purposefully aligned with indicators of success described in Table 1, which were articulated and refined by the *Nano* design team (NISE Network, 2012) through the design, development, and formative evaluation processes (Bequette & Van Cleave, 2011).

Indicator	Definition	Evidence
Sustained Use	Visitors stay in the exhibition a long time; some will make repeat visits.	Observed visitor dwell times. (Repeat visitation is not a focus of the current study.)
Interest and Enjoyment	Visitors find the exhibition fun and interesting.	Visitor responses to relevant questions.
Social Interaction	Visitors work together and talk about their experience.	Observed group use of components.
Broad Age Range	All ages are present and use the exhibition; different ages tend to use different parts.	Observed ages of visitors.
Further Exploration	Some visitors use materials such as panels, flips, and reading boards.	Observed visitor use of these elements.
Learning About Nano Content	Visitors take away key messages from the four areas of the NISE Network content map.	Visitor responses to relevant questions.

Table 1. Indicators of success for the Nano mini-exhibition.

Lastly, the fourth evaluation question was answered through the *Nano* mini-exhibition reporting survey sent to 41 Network partners hosting mini-exhibition copies as of January, 2013.

Summary of Findings

Finding 1: The estimated reach of the Nano mini-exhibition is sizeable and broad.

Based on counting tallies and annual attendance figures from seven different host sites, an **estimated 1.1 million people** will come into contact with the *Nano* mini-exhibition during a given year *at only those seven sites*. Considering the Network will create approximately 75 total copies, further estimation based on the counting study data and the annual attendance of the partner institutions selected to receive a copy suggests that **conservatively 7.1 million people** will come into contact with the mini-exhibition annually, assuming that a) all copies are out on the floor, and b) all copies are displayed for an entire year, as required by the contract that all recipients sign.

Further reach projections that estimate the total number of people who will come into contact with *Nano* over its lifespan feel premature at this point in time; the Network does not yet have a sense of how long partners will actually display *Nano*, and of course, these decisions would have a direct impact on the reach of the mini-exhibition. However, all of the 41 partners who have already received a copy of the mini-exhibition stated in their recent mini-exhibition reports that they **plan to keep or share *Nano* beyond the one-year commitment in the contract**, and 52% of partners indicated that they are planning on keeping Nano on their own floors indefinitely. Revisiting the reach projection for the lifetime of *Nano* in Year 10 of the NISE Network will be more appropriate, when a better understanding of the display patterns of partners can be used to inform reach estimates.

Potential Implications of Finding 1

The reach numbers for the mini-exhibition are quite large; for example, two popular traveling "blockbuster" exhibitions – *Titanic, the Artifact Exhibition*, and *BodyWorlds* – report attracting approximately 25 million and 35 million worldwide visitors respectively since they started touring in the 2000s[2,3]. In addition, unlike traveling exhibitions, the distribution plan for Nano includes many smaller cities that often are unable to draw blockbuster exhibitions due to the size of their local markets. Figure 1 provides an illustrative comparison of the tour sites for *BodyWorlds* and the planned distribution sites of *Nano*.

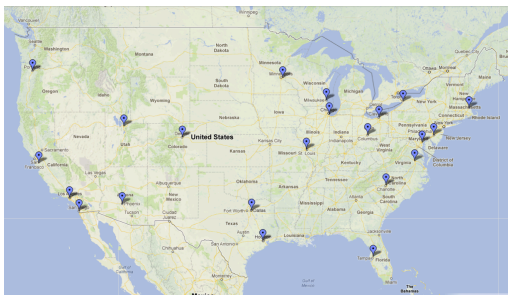

Figure 1a.
BodyWorlds traveling exhibition tour sites.

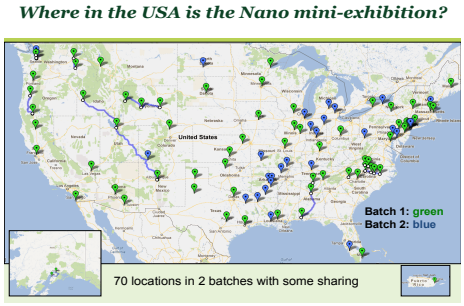

Figure 1b.
Distribution of Nano *across the NISE Network.*

Though not a focus of the current study, possible reasons for these high reach numbers emerged during data collection and analysis. One reason might be the small and flexible footprint of the mini-exhibition, which allows institutions to install the mini-exhibition in compact – yet very prominent – locations such as at an entrance or near a high traffic elevator, as was observed at two of the seven initial host sites. Another interesting aspect of the mini-exhibition reach was simply the high demand for *Nano* from the NISE Net partner institutions. The number of institutions who applied to receive a mini-exhibition was much greater than the original number of copies planned by the Network Leadership;

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[2] Institute for Plastination. (2013). http://www.bodyworlds.com/en/exhibitions/unparalleled_succress.html. Accessed March 12, 2013.
[3] RMS Titanic Inc. (2013). http://www.rmstitanic.net/about-us.html. Accessed March 12, 2013.

the Network decided to reallocate funds and commit to producing 70 copies of the mini-exhibition rather than the initial 50 planned due to high demand. Even with these additional copies, the Network still had to turn away partners as well as encourage sharing among some partners within geographic proximity of each other. This level of partner demand may suggest something about NISE Net partner perceptions of the quality of the mini-exhibition, the quality of work and products that partners have come to expect from NISE Net – touched on by the Network Communication Study (Alexander, Svarovsky, Goss, et al., 2012) and currently being explored further by the NISE Net Professional Impacts study – or perhaps the general rise in nano interest over the past few years.

The implications for NISE Net are numerous, as these reach estimates suggest that the mini-exhibition will be a prominent vehicle for reaching the public and presenting them with opportunities to engage with nano. Finding ways to leverage this reach – such as highlighting NISE Net programming that has been developed for the mini-exhibition, such as the Nano and Society activity developed for the *Balance Our Nano Future* exhibit component – may lead to even deeper public exposure to nano.

Finding 2: The *Nano* mini-exhibition is successful in providing visitors with an engaging experience and in promoting visitor learning of nano concepts.

Visitor data from all study sites (n=320 for surveys and interviews; n=418 for observations) demonstrates that the mini-exhibition was successful across all of the indicators defined by the *Nano* design team.

Sustained use. The average time spent by a visitor group within the Nano mini-exhibition was 6:07 (min:sec), and the median time was 4:00. Dividing the standard square footage of 400ft for the mini-exhibition footprint by the median dwell time leads to a Sweep Rate Index (SRI) of 100, which is approximately *four times greater* than the field average (Serrell, 1998; Yalowitz & Bronnenkant, 2009). Even if the mini-exhibition is installed in a larger space, the SRI is still well above average (at 500sq ft., the SRI is 125, still more than three times greater than the field average).

Interest and enjoyment. Almost all visitors reported finding the *Nano* mini-exhibition interesting and enjoyable for themselves (95% and 96% respectively). A subset of visitors were asked about the interest and enjoyment of the children in their group; 79% of those visitors reported that the youth in their group also found the experience interesting, and 87% reported the youth finding it enjoyable. The majority of visitors (71%) said they found *Nano* as or more interesting than other exhibits they had seen that day.

Visitor perceptions of the experience were overwhelmingly positive, with “interactive”, “informative”, and “family-friendly” being the most commonly selected as the ‘best’ word to describe the *Nano* mini-exhibition experience out of a list of ten positive and negative adjectives, and with 96% of all the words chosen by visitors being positive adjectives.

Social interaction. Group interaction was noted in 87% of the observations, strongly suggesting that one of the original design goals of the mini-exhibition – promoting group use of components during the experience – was accomplished.

Broad age range. *Nano* attracted visitors of all ages, as seen in Table 2. The range of visitors' observed ages was quite large , from 0 (infant) to 70+. Over half (55%) of visitors were also observed to be children, defined as being below the age of 18. Interestingly, the two largest age groups observed in the mini-exhibition were people in their 30s (19%) and children under the age of 5 (20%).

Age Range	Percentage
0-5	20%
6-8	17%
9-12	12%
13-17	6%
18-20	3%
21-29	5%

(a)

Age Range	Percentage
30-39	19%
40-49	10%
50-59	4%
60-69	3%
70+	1%

(b)

Table 2a & b. Distribution of observed ages within visitor groups; n=1207 across 418 group observations.

Further exploration. Visitors did explore the mini-exhibition beyond the hands-on activities. A majority of groups (70%) had at least one group member stop at least one panel. *Where Can You Find Nano? I Spy Nano* was the most visited panel, with over half (52%) of visitor groups being observed using it. Additionally, 62% of visitors who were interviewed reported noticing the flip panels, and the majority of visitors who noticed them said they had a positive effect on their experience within the exhibition. The books and reading boards were the least utilized of the "further exploration" components, with only 7% of visitor groups being observed using them.

Learning about nano content. Visitor learning goals were identified by the Nano design team and included in the goals document. These goals aligned most strongly with Strand 1 (*Developing interest in science*), Strand 2 (*Understanding science knowledge*), and Strand 6 (*Identifying with the scientific enterprise*) in the Learning Science in Informal Environments framework (NRC, 2009) while being simultaneously grounded in the four areas of the NISE Network content map:

1. Nanometer-sized things are very small, and often behave differently than larger things do.

2. Scientists and engineers have formed the interdisciplinary field of nanotechnology by investigating properties and manipulating matter at the nanoscale.

3. Nanoscience, nanotechnology, and nanoengineering lead to new knowledge and innovations that weren't possible before.

4. Nanotechnologies have costs, risks, and benefits that affect our lives in ways we cannot always predict.

In the summative study, focused learning on nano content was measured through a set of three specific questions posed to visitors. The first question had two parts: visitors were asked to rate their confidence in five items, each of which involved talking about and describing some aspect of the content map, before and after their mini-exhibition experience. Another question asked visitors to describe what they felt *Nano* was about overall. Finally, one last question asked visitors to describe what they would "tell a friend they learned at the exhibit today."

When asked to rate their confidence in describing and talking about five aspects of nano before and after their *Nano* experience, visitors showed a statistically significant increase in their confidence levels after using the exhibition. These increases are correlated with the total time visitors spend in the exhibition and the number of components they visit, suggesting an association between the exhibition experience and visitor learning.

In addition, 58% of visitors identified at least one area of the NISE Network content map when asked what they'd tell a friend they learned about nano at the exhibit, and 62% did so when they were asked what the exhibit was about overall. The distribution of how visitors responded to these two questions can be seen in Table 3.

NISE Net Content Map areas (n=320)	*What was the exhibit about overall?*	*What would you tell a friend you learned?*
Nanometer-sized things are very small.	11%	10%
Nanometer-sized things behave differently.	5%	9%
Nano is about manipulating things on the nanoscale.	7%	5%
New knowledge and innovation that weren't possible before.	19%	10%
Nanotechnologies have risks and benefits.	2%	2%
Nano is connected to our lives.	21%	24%
Other	5%	11%
General comments about science	19%	5%
I don't know	7%	8%
Nature/environment	4%	4%

Table 3. Summary of responses to two questions focused on learning of nano content within the visitor interview.

Lastly, 59% of visitors reported finding connections between their mini-exhibition experiences and their daily lives, which was also the most commonly referenced area of

the content map within the responses to the two questions listed above. This finding suggests that visitors found the mini-exhibition not only interesting (as seen in the second indicator above) but also relevant.

Table 4 provides an overview of the different indicators that contributed to Finding 2.

Indicator of Success	Indicator met?	Evidence
Sustained Use	Yes	Visitor dwell times were over 4 times greater than field wide average.
Interest and Enjoyment	Yes	Almost all visitors reported high levels of interest/enjoyment for themselves (95% and 96%); the vast majority reported high levels for the children in their group (79% and 87%).
Social Interaction	Yes	The vast majority of groups (87%) were observed interacting with *Nano* as a group.
Broad Age Range	Yes	Observed ages of visitors ranged from 0-70+; 55% were children.
Further Exploration	Yes	A majority of groups (70%) used at least one of these elements; over half (52%) used the Where Can You Find Nano? panel.
Learning About Nano Content	Yes	There were statistically significant increases in visitor confidence about nano; 58% mentioned at least one area of the NISE content map when asked to described what they learned.

Table 4. Summary of indicators demonstrating the success of the Nano mini-exhibition.

Potential Implications of Finding 2

The decision to go with a smaller footprint for the exhibition necessarily increased the need for exhibit efficiency and optimization. Given the findings on visitor use and learning, *Nano* appears to have accomplished these goals by providing visitors with an engaging experience through a small number of components with an accessible level and amount of nano content. This finding also has implications for the ISE field, where further study exploring these ideas of exhibit efficiency and optimization could be potentially useful. By providing evidence that much can be accomplished within a small space, the mini-exhibition may give institutions a reason to reflect on their exhibit design and installation practices. In addition, understanding how the mini-exhibition model – being small, nimble, flexible, and modular – works as a system can lead to the identification of key factors or leverage points within small exhibits that can be further optimized along a range of dimensions.

Finding 3: The *Nano* mini-exhibition is successful within different types of institutions.

Examining the data by institution type reveals that *Nano* was successful in engaging visitors and promoting learning of nano concepts both in the science center context as well as the children's museum context.

It is important to note that the goal of this analysis is NOT to compare science centers and children's museums to each other; rather, the aim is to demonstrate the success of *Nano* across all of the indicators defined by the Network in order to provide evidence that the mini-exhibition can accomplish its goals in a range of settings.

Science centers

Visitor data specifically from science centers (n=150 for surveys and interviews, n=209 for observations) demonstrates that the mini-exhibition was successful across all of the indicators defined by the *Nano* design team, as seen in Table 4.

The observed visitor groups in science centers were predominantly composed of adult-child groups (88%), though 12% of the groups were adult-only groups. Thirty percent of science center visitors reported hearing about nano "often" or "all the time", and 65% report a high level of interest in science.

The most commonly used component by science center visitors was *Small, Smaller, Nano*, with 82% of visitor groups having at least one member use it. The other two interactive components, *Build a Giant Carbon Nanotube* and *Balance Our Nano Future*, both had approximately 50% of visitor groups interact with each piece. Interestingly, 52% of visitor groups were also observed using the *Where Can You Find Nano?* panel; typically, panels are not as highly used as interactive components. In addition, 73% of visitors reported finding *Nano* as or more interesting than other exhibits they had seen that day.

Indicator of Success	Indicator met?	Evidence at Science Centers
Sustained Use	Yes	Visitor dwell times were nearly 4 times greater than field wide average.
Interest and Enjoyment	Yes	Almost all visitors reported high levels of interest/enjoyment for themselves (95% and 96%); the vast majority reported high levels for the children in their group (79% and 87%).
Social Interaction	Yes	The vast majority of groups (87%) were observed interacting with *Nano* as a group.
Broad Age Range	Yes	Observed ages of visitors ranged from 0-70+; 53% were children; the most common age range was 30-39 at 18%.
Further Exploration	Yes	A majority of groups (75%) used at least one of these elements; over half (52%) used the *Where Can You Find Nano?* panel.
Learning About Nano Content	Yes	There were statistically significant increases in visitor confidence about nano; 59% mentioned at least one area of the NISE content map when asked to described what they learned.

Table 4. Summary of indicators demonstrating the success of the Nano mini-exhibition at Science Centers.

Children's museums

Visitor data specifically from children's museums (n=135 for surveys and interviews, n=142 for observations) demonstrates that the mini-exhibition was successful across all of the indicators defined by the *Nano* design team, as seen in Table 5 below.

Not surprisingly, the observed visitor groups in children's museums were predominantly composed of adult-child groups (99%), with only one adult-only group being observed. Nineteen percent of children's museums visitors reported hearing about nano "often" or "all the time", and 52% report a high level of interest in science.

The most commonly used component by children's museum visitors was *Small, Smaller, Nano*, with 76% of visitor groups having at least one member use it. *Build a Giant Carbon Nanotube* was used by 58% of visitor groups, and *Balance Our Nano Future* was used by 54% of groups. Once again, use of the *Where Can You Find Nano?* panel was relatively high, with 44% of visitor groups in children's museums being observed using it. Finally, 77% of visitors reported finding *Nano* as or more interesting than other exhibits they had seen that day.

Indicator of Success	Indicator met?	Evidence at Children's Museums
Sustained Use	Yes	Visitor dwell times were over 4 times greater than field wide average.
Interest and Enjoyment	Yes	Almost all visitors reported high levels of interest/enjoyment for themselves (97% and 98%); the vast majority reported high levels for the children in their group (73% and 86%).
Social Interaction	Yes	The vast majority of groups (87%) were observed interacting with *Nano* as a group.
Broad Age Range	Yes	Observed ages of visitors ranged from 0-70+; 56% were children; the most common age range was 0-5 (26%).
Further Exploration	Yes	A majority of groups (72%) used at least one of these elements; 44% used the *Where Can You Find Nano?* panel.
Learning About Nano Content	Yes	There were statistically significant increases in visitor confidence about nano; 53% mentioned at least one area of NISE Net content map when asked to describe what they learned.

Table 5. Summary of indicators demonstrating the success of the Nano mini-exhibition at Children's Museums.

Potential Implications of Finding 3

The NISE Network knew that in order to work for the diversity of Network partners the mini-exhibition would need to be successful within a range of institutional contexts and physical configurations. The Nano design team worked to make the mini-exhibition modular and flexible, with a neutral look. The data for Finding 3 suggest that Nano is effective in both science centers as well as children's museums, two types of institutions that comprise the majority of the planned mini-exhibition recipients and typically draw from slightly different audiences.

Finding 3 has a potential impact on the ISE field overall. In a similar manner to how Finding 2 lays the groundwork for future inquiry, so does Finding 3; in particular, exploring what makes the mini-exhibition "transferrable" to different contexts – how it works within different Partner institutions, each with their own audience and institutional culture – may uncover key features that can be incorporated into future exhibits on other topics.

Finding 4: The *Nano* mini-exhibition shows promise for being successful for Hispanic visitors and visitors with disabilities.

The *Nano* design team sought to make the mini-exhibition more inclusive for Hispanic visitors and visitors with disabilities in specific ways, such as including Spanish

translations of all text throughout the mini-exhibition and making rich audio descriptions in English and Spanish of each component. The majority of visitors (73%) interviewed for the study reported noticing the Spanish translations; of those, 43% said the translations did not impact their experience, 30% said the translations had a positive impact, and 8% said the translations had a negative impact. About 27% of visitors noticed the availability of audio descriptions within the mini-exhibition; of those, 70% said the audio descriptions had no impact on their experience, 10% said they had a positive impact, and 15% reported not knowing what the icon meant. Only two of the 86 visitors who noticed the audio descriptions reported a negative impact.

Small exploratory studies conducted at four institutions focused on these two audiences begin to shed light on what the *Nano* mini-exhibition experience was like for Hispanic visitors and visitors with disabilities. Sample sizes for each of these visitor groups at the four institutions ranged from 12 to 25, and as such, broad claims cannot be made about the success of *Nano* for these groups. However, these data do provide insight into the experiences of visitors from these audience groups within their local contexts, which can not only inform future work in the NISE Network, but also contribute to the conversation about inclusivity within the ISE field.

Hispanic Audiences at Science Spectrum

Self-identified Hispanic visitors were observed, surveyed, and interviewed at two institutions: Science Spectrum in Lubbock, TX, and the Oregon Museum of Science and Industry (OMSI), in Portland, OR. Data collected from 21 Hispanic visitor groups at Science Spectrum suggest that for these visitors, the mini-exhibition was successful in providing an engaging experience and fostering learning about nano content. A summary of the indicators of success for these visitors can be seen in Table 6 below.

Indicator of Success	Indicator met?	Evidence at Children's Museums
Sustained Use	Yes	Visitor dwell times were over 6 times greater than field wide average.
Interest and Enjoyment	Yes	Almost all visitors reported high levels of interest/enjoyment for themselves (95% and 95%); the vast majority reported high levels for the children in their group (93% and 93%).
Social Interaction	Yes	The vast majority of groups (81%) were observed interacting with *Nano* as a group.
Broad Age Range	Yes	Observed ages of visitors ranged from 0-39+; 48% were children; the most common age range was 30-39 (28%).
Further Exploration	Yes	The vast majority of groups (86%) used at least one of these elements; 100% used the What Nano Means For Us panel.
Learning About Nano Content	Yes	There were statistically significant increases in visitor confidence about nano; 57% mentioned at least one area of NISE Net content map when asked to describe what they learned.

Table 6. Summary of indicators demonstrating the success of the Nano mini-exhibition at for Hispanic visitors at Science Spectrum.

While 47% of these Hispanic visitors said they found *Nano* less interesting than other exhibits they had seen that day, they still viewed their experiences in an extremely

positive manner, with 97% of adjectives chosen to describe their experiences being positive. Members of Hispanic audiences at Science Spectrum most commonly chose the word "informative" to best describe their experience, with 50% of these visitors reporting that choice.

Hispanic Audiences at OMSI

Data collected from 25 Hispanic visitor groups at OMSI suggest that for these visitors, the mini-exhibition was successful in providing an engaging experience and fostering learning about nano content. A summary of the indicators of success for these visitors can be seen in Table 7 below.

Almost all of these Hispanic visitors (94%) said they found *Nano* as or more interesting than other exhibits they had seen that day. Finally, in a similar manner to Hispanic visitors at Science Spectrum, Hispanic visitors at OMSI most commonly chose the word "informative" to best describe their experience, with over half of these visitors (56%) making that choice.

Indicator of Success	Indicator met?	Evidence at Children's Museums
Sustained Use	Yes	Visitor dwell times were over 8 times greater than field wide average.
Interest and Enjoyment	Yes	The vast majority of visitors reported high levels of interest/enjoyment for themselves (89% and 89%) and high levels for the children in their group (72% and 81%).
Social Interaction	Yes	The vast majority of groups (86%) were observed interacting with *Nano* as a group.
Broad Age Range	Yes	Observed ages of visitors ranged from 0-39+; 50% were children; the most common age range was 30-39 (26%).
Further Exploration	Yes	Almost all groups (93%) used at least one of these elements; 82% used the Where Can You Find Nano? panel.
Learning About Nano Content	Yes	There were statistically significant increases in visitor confidence about nano; 68% mentioned at least one area of NISE Net content map when asked to describe what they learned.

Table 7. Summary of indicators demonstrating the success of the Nano mini-exhibition at for Hispanic visitors at OMSI.

Language Preferences of Hispanic Visitors

In addition to observing component use and total time in the exhibition, all visitor groups at Science Spectrum and OMSI were observed for a language preference while interacting with *Nano*. As these groups completed their time in the exhibition and were approached by the interviewer to participate in the additional portions of the study, the interviewer asked the group in which language they would prefer to do the survey and interview. This self-reported language preference was recorded by the interviewer and used during the data analysis.

At Science Spectrum, most Hispanic groups actually preferred to do the survey and interview in English, while at OMSI, Hispanic groups typically preferred to do the survey

and interview in Spanish. However, just because groups self-identified with a specific language preference did not mean they were consistently observed using the exhibition in that language. For example, if a group used the exhibition primarily in Spanish and identified Spanish as their preferred language for the survey and interview, there were a few instances where that same group was also observed using the exhibition in English - and vice versa. Therefore, this evidence begins to suggest that having both languages present can be useful for bilingual groups, some of whom may choose to engage in both languages during their exhibition experience.

Visitors with Disabilities

Data were collected from visitors with disabilities at two locations including Port Discovery in Baltimore and Museum of Science, Boston (MOS). The data from Port Discovery are primarily school groups that included children with disabilities. School groups were not asked to complete surveys or interviews as it was not possible to gain parental consent for the child with a disability. At MOS, twelve family groups that included at least one person with a disability were recruited to participate in the study. Family groups at MOS were observed, surveyed, and interviewed.

Because the data for this exploratory study were collected using different protocols than the rest of the study, it was not appropriate to measure the success of *Nano* for this audience in the same ways and with the same indicators. Instead, data from both locations were analyzed in a more appropriate manner through the framework for inclusion set forth by Reich et al (2010). This framework suggests that inclusion in informal environments has physical, cognitive, and social dimensions. Learners in informal settings must be able to physically interact with and perceive the space, cognitively engage with available materials, and socially interact within the space for it to be successful.

Data collected from visitors with disabilities suggest that the mini-exhibition provides elements that impact inclusion across all three dimensions.

Physical inclusion. During the study, *Nano* was observed to promote physical inclusion by providing multi-sensory experiences, such as the smelling component on *Where Can You Find Nano? I Spy Nano* and the tactile quality of *Build a Giant Carbon Nanotube*. The mini-exhibit was also observed to promote physical inclusion by making it easier for visitors with disabilities to reach certain components and pull wheelchairs underneath some of the exhibit tables.

However, observations at both Port Discovery and MOS also identify the height of some components as the most apparent barrier toward physical inclusion. Specifically, visitors using larger scooters were observed not being able to pull under the panels, *Balance Our Nano Future,* and two of the three particle sizes at *Small, Smaller, Nano*. Visitors were observed pulling alongside these components and some created alternative formats for interaction such as having group members hand *Balance Our Nano Future* blocks to the person using a wheelchair. Other observed barriers to physical inclusion included visitors having difficulty reading the text on the standing panels and manipulating certain exhibit pieces that were hard to identify or assemble.

Cognitive inclusion. *Nano* was observed to promote cognitive inclusion in several ways. Children with disabilities both at Port Discovery and at MOS were observed making comments to group members that suggested cognitive engagement, saying phrases such as "I like!" (Port Discovery) about *Balance Our Nano Future* or "Come look!" (Port Discovery) or "Wow" (MOS) at *Small, Smaller, Nano*. Visitor interviews at MOS suggest that the exhibit content was also cognitively engaging for adults with disabilities as they reported that they enjoyed learning new content – and often mentioned learning a specific fact – from the exhibition.

However, barriers for cognitive inclusion were also observed. For example, several visitors were observed commenting that the *Small, Smaller, Nano* exhibit was "broken" when the different stations did not all provide the more visually stimulating experience provided by the ferrofluid at the "nano" station. Although noticing this difference is a goal of the component, visitors appeared frustrated and took turns using the station that "worked." In another example, one adult who is blind and used the audio description via iPod found it confusing and felt that it did not completely align with the exhibit experience.

Social inclusion. *Nano* promoted social inclusion both on the individual component level as well as the exhibition-wide level. For example, observations at both Port Discovery and MOS highlight how *Small, Smaller, Nano* provides a combination of social interaction and individual autonomy. While using this component, visitors engaged with one particle size as an individual experience while still acknowledging the particle sizes at the other two visitor stations. At Port Discovery and MOS, the building and teamwork nature of *Balancing Our Nano Future* and *Build a Giant Carbon Nanotube* resulted in several groups assigning roles or duties to different group members in order to complete construction together.

Visitors with disabilities seemed to appreciate the socially inclusive atmosphere provided by the mini-exhibition layout at both Port Discovery and MOS, each of which involved very different spaces and formations. For example, the quiet, closed off nature of the arrangement at Port Discovery provided a space for one child with a disability to spend approximately 25 minutes on the sofa while a large group of visitors loudly assembled outside the exhibition. At MOS, the design and layout of the space was identified as welcoming by a family with two adults who use wheelchairs, allowing them to engage with the exhibition in multi-modal ways together and as individuals.

Potential implications of Finding 4

Unpacking how the mini-exhibition worked for different visitors – particularly those who are underrepresented in ISE and STEM fields – can advance the field's understanding of how to reach and engage these audiences. Although these small exploratory studies cannot be broadly generalized, they do add to the understanding of the NISE Network, as well as the overall ISE field, about the role that specific aspects within the mini-exhibition can play in terms of inclusion. The NISE Network can use this information when designing future products and refer to these findings when engaging Network partners in discussions about making ISE experiences more inviting to a broader spectrum of visitors.

Finding 5. Partners report the mini-exhibition is catalyzing new public programming around nano and enhancing current programming efforts.

A thorough examination of how the mini-exhibition is generative and supportive of nano programming was not appropriate at this time, given that many partners had just received *Nano* when the data were being collected for this study and that it takes time for a new exhibition to be integrated into an institutional culture. However, data from the 2012 NISE Network mini-exhibition report does begin to shed light on impact Nano is having within partner organizations in terms of additional and expanded public programming.

All of the partners who received the mini-exhibition in 2012 responded to questions about changes in programming and the impact the mini-exhibition has had at their institution. The vast majority (87%) of partners who responded reported implementing new or expanded programming as a result of the mini-exhibition. In particular, partners reported that having the mini-exhibition led to having new or expanded demos, classes, events, and workshops for visitors. For example, one partner said:

> *[We have] drastically increased the amount of programming since the addition of the exhibit… The exhibit is a regular stop for field trips, where children participate in an experiment and scavenger hunt. In the fall, [we] launched an after school program, serving 45 children grades Kindergarten through 2nd. This spring, a traveling version will go out to schools… serving 360 children. [We have] also hosted a "Meet a Nanoscientist" event and will host [an additional program] in conjunction with NanoDays 2013.*

Another partner shared:

> *We hosted an Exhibit Opening reception in August of 2012, which was attended by our State Senator. We have created a Traveling Exhibit program and have planned to visit two more schools with our copy of the exhibit. We offer tours of the Exhibit in our field trip options, and we have centered a number of after school clubs around Nano as a result.*

Over half of partners (62%) also reported new and expanded partnerships with outside organizations, which focused on a range of relationships from sharing the mini-exhibition to enhancing activities and programs for visitors. For example, one partner reported the following:

> *The nano mini-exhibition has helped strengthen collaborations between [our institution] and local scientists working on nanotechnology science by providing a new location within our institution where we can present the subject of nanotechnology. This dedicated space to covering the topic of nanotechnology has increased our ability to create new partnerships and expand current collaborations.*

Over half (55%) of partners specifically reported the mini exhibition has increased the engagement of their visitors with nano. For example, one partner shared:

> *The Nano Mini Exhibition has immediately become one of our visitor favorites in visitor surveys. The impact of a 450 square foot exhibit on a small museum like ours has been tremendous. It has given our visitors a new area to enjoy, which is important for small centers to be able to replace old exhibits in a cost effective way. I have seen families building together, trying to balance their nano future, and talking about nano and how the new technologies might impact them. It has sparked conversations between guests and our staff. This exhibit has also given us a great starting point to build from. We are in the process of incorporating more about careers and the local nano career pipeline. We are able to highlight local labs and what is being done there. This would not be possible, or would not be as easy for visitors to understand without the context of the nano mini exhibit.*

Approximately 34% of partners said they are providing new content or information to the public that they otherwise would not be, and a few partners (13%) reported that they are reaching new and different audiences with the mini-exhibition. For example, one partner said:

> *We have a very large open lobby area. The NanoDays Mini Exhibition displayed in this area has provided the opportunity to reach audiences not previously impacted. We have a lot of traffic through our building for facility rentals – churches, school groups, professional meetings, etc. This traffic is usually unaware of our educational programming. The mini-exhibition has provided the opportunity to share nanotechnology with this new and diverse audience. It is fun to see people reading and exploring the exhibit before and after their events. We have also strengthened our nanotechnology presence after receiving the mini-exhibition. Shortly after receiving the exhibition, we also received a mini-grant. We are in the process of fully integrating the mini-exhibition and NanoDays materials into our current programming.*

Potential Implications of Finding 5

The partner-reported public impact of the mini-exhibition begins to provide another measure of the success of *Nano*. As the full set of copies are distributed to partners, examining the synergistic effects of having a permanent nano-focused presence on the floor will be key to further understanding the public impact of the mini-exhibition as well as the NISE Network overall. Conducting a small follow-up study in Year 10 may help the Network understand the longer-term impacts of the mini-exhibition. Such a study may also provide a significant contribution to the field in terms of further understanding the mini-exhibition model.

Conclusion

The NISE Network took considerable risks when designing the *Nano* mini-exhibition and conceptualizing the plan for its dissemination throughout the Network. *Nano* needed to

be a compact, flexible, and compelling exhibition that Network partners wanted to install on their floors. The demand for *Nano* surpassed initial projections, and the Network Leadership is responding to this demand by creating at least 20 additional replicas beyond what they had originally envisioned. The estimated reach of *Nano* is expansive, with over 7 million visitors a year projected to come in contact with the mini-exhibition. Visitors find *Nano* interactive, informative, and family-friendly, both at science centers as well as children's museums. Visitors demonstrate learning and understanding about nano in a variety of ways after visiting the mini-exhibition. *Nano* shows potential for being successful with Hispanic visitors and visitors with disabilities, two traditionally underrepresented groups that the ISE field seeks to reach more effectively. Lastly, the mini-exhibition has already begun to catalyze new public programming – as well as enhance current public programming –around nano at NISE Network partner institutions.

The findings from this study have implications both for the NISE Network as well as the ISE field overall. Given the projected reach of *Nano*, it will likely be fruitful for the NISE Network to consider ways to leverage the mini-exhibition to further its impact on the public. In addition, the Network may find it useful to plan additional follow up studies – as well as purposeful connections to other, in-process NISE Network evaluation and research studies – in order to see the longer term impact of the mini-exhibition, both on Network partners as well as on the public. In terms of implications for the field, this study, as well as future inquiry focused on the mini-exhibition, can advance the field's understanding of how and why small, compact exhibits are able to have such a reach and impact, what makes an exhibition transferrable to a range of institutions and contexts, the ways in which a small exhibition can provide an inclusive experience for Hispanic visitors and visitors with disabilities, and how a small but successful exhibition can synergistically generate a range of new learning experiences around a specific topic for visitors.

Appendix A:
Description of Methods and Supplemental Findings

As described in the Summary of Findings, the Nanoscale Informal Science Education Network (NISE Net) Public Impacts Evaluation group embarked on a three-year study in March, 2012, to explore the public impacts of the most resource-intensive educational products developed by the Network. During the first year of the study, the Public Impacts Evaluation focused on conducting a summative evaluation of the *Nano* mini-exhibition. This appendix will provide a more complete description of our study methods as well as supplemental findings that support and expand on those presented in the Summary of Findings.

Description of the *Nano* mini-exhibition

Nano is an interactive mini-exhibition that engages family audiences in nanoscale science, engineering, and technology. Hands-on exhibits present the basics of nanoscience and engineering, introduce some real world applications, and explore the societal and ethical implications of this new technology.

The mini-exhibition was originally designed to have footprint of 400 square feet. There are seven main components, including four panels (*What Happens When Things Get Smaller?, Where Can You Find Nano? I Spy Nano, What's New About Nano?* and *What Does Nano Mean for Us*), the *Balance Our Nano Future* tippy table, the *Small, Smaller, Nano* ferrofluid interactive display, and *Build a Giant Carbon Nanotube*. The mini-exhibition also contains a *Static Beads* component and a seating area with a variety of nano-themed books and reading boards. At the time this report is being written, over seventy identical copies of *Nano* will be produced and distributed to Network partners; as of January, 2013, 43 copies have been shipped. For a more detailed description of the mini-exhibition, please see http://www.nisenet.org/catalog/exhibits/nano_mini-exhibition.

The Network established three broad public-focused goals for the mini-exhibition:

1. *Nano* will reach tens of millions of visitors during the life of exhibition copies.

2. *Nano* will create an environment that encourages engagement and learning for a broad public audience.

3. *Nano* will complement other nano learning experiences, including NanoDays.

The Network also identified a set of goals focused on professionals at partner institutions; however, examining those goals was beyond the scope of this public impacts study.

Summative Evaluation Questions

By committing to the small footprint design and national distribution plans of *Nano*, the NISE Network took several risks. First, in order to achieve the desired reach numbers for the mini-exhibition, it had to be something that Network partners wanted to put out and

keep on public display. Second, the mini-exhibition needed to be successful in a wide range of institutions that each drew an even wider range of visitors. Lastly, the mini-exhibition needed to effectively and efficiently communicate key messages about nano to visitors within a compact space. Together, the goals and risks of *Nano* led to the articulation of the following evaluation questions for the summative study:

1. What is the projected reach of the *Nano* mini-exhibition?

2. Is *Nano* successful in providing visitors with an engaging experience and promoting visitor learning of nano concepts?

3. Is *Nano* successful in these ways for different types of contexts and for different types of audiences, including Hispanic visitors and visitors with disabilities?

4. Does *Nano* catalyze new or expanded public programming around nano at the host institutions?

Methods

In order to study the mini-exhibition from a summative perspective, the Network Leadership strategically placed a set of six *Nano* copies within a range of institutions that varied in size, geographic region, visitor demographics, and institution type (science museum or children's museum). All of the initial host institutions were active and engaged NISE Net partners: Arizona Science Center in Phoenix, AZ, Duluth Children's Museum in Duluth, MN, Port Discovery Children's Museum in Baltimore, MD, Sciencenter in Ithaca, NY, Science Museum of Minnesota in St. Paul, MN, and Science Spectrum in Lubbock, TX.

As the work of the study unfolded, two additional partner institutions, the Oregon Museum of Science and Industry (OMSI) in Portland, OR and the Museum of Science in Boston, MA, were added as data collection sites for further exploration of specific audiences. All eight study contexts are described in more detail below.

The study used an array of methods – including a counting study, visitor observations, surveys, and interviews, and NISE Net partner responses on a reporting form focused on the mini-exhibition – to answer the four summative evaluation questions.

Counting Study

The first evaluation question in our study was answered through a counting study conducted at seven of the host sites described below.

Data Collection

For this counting study, the number of adult and child visitors over the age of three present within the mini-exhibition over the course of a half-hour time period was recorded at different times during the week and weekend for each institution. Since both the type and quantity of visitors at museums may vary based on the day of the week and time of day, the number of visitors exposed to the exhibition was counted four different

times and days during the week, and four different times and days during weekends. Daily attendance and hours of operation were also collected from each site on each day that the counting study was done, as well as total annual attendance for the full prior fiscal year.

Visitors were counted if they were in the gallery or entered the gallery during the ½ hour data collection, and engaged with an exhibit in the mini-exhibition by touching it or paying attention to it for at least five seconds. Children were counted separately from adults, and included all participants between the ages of approximately three years to 18 years. Adults were counted to include every participant approximately 18 years or older.

Calculation of Projections

To calculate the estimated total number of visitors exposed to the *Nano* Mini-Exhibition, the number of adult and child visitors were totaled for each data collection session. Using daily attendance and hours of operation, an average actual number of visitors per half hour was calculated for each day at each site. The number of visitors counted at the mini-exhibition for a half-hour data collection session was divided by the average total museum attendance per half-hour per site, giving an approximate percent of museum attendees observed in the mini-exhibition. These calculations assumed that attendance was evenly spread out throughout the course of the day.

Since attendance often varies greatly depending on the time of day and time of the week, the average percent of museum attendees exposed to the Mini-exhibition was calculated by the average morning and afternoon weekday and weekend audiences. From this percentage and the total annual museum attendance, an estimate of the total number of visitors who may attend the exhibit over the course of a year at each study site was calculated.

To provide an example, we walk through the projection calculations from the Arizona Science Center.

Tallies of visitor contact with the mini-exhibition over a half-hour period were taken in the mornings and afternoons of both weekday days and weekend days, as seen in Table 1.

Table 1. Counting Tallies

(A)	(B)	(C)	(D)	(E)
Day of week	**Morning or Afternoon**	**Number of adults**	**Number of children**	**Total people in contact with *Nano* per 1/2 hour**
Sat	Afternoon	10	18	**28**
Sun	Afternoon	14	18	**32**
Thurs	Afternoon	8	6	**14**
Sat	Morning	17	23	**40**
Sun	Morning	2	3	**5**
Tues	Afternoon	4	2	**6**
Wed	Morning	3	22	**25**
Thurs	Morning	10	49	**59**

Next, information about the total hours of operation for a given day and the total museum attendance per day allowed for the estimated number of people in the museum for every half-hour it was open, as seen in Table 2.

Table 2. Estimation of Museum Attendance per Half Hour of Operation

(F)	(G)	(H)	(I)	(J)	(K)	(L)
Day of week	**Morning or Afternoon**	**Total data collection time (in hours)**	**Hours of operation**	**Percent of total hours of operation**	**Total museum attendance for the day (if available)**	**Estimated museum attendance per ½ hour**
Sat	Afternoon	0.5	7	7%	1209	**85**
Sun	Afternoon	0.5	7	7%	656	**46**
Thurs	Afternoon	0.5	7	7%	317	**22**
Sat	Morning	0.5	7	7%	1124	**79**
Sun	Morning	0.5	7	7%	950	**67**
Tues	Afternoon	0.5	7	7%	455	**32**
Wed	Morning	0.5	7	7%	209	**15**
Thurs	Morning	0.5	7	7%	728	**51**

Averages were then calculated for the estimated percentage of people who came into contact with *Nano* during a weekday day and during a weekend day, bolded and found in Columns O and R in Table 3 below. These numbers were calculated using the half-hour tallies in Table 1 and half-hour attendance estimates found in Table 2.

Table 3. Average Estimated Percentage of People in Contact with Nano During Weekday Days and Weekend Days

(M)	(N)	(O)	(P)	(Q)	(R)
Average number of visitors who see *Nano* per weekday 1/2 hour	**Average estimated weekday attendance per 1/2 open**	**Average % of visitors who see *Nano* on weekdays**	**Average number of visitors who see *Nano* per weekend 1/2 hour**	**Average estimated weekend attendance per 1/2 hour open**	**Average % of visitors who see *Nano* on weekends**
26	30.52	**85.20%**	26.25	70.34	**37.32%**

Finally, an average of the weekday and weekend percentages yielded an overall estimated percentage of people who came into contact with *Nano* during any given day, as seen in Column S, Table 4 below. When this percentage is combined with the documented yearly attendance of the institution, the final projection for the number of visitors coming into contact with *Nano* for a given year is calculated, as seen in Column U, Table 4.

Table 4. Final Attendance Projections for Arizona Science Center

(S)	(T)	(U)
Average % of visitors who see *Nano* per year	**Documented yearly attendance**	**Projected number of visitors to encounter *Nano* in one year at site**
61.26%	181,755	**111,339**

These calculations were carried out for each of the seven institutions included in the counting study, as seen in Table 5, which led to the projection that over 1.1 million visitors will see *Nano* across these organizations, as seen in Table 6.

Table 5. Average Percentage of Visitors Seeing Nano at Seven Host Institutions During Weekday Days and Weekend Days

Institution	Average number of visitors who see *Nano* per weekday 1/2 hour	Average estimated weekday attendance per 1/2 open	Average % of visitors who see *Nano* on weekdays	Average number of visitors who see *Nano* per weekend 1/2 hour	Average estimated weekend attendance per 1/2 hour open	Average % of visitors who see *Nano* on weekends
Arizona Science Center	26	30.52	**85.20%**	26.25	70.34	**37.32%**
Duluth Children's Museum	14	5	**over 100%**	11.83	5	**over 100%***
Oregon Museum of Science and Industry	34.4	74.29	**46.30%**	51	107.74	**47.34%**
Port Discovery Children's Museum	11.25	38.32	**29.36%**	38.75	81.93	**47.30%**
Science Museum of Minnesota	55	96.17	**57.19%**	53.5	101.77	**52.57%**
Science Spectrum	11.75	24.77	**47.44%**	17	24.27	**70.05%**
Sciencenter	19.25	13.3	**over 100%**	39	40.77	**95.66%**

In two smaller institutions, Duluth Children's Museum and Sciencenter, nearly all visitors within the half hour observation period came into contact with the mini-exhibition. These tallies produced estimates over 100% for the percentage of visitors who saw the mini-exhibition for a given half hour, thus reinforcing the anecdotal data provided by data collectors that the exhibit was seen by all or nearly all visitors within these small museums.

Table 6. Yearly Projections for Visitor Contact with Nano at Each Site

Institution	Average % of visitors who see *Nano* per year	Documented yearly attendance	Projected number of visitors to encounter *Nano* in one year at site
Arizona Science Center	61.26%	181755	**111,339**
Duluth	Capped at 100%	no annual attendance figures available	**---**
Oregon Museum of Science and Industry	46.82%	761500	**356,537**
Port Discovery Children's Museum	38.33%	261822	**100,349**
Science Museum of Minnesota	54.88%	796,051	**436,873**
Science Spectrum	58.75%	140252	**82,395**
Sciencenter	97.83%	97486	**95,368**
GRAND TOTAL PROJECTED ACROSS ALL SEVEN SITES			**1,182,861**

This projection is conservative across seven sites because an estimate for Duluth Children's Museum was not included. The organization had just moved into a new facility a few months before we conducted the counting study, and therefore they did not yet have any annual attendance data.

Finally, annual attendance data from the mini-exhibition applications of 67 NISE Net partners (all approved to receive a mini-exhibition copy at the time this report was written in March, 2013) were used to make a Network-wide projection for the number of visitors across the nation that would come in contact with *Nano*. Using the most conservative percentage number from Table 6 (38%) and multiplying it by the average annual attendance reported by the 67 partners (222,225 visitors per year), we were able to determine the average number of visitors coming into contact with *Nano* per copy placed in a partner institution: 84,456.

Multiplying that number by 70 copies yields a projection of 7,094,836 visitors viewing *Nano* over one year across the Network, assuming all copies are displayed for one full year (which partners are contractually bound to do). Considering the Network has already committed to at least five additional copies, for a total of 75, at the time of this report, that suggests that **over 7.1 million people** will come into contact with *Nano* in a given year.

Core Study of Visitor Experiences and Learning

In order to answer evaluation questions 2 and 3, visitor observations, surveys, and interviews were conducted. These data made up the section of the summative study that is called the *Core Study of Visitor Experiences and Learning*, which includes 455 data

points across all eight study contexts described below.

As mentioned earlier, the *Nano* mini-exhibition was designed to be engaging for both individuals and groups, providing a welcoming space that allowed for multiple types of interaction as well as learning about nano content. Through the design, development, and formative evaluation processes (Bequette & Van Cleave, 2011), the *Nano* design team articulated and refined a set of success indicators (NISE Network, 2012) for visitor experiences, which is described in Table 7 below.

Table 7. Indicators of Success for the Nano Mini-exhibition

Indicator	Definition	Evidence
Sustained Use	Visitors stay in the exhibition a long time; some will make repeat visits.	Observed visitor dwell times. (Repeat visitation is not a focus of the current study.)
Interest and Enjoyment	Visitors find the exhibition fun and interesting.	Visitor responses to relevant questions.
Social Interaction	Visitors work together and talk about their experience.	Observed group use of components.
Broad Age Range	All ages are present and use the exhibition; different ages tend to use different parts.	Observed ages of visitors.
Further Exploration	Some visitors use materials such as panels, flips, and reading boards.	Observed visitor use of these elements.
Learning About Nano Content	Visitors take away key messages from the four areas of the NISE Network content map.	Visitor responses to relevant questions.

These indicators also informed the design of our observation, survey, and interview instruments, which can be seen in Appendix B.

Observations

Unobtrusive and uncued observation data were collected to capture group level data before talking with a target visitor (the first adult in a group to enter into the exhibition) via the survey and interview. Groups who entered the exhibition area were randomly sampled following the standard of observing and approaching every third group that entered the exhibition area. To make sure we could talk with our target person (the first adult in a group to enter into the exhibition) we focused mainly on "adult and children" and "adult only" groups.

To determine how groups utilized the exhibition components and interacted with each other, we first determined our definition of a "group" as four consecutive people who entered the exhibition within 30 seconds of each other and appeared to be visiting the museum together. We also worked with the *Nano* design team to identify key pieces of information we wanted to learn from the observation data, such as who out of the group utilized which components, interactions with each other at components, if anyone in the group utilized the sofa and chair provided as components within the mini-exhibition, and how long the group spent in the exhibition. These conversations led to the development of our observation form, which can be seen in Appendix B.

Visitors who interacted with components were identified on our map simply as an "adult,"

or a "child." When a visitor engaged with an exhibition alone it was coded as "individual" and when visitors engaged with an exhibition together it was coded as "group." Interaction at an exhibition was coded as more than one of the above, but once it was coded as one of the above it was not double coded. We were interested in use of the sofa and chair, but again not at a micro level. To accommodate this, we recorded a person's gender and if he or she was an adult or a child along with a time of how long the individual sat on the sofa or chair. In addition, time in the exhibition was recorded at the group level with the time the first person entered marked as the beginning time and the time the last person left marked as the end time.

Observation data was entered using a Survey Gizmo survey and the resulting data file was cleaned by one of the lead data collectors. Mean and median dwell times were calculated using observation data, and a Sweep Rate Index (Serrell, 1998; Yalowitz & Bronnenkant, 2009) was also calculated as one point of comparison to the broader informal science education field. It should be noted that we opted to use the median value in our sweep rate index calculation as opposed to the standard mean value in order to minimize the effect of outliers, particularly on the upper end of the dwell time range – thus leading to a more conservative estimate.

Surveys and Interviews

Once the last person in the group had left the exhibition area, the target adult was approached to complete a survey and interview about his or her individual experience. A subset of visitors, including all of those surveyed at children's museums, were also asked about their perceptions of the experiences of children in their group. Once again, survey and interview instruments can be seen in Appendix B.

Survey data were analyzed for frequencies and patterns. Confidence scores were calculated for the retrospective-pre and post questions on the survey and then compared with a non-parametric Wilcoxon Ranked Sign Test. Interview data were coded for emergent themes as well as for areas of the NISE Net content map as appropriate.

Reports from 2013 Mini-exhibition Host Sites

Lastly, the fourth evaluation question was answered through the *Nano* mini-exhibition reporting survey sent to 41 Network partners hosting mini-exhibition copies as of January, 2013.

Small Exploratory Studies

In addition to the core study, two small exploratory studies were conducted with visitors from traditionally underrepresented audiences. Hispanic audiences were observed, surveyed, and interviewed at two sites. Observations of visitors with disabilities were conducted at two sites. In addition, family groups of mixed abilities were surveyed and interviewed at one of those sites. While the sample sizes for these small studies do not allow for generalizations to be made, they do begin to provide some insight into how *Nano* is or is not successful for these audiences.

Study Contexts

The summative study of *Nano* required data collection at eight different sites which are described in this section.

Arizona Science Center; Phoenix, AZ
Data from the Arizona Science Center contributed to the counting study portion of the summative evaluation.

Nano is located on the first floor in the lobby of the Arizona Science Center just near the entrance. Visitors walk down the ramp into the building and the exhibit is clearly visible as they turn the corner, even before they reach the admissions and membership counters. Technically, anyone can visit *Nano* for free because of its location. Featured next to *Nano* is ASU's *Lunar Reconnaissance Orbiter Camera* exhibit. The lobby is a vast open area and a fairly high traffic zone, especially on the weekends and when school groups head to lunch in the lunch room located immediately behind the exhibition. *Nano* is located between the gift shop and café, both of which are also considered to be high traffic areas.

Duluth Children's Museum; Duluth, MN
Data from the Duluth Children's Museum contributed to the counting study and core study portions of the summative evaluation.

Data was collected in two rounds at the Duluth Children's Museum. The first round of data was collected during a normal weekend at the museum. The second round of data was collected during the museum's annual Bubble Festival. An estimated 2,800 people attended based on the number of t-shirts given away, food and gift store sales, and the estimated numbers of people who attended performances and events such as skating, a puppet show, and rock climbing.

The Duluth Children's Museum (DCM) just moved to a new location one month prior to the NISE Net data collection. At their new location, the museum has two floors. On the first floor is the gift shop, the party room, and an exhibition space consisting of the NISE exhibition, an exhibition on aging and memory produced by Oregon Museum of Science and Industry, a butterfly room where projected butterflies will land on your shadow, a room where you can draw on the wall, and an area where you can dig up dinosaur "fossils." The second floor is more of a "play area" with a couple of houses for kids to play in, an art area, and Legos. The second floor also has an exhibition geared towards children that teaches about the stock market. The mini-exhibition is located directly in front of the entrance the exhibition space and if visitors walk straight into the room they walk into *Nano*. In addition to the mini-exhibition components, the Duluth Children's Museum put up the "How tall are you ruler" from the NanoDays kit and has lab coats for kids to wear while they play with the exhibition. They also have programming around the mini-exhibition, and there is a staff person who demonstrates how components work and who talks about nano with groups when he has time.

The mini-exhibition installation at Duluth Children's Museum contains all nine components of *Nano* and takes up about 600 square feet of the museum space on the first floor.

Museum of Science; Boston, MA
Data from the Museum of Science contributed to the small exploratory study of visitors with disabilities portion of the summative evaluation.

The Museum of Science (MOS) building has two wings, with its main exhibit hall in the Blue Wing. The Blue Wing has three stories and an open design such that visitors can see the other two floors from the floor they are on. The escalators for travelling between levels are in the middle of the floor. The NISE Net mini-exhibition is on the bottom floor of the Blue Wing in what was previously an open area, colloquially called "The Well." The four panels and the chair are positioned up against the escalator, with the couch sitting next to the chair at an angle, forming a partial border for the exhibition. The rest of the components are positioned a few feet away from the panels or the couches, and there is no boundary on the other side. The mini-exhibition is abutted by another exhibition about nanotechnology with only a couple of feet of space in between. Other exhibitions nearby are related to energy conservation, including "Energized!" and "Catching the Wind." The energy exhibitions are separated from *Nano* by a larger amount of space.

Oregon Museum of Science and Industry (OMSI); Portland, OR
Data from OMSI contributed to the counting study, core study, and small exploratory study of Hispanic visitors.

The mini-exhibition at OMSI is installed in the Turbine Hall exhibit floor on the main level, 1 out of 2, of the building. This floor contains an Earthquake House, a lunch room for visitors, a group of engineering exhibits, the Physics Chemistry and the Vernier Technology Lab, Autovation exhibition, the Inventor's Ball Room, along with a spinning wheel table, probability ball drop exhibit, computer hardware exhibits, and robotic exhibits.

The mini-exhibition installation at OMSI contains all the nine components developed by NISE Net and a seating area including all books and materials for the seating area. The mini-exhibition occupies approximately 415 square feet and it is located in an alcove on the river side of the building right in front of the elevator located in the northwest part of the hall. The mini-exhibition is shaped in a rectangular form with the reading rail panels facing the river view wall and the rest of the components distributed throughout the rest of the alcove space. Staff are not stationed at the mini-exhibition specifically, and there were no floor staff re-setting or cleaning exhibit components while data collection was conducted.

Port Discovery Children's Museum; Baltimore, MD
Data from Port Discovery contributed to the counting study, core study, and small exploratory study of visitors with disabilities portions of the summative evaluation.

Port Discovery Children's Museum has three floors. The mini-exhibition at Port Discovery is located on the first floor and is set in it's own gallery space separated from the rest of the museum (See Figure 1). The *Where Can You Find Nano? I Spy Nano* panel is set outside two open doors to the gallery. Having this piece outside of the gallery is meant to act as a marker indicating that there is more about nanotechnology within the gallery.

The mini-exhibition installation at Port Discovery contained only the nine components developed by NISE Net and a seating area. In addition, Port Discovery has *NanoFabulous* in the same space . *NanoFabulous* was designed to complement the mini-exhibition and was produced by the Materials and Research Science and Engineering Center (MRSEC) at the University of Maryland with support from NSF and the University

of Maryland Departments of Physics and Chemistry. They also have several Port Discovery specific components including posters and a picnic table with toys for visitors to measure as well as the *How Tall Are You Ruler* which is provided in the NanoDays kit. There is a staff person located at the entrance to the mini-exhibition almost all the time.

Science Museum of Minnesota; St. Paul, MN
Data from the Science Museum of Minnesota contributed to the counting study and core study portions of the summative evaluation.

The mini-exhibition at the Science Museum of Minnesota (SMM) is installed in the Atrium on level 3 of 5, which is the bottom floor of the exhibit hall. This floor contains the Experiment Gallery, Math Moves, Dinosaurs and Fossils Gallery, Future Earth, Science Live Theater, several freestanding exhibit components, and the "Chomp" eating area. The reading rail panels and the staircase create the perimeter, but there are no clear boundaries setting the exhibit apart from the surrounding area. Nearby exhibits include the Wave Tank, Gear Rations, and the Chain Lariat.

The mini-exhibition installation at SMM contained only the nine components developed by NISE Net and a seating area. The mini-exhibition is located directly next to the bottom of the stairs and fills roughly 710.5 square feet in a half-oval shape.

Staff are not stationed at the mini-exhibition specifically, however gallery attendants on the floor regularly visited the area to assist visitors, clean the space, and reset exhibit components.

Science Spectrum; Lubbock, TX
Data from Science Spectrum contributed to the counting study, core study, and small exploratory study of Hispanic visitors portions of the summative evaluation.

The NISE Net mini-exhibition at Science Spectrum in Lubbock is installed on the exhibit floor on the lower level, 1 out of 3 of the building. This floor contains a series of exhibits related to human health and biology, dinosaur models, a rock climbing wall and a major exhibit Texas Alive: The Brazos River Journey. There is also a computer lab, a classroom, a tinkering counter, and the birthday party room. The mini-exhibition is located in the corner occupied by the birthday party room and classroom. The reading rail panels and the natural corner of the room limit the perimeter of the exhibit.

The mini-exhibition installation at Science Spectrum contains all the nine components developed by NISE Net and a seating area. The reading area does not have the books and the laminated materials are incomplete. It fills out approximately 500 square feet in a square shape.

Staff are not stationed at the mini-exhibition specifically, however floor educators leading birthday party activities often re-set exhibit components, mainly the *Build a Giant Carbon Nanotube*.

Sciencenter; Ithaca, NY
Data from Sciencenter contributed to the counting study portion of the summative evaluation.

The *Nano* exhibition is in an upstairs galley and connects the front staircase with the rest of the upstairs galleries, so it gets used a bit as a hallway. This area is considered to be a high traffic zone at the institution.

General Audience Sample

The General Audience sample for this study included all possible visitor data sets across each of the data collection sites. The total number of observations collected (n=427) was greater than the total number of complete observation-survey-interview sets (n=320). Please see Table 22 for a summary of the data collection and analysis groupings across the different data sites.

Demographic data is presented in Tables 8-21 and includes visitor Gender, Age, Race, Ethnicity, Cultural Background, Languages Spoken at Home, If the Household is MultiLingual, Education, Income, Disability, Type of Disability, Use of Science in Daily Work, Previous Visits to the Museum, Interest in Science, and Previous Exposure to Nano.

Tables 8. Gender (n=323)

Male	Female
38.4%	61.6%

Tables 9. Age (n=318)

Under 21	21-29	30-39	40-49	50-59	60+
3.8%	17.0%	40.9%	21.7%	7.2%	9.4%

Tables 10. Race (n=300)

African-American	White	American Indian or Alaskan Native	Native Hawaiian or Other Pacific Islander	Asian	Not Sure	Two or More
3.7%	85%	2.0%	0.3%	5.7%	2.0%	4.0%

Tables 11. Ethnicity (n=290)

Hispanic/Latino	Not Hispanic/Latino	Not Sure	Other
19.7%	65.5%	0.7%	14.1%

Tables 12. Cultural Background of Hispanic/Latino Visitors (n=58)

Mexican	Puerto Rican	Salvadoran	Guatemalan	Ecuadorian	Peruvian	Other
86.2%	8.6%	3.4%	1.7%	1.7%	3.4%	3.4%

Tables 13. Languages Spoken at Home (n=340)

English	Spanish	Other
87.1%	9.7%	3.2%

"Other" languages included Cantonese, Chinese, Hmong, Japanese, Korean, Maya, and Vietnamese.

Tables 14. Is Household Multi-Lingual (n=329)

Yes	No
6.1%	93.9%

Tables 15. Education Level (n=317)

Less than high school	Completed high school	Some college or technical ed.	College degree	Post- graduate degree
5.7%	8.8%	20.8%	40.4%	24.3%

Tables 16. Income (n=286)

Under $20,000	$20,000-$39,999	$40,000-$59,999	$60,000-$79,999	$80,000-$99,999	$100,000-$149,999	$150,000+
8.7%	16.4%	17.1%	15.6%	12.2%	21.0%	8.7%

Tables 17. Disability (n=322)

Yes	No
8.7%	91.3%

Tables 18. Type of Disability (n=24)

Mobility	Visual	Auditory	Learning	Cognitive	Other
50.0%	17.4%	17.4%	26.1%	25.0%	16.7%

"Other" disabilities included autism, autism and anxiety, neurological

Tables 19. "Do You Use Science in Your Daily Work?" (n= 317)

Yes	No
45.4%	54.6%

Tables 20. Visits to the Museum in the Last Two Years (n= 325)

None	1-2 times	3-4 times	5 or more times
41.8%	27.1%	15.7%	15.4%

Table 21. St. Paul, Scale Questions Regarding Interest in Science and Previous Exposure to Nanoscience

	N	Mean	*SD*
Interest in Science (on a scale of 0-10)	319	7.57	1.9
Previous Exposure to Nanoscience (on a scale of 1-4)	329	2.99	.848

Table 22. Data Collection and Analysis Summary

Location	Counting study site?	N, Complete sets (Obs, S, I)	N, Obs only	General Audience Analysis		Science Center (inst. type) Analysis		Children's Museum (inst. type) Analysis		Hispanic Visitors Analysis		Visitors with Disabilities Analysis		Institution Totals
				S,I	Obs	S,I	Obs	S,I	Obs	S,I	Obs	S,I	Obs	
Science Museum of Minnesota	Yes	100		X	X	X	X							***158***
			58		X		X							
Duluth Children's Museum	Yes[A]	103		X	X			X	X					***108***
			5		X				X					
Port Discovery	Yes	32		X	X			X	X					***59***
			2		X				X					
			25[B]										X	
Science Spectrum	Yes	14		X	X									***51***
			16[D]		X									
		21[C]		X	X					X	X			
OMSI	Yes	22		X	X	X	X							***67***
			17[D]		X		X							
		28[C]		X	X	X	X			X	X			
Sciencenter	Yes	N/A	N/A											***N/A***
Arizona Science Center	Yes	N/A	N/A											***N/A***
Museum of Science	No	12[B,E]		X (7)								X	X (7)	***12***
Group Totals		***332***	***123***	*320*	*418*	*150*	*209*	*135*	*142*	*49*	*49*	*12*	*32*	***455***

A = Site was not included in annual projections because annual attendance for the site was not available.
B = Visitors with Disabilities.
C = Hispanic Visitor Groups.
D = Language preference undetermined.
E = Recruited groups; some groups had more than one survey and interview set associated with it.

Supplemental Findings

The data reported in the Summary of Findings was based on the full analysis performed on the data collected during the study. Below, we provide the additional tables and information that could not be included in the Summary of Findings but still contributed in some way to the document. The format of this section will echo that of the Summary and be divided by the indicators of success listed above in Table 7 and outlined by the *Nano* design team. It should be noted that for the ***Social Interaction, Broad Age Range***, and ***Further Exploration*** indicators, all relevant data was reported in the Summary of Findings.

Sustained Use

Table 23. Mini-exhibition Use (n=418)

Indicator	Time
Mean Dwell Time	6:07 (min, sec)
Median Dwell Time	4:00
Sweep Rate Index	100, assuming 400 sq. ft.

Once again, we are using the median dwell time in the Sweep Rate Index calculation, in order to provide a more conservative estimate of this ratio.

Interest and Enjoyment

Table 24. Interest and Enjoyment Reported by Visitors (n=320)

Interest and Enjoyment	Percent of Visitors or Responses
Top two levels of interest	95%
Top two levels of enjoyment	96%
Top two levels of interest for child	79%
Top two levels of enjoyment for child	87%
As or more interesting than other exhibits	71%
Percent of positive adjectives chosen to describe experience	96%, with 1,210 total adjectives chosen

In addition, 29% of visitors across all five sites (total n=318) reported finding something about the mini-exhibition challenging. When those visitors were asked to elaborate on what was challenging, 31% of those respondents said the content was confusing or challenging, as seen in Table 25.

Table 25. Reasons Nano was Challenging for Visitors (n=97*)

Reasons it was Challenging	Percent of Responses
Confusing/Challenging content	30.9%
Difficult to use	22.7%
Not engaging	18.6%
Non-NISE Net Component	8.2%
Not sure how something works	7.2%
Something not working	4.1%
Other	11.3%

*Responses could be coded into more than one category

Visitors most commonly indicated the *Small, Smaller, Nano* component was the favorite part of the mini-exhibition, with 45% of respondents making this choice. The next most frequently identified favorite components were *Build a Giant Carbon Nanotube* (with 15% of respondents choosing this element as their favorite) and generally the panels of the exhibition in general (with 12%) identifying at least one panel as their favorite piece, as seen in Table 26.

Table 26. Favorite Exhibit Components as Identified by Visitors (n=348)

Favorite Component Identified	Percent of Visitors
Small, Smaller, Nano	44.8%
Build a Giant Carbon Nanotube	15.2%
Exhibition Panels	11.5%
Balance Our Nano Future	8.0%
No favorite named	6.3%
Static Beads	4.6%
All components	1.7%
Sofa/reading area	0.3%
Other	5.2%
I don't know	2.3%

Visitors provided several reasons for why a particular component was their favorite piece, such enjoying the interactive nature and the visual appearance of the exhibition. They also reported enjoying the accessible and welcoming nature of the content as well as the fact that it was family friendly and something they could do as a group. Table 27 provides the range of reasons that visitors shared.

Table 27. Reasons Why Visitors Identified Components as Their Favorite (n=298*)

Reason why something was a favorite part of the exhibition	Percent of Responses
Overall experience - interactive	19.5%
Overall look and feel – visual appearance	16.4%
Content information	16.1%
Engaging for kids only	14.0%
Accessible/welcoming – I can understand	6.4%
Family friendly/something we all could do	5.7%
Other	10.1%
No reason given	25.2%

*More than one reason could be given

Learning About Nano Content

The tables below were summarized in the Summary of Findings document and provide evidence to suggest that visitors across the different sites were engaging with nano content and learning about different areas of the NISE Net content map. Table 28 shows the percentage of visitors who identified at least one area of the content map when asked two different questions about what they learned at the exhibition.

Table 28. Visitors Who Mentioned at Least One Area of the NISE Net Content Map When Responding to Questions About Learning in the Exhibit (n=320)

Visitor Learning	Percent of visitors who mentioned at least one area of the NISE Net content map
Q3. What do you think the exhibit was about overall?	62.0%
Q10. If a friend asked you what you leaned at the exhibit today, what would you tell them?	58.0%

In addition, 59% of visitors answered "Yes" to the question "Did the exhibit connect to anything in your own life?", suggesting visitors found the experience relevant.

Table 29 reports the non-parametric Wilcoxon Ranked Sign Test performed on the confidence scores of Hispanic visitors, showing a statistically significant increase in confidence from retrospective pre- to post scores.

Table 29. Difference in Visitor's Reported Confidence Levels Based on Retrospective Pre and Post Answers (n=320)

Confidence Items	Percent of visitors reporting top two levels of confidence after visiting the mini-exhibition	*Mean confidence score, pre*	*Mean confidence score, post*	*Z*
Talk about how scientists are able to build things atom by atom at the nanoscale.	21%	1.53	1.94	-9.589**
Describe one example of how nanoscale objects behave differently than other objects.	28%	1.52	2.02	-9.750**
Name a product, technology, or example in nature that involves nanoscale science.	41%	1.81	2.26	-9.019**
Identify at least two factors to consider when thinking about using new nanoproducts or nanotechnologies.	24%	1.47	1.89	-9.435**
Identify at least one way that nano will impact my life in the future.	38%	1.79	2.22	-9.086**

***p<0.01, Wilcoxon Signed Rank Test; Scale goes from 1-4.*

Spanish Translations and Audio Descriptions

Visitors were asked about whether they noticed two specific exhibition elements to make *Nano* more inclusive: the Spanish translations and the Audio Descriptions. Visitors were handed a sheet with images of the translations, the audio description label, and the flip panels. Visitors were then asked whether or not they noticed each of the three elements, and if so, what impact the element had on their experience.

Across the different data collection sites, 73% of visitors (with the total n=322) reported noticing the Spanish translations. Responses from these visitors who noticed were coded for a positive, neutral, or negative impact, as seen in Table 30.

Table 30. Reported Impact of Spanish Translation on Visitors' Experiences (n=234)

Impact of Spanish Translations on experience	Percent of Visitors
Positive	31%
Neutral	43 %
Negative	9%
No impact - did not use	18%

Exploring themes within the responses coded as Positive and Negative, we find additional information about how the ways the translations impacted visitors, as seen in Tables 31 and 32 below.

Table 31. Positive Impact of Spanish Labels on Visitors' Experiences (n=64*)

Positive Impact of Spanish Labels	Percent of Responses
Inclusive	37.7%
Learn about language	24.6%
Other	21.7%
General positive comment	15.9%

*Responses could be coded into multiple categories

Examples of visitor responses for each of the themes include the following:

- Inclusive: "*I thought it was more culturally sensitive. This area is not so much. I appreciated it.*"
- Nice to have: "*No but I liked that it was available.*"
- Learn about language: "*I look at the words and try to figure out how to say things in Spanish. Otherwise, how would I know how to say "nanotechnology" in Spanish?*"

Table 32. Negative Impact of Spanish Labels on Visitors' Experiences (n=18*)

Negative Impact of Spanish Labels	Percent of Responses
Distracting	44.1%
Not appropriate	27.8%
Confusing	16.7%
Other	11.1%

*Responses could be coded into multiple categories

Examples of visitor responses for each of the themes in Table 32 include the following:

- Distracting: "*It was a little distracting", "I was looking for English",* or "[My experience was impacted] v*ery negatively. Eyes were drawn to it more. Blue should be the more predominant language.*"
- Not appropriate: "*It made me think if you live in America, you should learn to read and speak English.*"
- Confusing: "*This makes it a little confusing.*"

As for the Audio Description labels, 28% of visitors across the different sites reported noticing these exhibit elements. Responses from these visitors who noticed were coded for a positive, neutral, or negative impact, as seen in Table 33.

Table 33. Reported Impact of Audio Descriptions on Visitors' Experiences (n=73)

Impact of Audio Descriptions on experience	Percent of Visitors
Positive	12.3%
Neutral	24.7 %
Negative	2.7%
No impact - did not use	31.5%
No impact – did not know what it was	28.8%
No impact – others used them	2.7%

Exploring the comments of these visitors who had noticed, but not used, the audio description label illustrates that visitors were generally neutral about the presence of this feature, as described in Appendix D, focused on the exploratory study of visitors with disabilities. Of the nine visitors who felt positively about the audio descriptions, the most common theme within the reasons provided for their view was that having the audio descriptions made the exhibition feel inclusive. The two visitors who felt negatively about the audio descriptions reported being confused about or by them.

Discussion and Implications

As seen in the Summary of Findings and within this appendix, the findings from the summative study of the mini-exhibition show that it is successful for visitors, providing both an engaging experience and as well as an opportunity to learn about nano concepts and content.

Methodologically, studying *Nano* from a summative perspective was a complex endeavor for several reasons. The "small footprint/many copies" model embraced by the Network was quite innovative, and as such, required a creative, highly-collaborative multi-institutional evaluation team being deployed across a multi-site study. Experts within the team lead the two small exploratory studies, and the collective expertise of the Public Impacts team, the larger NISE Net Evaluation team, the NISE Net Committee of Visitors, the *Nano* design team, and the Network Leadership informed the design and interpretation of this work.

This study has many implications for the field and leads to additional interesting questions for future inquiry, including:

- **What made the mini-exhibition successful for visitors?** The summative study suggests that the mini-exhibition was successful, but more investigation around how and why it was successful would be powerful. Specifically, this type of

deeper inquiry could advance the understanding of the field in terms of designing compact exhibits that are "content-efficient" and "message-optimized" such that visitors can engage with ideas but are not overwhelmed by their level, amount, or complexity.

- **What infrastructure and groundwork needed to be in place within the NISE Network in order the mini-exhibition to be successful?** The success of the mini-exhibition was not solely based on its design. In order for *Nano* to achieve its projected public reach and engage visitors in nano learning, NISE Net partners first and foremost needed to be ready to commit to placing a mini-exhibition on their floors and integrating it into their institutional culture. Understanding what it took to prepare the Network for this type of broad deployment can provide key insights for the Informal Science Education (ISE) field, as well as for funders and policy makers.

- **How do we continue to expand on the work from our exploratory studies, in terms of both advancing theory and methodology for the field?** The study of Hispanic visitors and visitors with disabilities lead to many additional questions that would be worthwhile for the field as a whole to pursue. Understanding in more detail how and why these visitors engaged with *Nano* in the ways that they did can provide a wealth of information focused on broadening participation in ISE experiences and STEM learning overall. Informal learning institutions provide an opportunity to engage with traditionally underrepresented groups in authentic ways, thus creating a fruitful window into advancing and refining theories about how different perspectives and cultures participate in informal learning. In addition, the ISE field can lead innovation in the methods used to study and collaborate with these groups, such that the ways we invite members of these communities to share their stories and co-construct meaningful experiences are not only culturally appropriate and but also culturally responsive.

- **What are the longer-term impacts of the mini-exhibition for ISE organizations, ISE professionals, and ultimately, the public?** This study focused on assessing the success of *Nano* as an exhibition. However, returning to partners in a few years – after the mini-exhibition has been on the floor for a while – and examining about how *Nano* functioned as a multi-platform catalyst would provide valuable insight into the longer term impact of this effort and useful information for the ISE field about the potentially powerful ways a network can be mobilized around a key product deliverable.

These questions are just an initial set of possible future directions to consider as the story of the mini-exhibition continues to unfold in the coming years. Through the nature of the mini-exhibition replication and distribution model, *Nano* provides a dynamic and rich context for studying informal learning across contexts and for a broad range of visitors that can be leveraged in meaningful and powerful ways to advance theory and practice within the ISE field.

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Serrell, B. (1998). *Paying Attention: Visitors and Museum Exhibitions*. Washington, DC: American Association of Museums.

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Appendix B: Instruments

This appendix contains the observation, survey, and interview instruments used in the Summative Study of the *Nano* mini-exhibition.

Data Collection Instruments

Example Observation Sheet

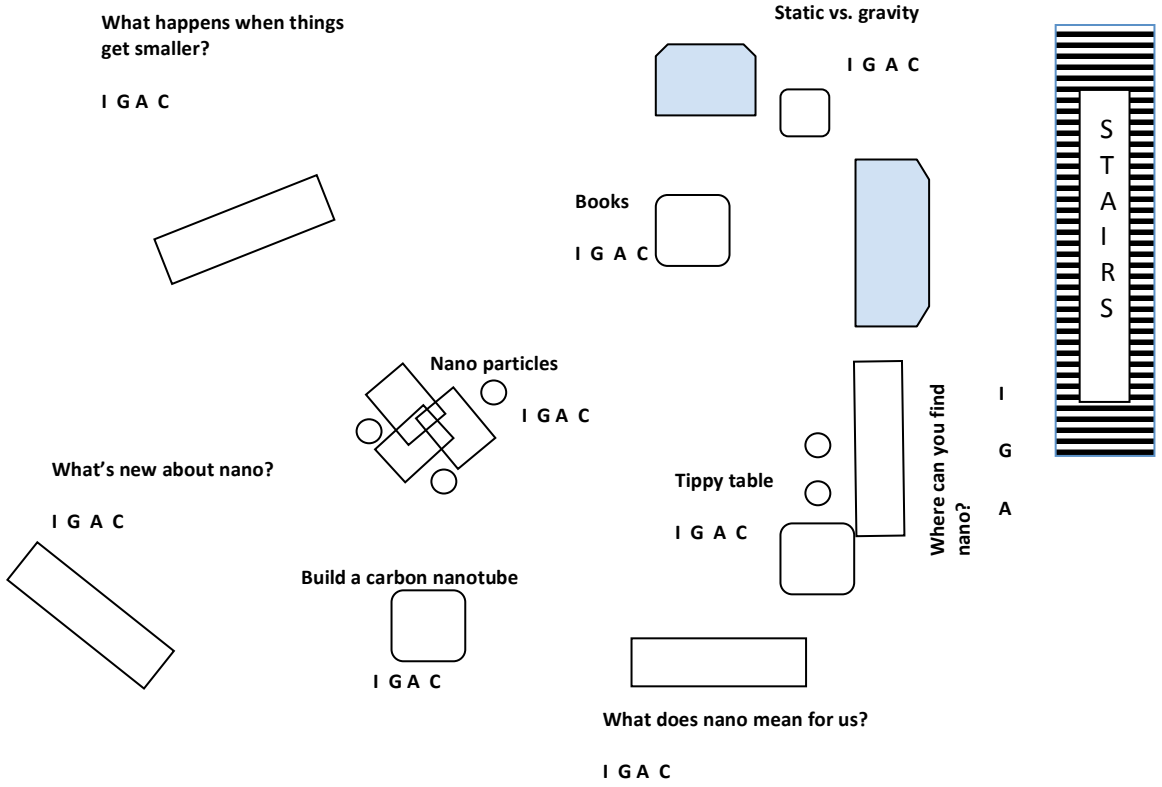
Visitor Information: Circle the visitors in your Group of 4

Time enter (1st person)_____ Time leave (last person)_____ GROUP TOTAL TIME_____

Adult F _____ # Adult M _____ # Child F _____ # Child M _____ TOTAL #____ ~age(s) _____ ~age(s) _____ ~age(s) _____ ~age(s) _____

Group type: ❑ Adults only ❑ Adults and kids ❑ Other: _____

- Record visitor information for all visitors thought to be part of group no matter when they enter
- Observe up to 4 people per Group if traffic is high
- (Group = people who enter within 30 seconds of each other)



Sofa/Chair time – Indicate if visitor is an Adult (A) and/or Child (C) and record time.
Visitor AMF/CMF: Start:____ End:____ Total:___
Visitor AMF/CMF: Start:____ End:____ Total:___
Visitor AMF/CMF: Start:____ End:____ Total:___
Visitor AMF/CMF: Start:____ End:____ Total:___
Visitor AMF/CMF: Start:____ End:____ Total:___

_____

Circle code for each behavior observed next to appropriate component:
I = component used by individual
G = component used by smaller Group of 4 (joined within 10 seconds)

NOTES OR COMMENTS:
Chair/sofa is occupied by other visitors ☐
*If someone from group stays on sofa/chair longer than 20 minutes note and proceed to survey if necessary ☐
Someone in the Group of 4 interacted with staff person ☐
Someone in the Group of 4 Interacted with someone from the larger group (not a stranger) ☐
*Enter Spanish component usage (S) next to exhibit if used
*Enter Audio component usage (AU) next to exhibit if used

_____

OBSERVATION ONLY BECAUSE:
Couldn't find target person ☐
Target person refused ☐

NISE Mini-Exhibition Study
Visitor Questionnaire

Thank you for agreeing to participate in our study! Your responses will help us understand how our exhibits are working for our visitors. Please read and answer the questions below.

1. How interesting was the exhibit you just saw? (CHECK ONLY ONE)

- ☐ I was so interested I'd encourage others to see it.
- ☐ I was interested.
- ☐ I wasn't really interested.
- ☐ I didn't find it interesting at all.

2. How enjoyable was the exhibit? (CHECK ONLY ONE)

- ☐ It was so enjoyable I'd encourage others to see it.
- ☐ It was enjoyable.
- ☐ I didn't really enjoy it.
- ☐ I didn't find it enjoyable at all.

3. How interesting was the exhibit you just saw <u>for the children</u> in your group? (CHECK ONLY ONE)

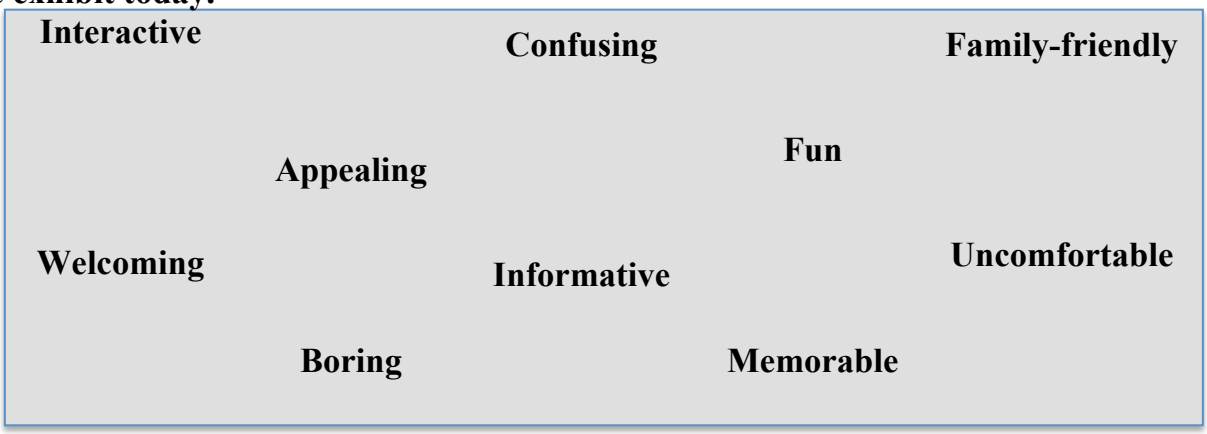
- ☐ They were so interested they'd tell others about it.
- ☐ They were interested.
- ☐ They weren't really interested.
- ☐ They weren't interested at all.
- ☐ Not Applicable – there are no children in my group.

4. How enjoyable was the exhibit <u>for the children</u> in your group? (CHECK ONLY ONE)

- ☐ It was so enjoyable they'd tell others about it.
- ☐ It was enjoyable.
- ☐ They didn't really enjoy it.
- ☐ They didn't find it enjoyable at all.
- ☐ Not Applicable – there are no children in my group.

TURN OVER

5. Please CIRCLE ANY OF THE WORDS BELOW that describe your experience with the exhibit today.



6. Before today, how much have you heard about nanoscale science and technology? (CHECK ONLY ONE)

- ☐ I hear about it all the time.
- ☐ I hear about it often.
- ☐ I have heard about it a few times.
- ☐ I have never heard about it.

7. Before today, how would you rate your confidence in your ability to do each of these? (CIRCLE ONE PER LINE)

Opportunity	Level of Confidence			
Talk about how scientists are able to build things atom by atom at the nanoscale	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**
Describe one example of how nanoscale objects behave differently than other objects	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**
Name a product, technology, example in nature that involves nanoscale science	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**
Identify at least two factors to consider when thinking about using new nanoproducts or nanotechnologies	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**
Identify at least one way that nano will impact my life in the future	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**

8. Now after visiting this exhibit, how confident are you in your ability to do each of these? (CIRCLE ONE PER LINE)

Opportunity	Level of Confidence			
Talk about how scientists are able to build things atom by atom at the nanoscale	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**
Describe one example of how nanoscale objects behave differently than other objects	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**
Name a product, technology, example in nature that involves nanoscale science	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**
Identify at least two factors to consider when thinking about using new nanoproducts or nanotechnologies	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**
Identify at least one way that nano will impact my life in the future	**Not at all confident**	**Somewhat confident**	**Confident**	**Extremely confident**

Thank you for your responses. We'd now like to ask you a few questions.

NISE Mini-Exhibition Study: Visitor Interview

(to be conducted after survey is completed by visitor)

1. *(Look at response to survey question #2.)* **I see that you found the exhibit** *(fill in response to Survey Question #2)*. **What made the exhibit enjoyable/not enjoyable for you**? *Probe: Was it the subject matter? The interactive elements? Something else?*

2a. What other exhibits have you seen on your visit today?

2b. On average, was this exhibit *(point to the mini-exhibit)*, **AS interesting, MORE interesting, or LESS interesting than the other exhibits you've seen today?**

☐ as interesting ☐ more interesting ☐ less interesting

2c. What made this exhibit [as/more/less] interesting to you?

3. In your own words, what would you say the exhibit *as a whole* was trying to show visitors?

4. Did this exhibit connect to anything in your own life? ☐ yes ☐ no

(If yes) **In what way?**

5. What was your favorite part of the exhibit?

Probe: If you had to choose only one specific thing, what would it be? Why?

6. Did you find any parts of the exhibit challenging? ☐ yes ☐ no

(If yes) Which parts? What was challenging about them?

(if no) Additional probes: Difficult to use? Things you don't agree with? Difficult to understand?)

7. *(Look at response to survey question #5 – circled words.)* **I see you've circled these words under Question 3. Which word do you think BEST describes your experience?**

Probe: Can you tell me more about why you chose that word?

8. *Look at response to survey question #8, last row. Skip this question if they marked "Not Confident" or "Somewhat Confident."* ***If Confident/Extremely Confident****, ask:*

I see you marked [x] here. Can you tell me how you think nano will connect to your life in the future?

9. *(Use handout)* **Here is a page with a few images from the exhibit. Please point to ***ANY*** of the following features you noticed within the exhibit.**

(Check features visitor points at below. Circle here if NONE.)

(For each one checked)

☐ How did Spanish Content affect your exhibit experience?

☐ How did Audio Description affect your exhibit experience?

☐ How did Flip Panels affect your exhibit experience?

10. If a friend asked you, "What did you learn about nanotechnology at the exhibit today?," what would you say?

Please answer the following questions to help us better serve our audience.

1. How would you rate your interest in science on a scale of 0 to 10?

No Interest										Extreme Interest
0	1	2	3	4	5	6	7	8	9	10

2. Who did you come to the museum with today? (CHECK ONLY ONE)

☐ Adults only ☐ Adults and children ☐ Alone

3. Your age: _____

4. Please list the ages of the other people in your group:

_____ _____ _____ _____ _____ _____ _____ _____

5. Are you…?

☐ Male ☐ Female ☐ Other

6. What is your race? (check as many as apply)

☐ White
☐ Black or African American
☐ American Indian or Alaskan Native
☐ Asian
☐ Native Hawaiian or Other Pacific Islander
☐ Two or more races
☐ Not sure

7a. What is your ethnicity? (Check one)

☐ Hispanic/Latino ☐ Not Hispanic/Latino ☐ Not Sure ☐ Other:_____

7b. If Hispanic, which of the following cultural background(s) do you most identify with?

☐ Mexican
☐ Puerto Rican
☐ Cuban
☐ Salvadoran
☐ Dominican
☐ Guatemala
☐ Colombian
☐ Honduran
☐ Ecuadoran
☐ Peruvian
☐ Other: _____

8. Are you or your family a member of this museum?

☐ Yes
☐ No
☐ No, but I have been in the past
☐ Not sure

9. Before today, how many times have you visited the museum in the last 2 years?

☐ 1-2 times
☐ 3-4 times
☐ 3-4 times
☐ 5 or more times
☐ None

TURN OVER

10a. Do you homeschool your children?

- ☐ Yes
- ☐ No
- ☐ I don't have school aged children

10b. If yes, are you using the museum today for homeschool activities?

- ☐ Yes
- ☐ No, but we have in the past
- ☐ No, we don't use the museum for homeschooling needs

11a. Do you or someone you came with to the museum today have a temporary or permanent disability? ☐ Yes ☐ No

11b. *If yes*, how would you describe the disability? (CHECK ALL THAT APPLY)

☐ Mobility	☐ Me	☐ Someone I came with
☐ Visual	☐ Me	☐ Someone I came with
☐ Auditory	☐ Me	☐ Someone I came with
☐ Learning	☐ Me	☐ Someone I came with
☐ Cognitive	☐ Me	☐ Someone I came with

☐ Other:_____ ☐ Me ☐ Someone I came with

12. What is your zip code? _____

13. What language or languages do you MOSTLY speak at home?

_____

_____

14. What was your total annual household income last year? (CHECK ONLY ONE)

- ☐ Under $10,000
- ☐ $10,000 to 19,999
- ☐ $20,000 to 29,999
- ☐ $30,000 to 39,999
- ☐ $40,000 to 49,999
- ☐ $50,000 to 59,999
- ☐ $60,000 to 69,999
- ☐ $70,000 to 79,999
- ☐ $80,000 to 89,999
- ☐ $90,000 to 99,999
- ☐ $100,000 to 149,999
- ☐ $150,000 or more

15. What is the highest level of education you have completed? (CHECK ONLY ONE)

- ☐ Elementary School
- ☐ Middle School
- ☐ Some High School
- ☐ Completed High School
- ☐ Some College or Technical Education
- ☐ College Degree
- ☐ Post-Graduate Degree

16a. Do you use science in your work? ☐ Yes ☐ No

16b. If Yes, how?

_____

NISE Mini-Exhibition Study
Visitor Interview, Question #8

Please point to any of the following features you noticed within the exhibit.

Spanish Content

Flip Panels

Audio Description Labels

Appendix C: Exploratory Study of Hispanic Audiences

As described in the Summary of Findings, the Nanoscale Informal Science Education Network (NISE Net) Public Impacts Evaluation group embarked on a three-year study in March, 2012, to explore the public impacts of the most resource-intensive educational products developed by the Network. During this first year of the study, the Public Impacts Evaluation focused on conducting a summative evaluation of the *Nano* mini-exhibition.

As part of the summative study, an exploratory study of Hispanic visitors was conducted at two partner organizations. The sample sizes at both sites were quite small, and as such, the findings generated from the exploratory study should not be broadly generalized and assumed to be representative of all Hispanic visitors in all types of institutions across all of NISE Net's geographic regions. Rather, the information gathered through this small study should be seen as beginning to shed light on how *Nano* may work as an experience and learning environment for Hispanic visitors.

This appendix will provide a more complete description of our study methods as well as supplemental findings that support and expand on those presented in the Summary of Findings.

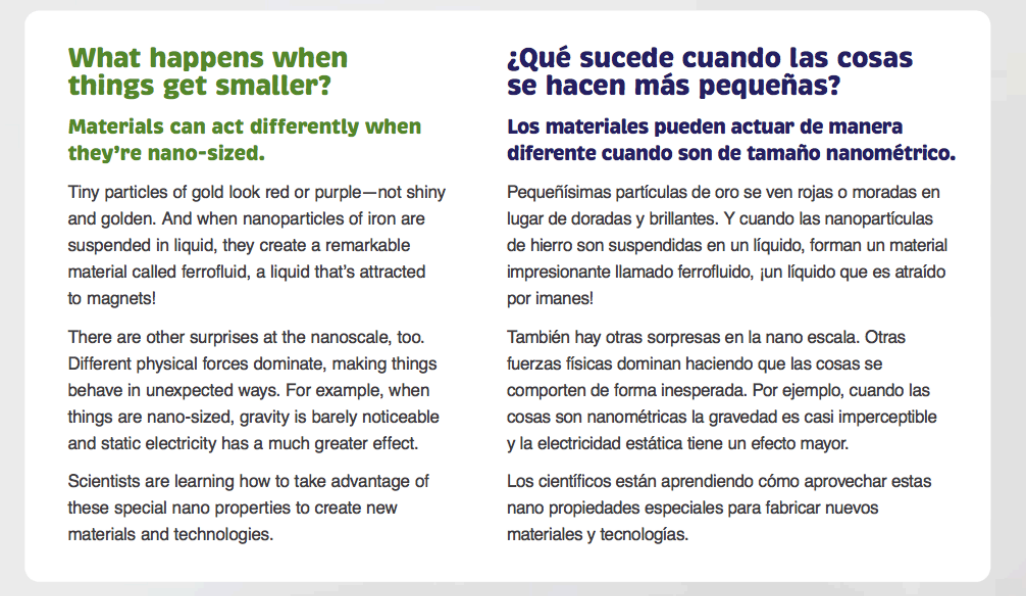
Bilingual Signage Approach of the *Nano* mini-exhibition

As described in earlier sections of this document, *Nano* is an interactive mini-exhibition that engages family audiences in nanoscale science, engineering, and technology. Hands-on exhibits present the basics of nanoscience and engineering, introduce some real world applications, and explore the societal and ethical implications of this new technology. The mini-exhibition was originally designed to have footprint of 400 square feet. There are seven main components, including four panels (*What Happens When Things Get Smaller?, Where Can You Find Nano? I Spy Nano, What's New About Nano?* and *What Does Nano Mean for Us*), the *Balance Our Nano Future* tippy table, the *Small, Smaller, Nano* ferrofluid interactive display, and *Build a Giant Carbon Nanotube*. The mini-exhibition also contains a *Static Beads* component and a seating area with a variety of nano-themed books and reading boards. Currently, over seventy identical copies of Nano will be produced and distributed to Network partners; as of January, 2013, 43 copies have been shipped. For a more detailed description of the mini-exhibition, see http://www.nisenet.org/catalog/exhibits/nano_mini-exhibition.

The NISE Network is committed to making educational products accessible to non-English speaking audiences, particularly Spanish speakers (as Spanish is anticipated to continue to be the second most common language nationwide). The Network has adapted its most popular programs for Spanish-speaking audiences, placing the highest priority on translating products that directly serve public audiences. More information about NISE Net bilingual resources – including a Translation Process Guide and a Bilingual Design Guide - can be found on the project website, *www.nisenet.org/catalog/spanish*.

Within the mini-exhibition, English and Spanish are used side-by-side throughout the exhibition signage. The *Nano* design team worked with a set of advisors who provided insight about cultural and social relevance for Hispanic groups during the translation

process. They also provided feedback on translations as they were developed. The resulting bilingual text is presented consistently throughout the exhibition in different colors to assist visitors, as seen in Figure 1, which illustrates text from the *What Happens When Things Get Smaller?* Panel, and in Figure 2, which illustrates text from the *Small, Smaller, Nano* component. Lastly, the Audio Description for blind and low-vision visitors is also available in Spanish.



What happens when things get smaller?

Materials can act differently when they're nano-sized.

Tiny particles of gold look red or purple—not shiny and golden. And when nanoparticles of iron are suspended in liquid, they create a remarkable material called ferrofluid, a liquid that's attracted to magnets!

There are other surprises at the nanoscale, too. Different physical forces dominate, making things behave in unexpected ways. For example, when things are nano-sized, gravity is barely noticeable and static electricity has a much greater effect.

Scientists are learning how to take advantage of these special nano properties to create new materials and technologies.

¿Qué sucede cuando las cosas se hacen más pequeñas?

Los materiales pueden actuar de manera diferente cuando son de tamaño nanométrico.

Pequeñísimas partículas de oro se ven rojas o moradas en lugar de doradas y brillantes. Y cuando las nanopartículas de hierro son suspendidas en un líquido, forman un material impresionante llamado ferrofluido, ¡un líquido que es atraído por imanes!

También hay otras sorpresas en la nano escala. Otras fuerzas físicas dominan haciendo que las cosas se comporten de forma inesperada. Por ejemplo, cuando las cosas son nanométricas la gravedad es casi imperceptible y la electricidad estática tiene un efecto mayor.

Los científicos están aprendiendo cómo aprovechar estas nano propiedades especiales para fabricar nuevos materiales y tecnologías.

Figure 1. Bilingual text on *What Happens When Things Get Smaller?* Panel.

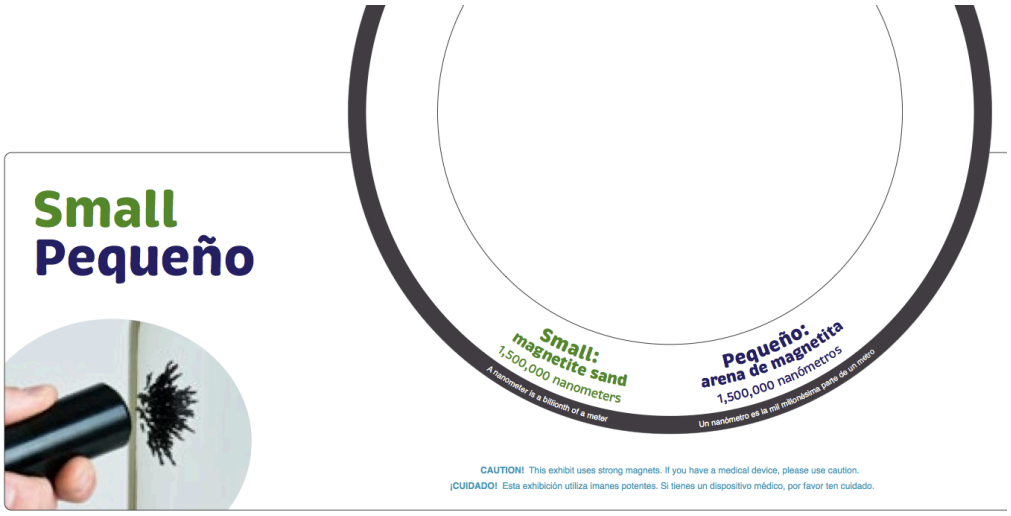


Figure 2. Bilingual text on the *Small, Smaller, Nano* component.

Exploratory Study Questions

Given the inclusion of Spanish translations in the mini-exhibition, the Network was interested in learning about how *Nano* was working for Hispanic Audiences, both in terms of providing an engaging experience and promoting learning of nano concepts. In addition, the exploratory study examined the level to which the broader general audience for *Nano* – across all of the study sites – noticed the Spanish translations and how they reacted to them.

Thus, the main questions for this exploratory study were:

1. Is *Nano* successful in providing a small sample of Hispanic visitors with an engaging experience and promoting visitor learning of nano concepts?
2. Overall, did visitors across all of the different data collection sites notice the Spanish translations? If so, did the translations impact their experience?

It should be noted that these questions and this study focus on the printed translations in the mini-exhibition, and do not include the Audio Descriptions in Spanish that were also available.

Methods and Considerations

Conducting a study focused on a traditionally underrepresented minority group such as Hispanic visitors requires several additional considerations throughout the different phases of the work. In order to develop culturally appropriate methods, analyses, and findings, the Public Impacts team was purposefully assembled to include an experienced, bilingual/bicultural evaluator who had extensive experience working with Hispanic audiences. (In a similar manner, our team included an evaluator experienced in conducting evaluations with visitors with disabilities, which led to the other small exploratory study described in Appendix D.)

As the team designed and conducted our study, we engaged in discussions about common evaluation methods and practices that could be slightly modified in order to be more culturally appropriate and responsive to the Hispanic audiences we hoped to study. Below, we provide a list of these modifications, which we present as one example of how to begin to think about doing more culturally responsive evaluations. Certainly, each of these areas could be further expanded and explored; our goal is not to provide a definitive set of considerations for this work, but rather, to simply share and document our process.

Considerations for Protocol and Instrument Design

While the instruments and protocols were being designed for the general audience portion of our summative study, we engaged in conversations about how to modify these pieces for the Hispanic audiences work.

Protocol Modifications

The protocol for our general audience sample began with an uncued observation of a target visitor group with the *Nano* mini-exhibition, where the data collector filled out an observation form to record visitor behaviors. After the target group was finished their time at *Nano*, the nearest adult in the group was approached and invited to participate in the survey and interview portions of the study.

As we were thinking about the exploratory study and observing Hispanic visitors, two modifications were suggested by our experienced bilingual evaluator and incorporated by our team:

- Noting the language use during the group observation. Groups were noted as speaking primarily in Spanish, English, or a mix of both.

- Asking about language preference during the post-observation intercept. Visitors who were asked to participate in the other portions of the study were asked what language they preferred to engage with the survey and interview. Our bilingual/bicultural data collectors were then able to proceed with the rest of the protocol in the preferred language of the visitor.

These additions contributed to our analysis and ultimately allowed us to see differences in the language preferences of Hispanic audiences specific to the two sites we studied.

Instrument Modifications

As a team, we discussed whether or not to change the general audience instruments we were developing in order to better align with the experiences of Hispanic audiences. Ultimately, we decided not to significantly modify any of the survey or instrument questions specifically for Hispanic audiences. However, we did do the following during the instrument development phase:

- Edited our demographics section of the survey to be more inclusive overall, including:
    - A question about participant gender was edited to include an "other" option, going beyond "male" and "female".
    - Racial categories were aligned with census categories, and an option for "Two or more races" was added.
    - An ethnicity question was added where visitors could identify themselves as "Hispanic/Latino", "Not Hispanic/Latino", "Not sure", or "Other".
    - A follow up question to the ethnicity question – providing visitors with a way to identify the cultural backgrounds they associated with if they were Hispanic/Latino – was asked.
    - Additional categories were added to the "total annual income" question and the "highest level of education" question in order to provide more nuanced understandings of our respondents.

- Translated the survey and interview instruments into Spanish, and then piloted them with Spanish speakers at one of the study sites. The translation of the instrument and further revisions went through a quality control process, which

entailed the review of materials by at least two bilingual evaluation staff members in addition to the original translator.

- Asking more follow-up questions as appropriate. Our bilingual data collectors often attempted to ask more follow up questions to Hispanic visitors after a specific question in the interview (*"Did you notice the Spanish translations? If so, how did they impact your experience?")* in order to gain a richer understanding of their experience. In particular, data collectors probed further on the notion of impact, frequently asking "How so?" after the initial response provided by the Hispanic visitor.

Considerations for Data Analysis and Reporting

After all the data was collected for the summative study, our team discussed different ways to analyze the data and report findings from Hispanic visitors.

Data Analysis Modifications

Our experienced bilingual/bicultural evaluator suggested the following practices:

- Conducting data analysis in Spanish when the data was collected in Spanish. By having bilingual evaluators doing the qualitative coding of open-ended responses in the original language, there was less risk of losing context and meaning due to translation into English. Similarly, as coding schemes were refined, the bilingual evaluators continued to do the qualitative coding on the Hispanic audience data, allowing for further preservation of the original language.

- Translating into English in order to communicate with the rest of the team as well as to provide examples in English if/when needed. Once again, the quality-controlled process of translation was used with the collected data, in order to ensure accuracy. The English versions of the responses were used during team meetings to share responses and perspectives from Spanish-speaking Hispanic visitors.

- Checking frequently with the rest of the team about the emergent themes and coding scheme development. Often times, when studying different audiences, emergent themes for visitor responses differ by group. In this study, there was quite a bit of similarity between the emergent themes from the general audience analysis and the Hispanic audience analysis, which became evident as different members of the team worked together on parallel analysis activities.

- Hispanic visitor data should be aggregated for analysis only within a particular institution, not across institutions. Due to the vast regional differences in the use of language (amid other factors, such as the history of the Hispanic/Latino community in a particular area) that exist, it was not appropriate to combine data from different exploratory study sites for analysis.

Report Writing and Dissemination

Part of the challenge with writing up the findings from the exploratory work was related to the need of summarizing large, Network-wide studies. Often, executive summaries must leave out all but the main message of any particular finding, and given the importance of contextualizing the exploratory findings from each of the two sites where we conducted this work, finding ways to describe and talk about the small study on Hispanic audiences was challenging. However, working with our bilingual/bicultural evaluator and several other members of the NISE Net evaluation team, we feel our final summaries balance the need for both brevity and context. Some key considerations along the way included:

- Thinking about how to write and talk about the participants. When we began study planning, we were focused on understanding the experiences of Spanish-speakers within *Nano*. However, as our data collectors went out to different sites, it became clear that in one of the locations, very few of the Hispanic visitors who were asked to participate in the study actually preferred to speak Spanish – instead, they preferred to speak English. Thus, the descriptions of our target sample for the exploratory study changed to Hispanic visitors, and then we noted language preference both during the exhibit observation and through the self-report of the visitor during the survey and interview portions of the study.

- When writing up findings from the study, be extremely thoughtful about not making comparisons between the underrepresented target group and other groups. This study was exploratory in nature, not comparative. It was not set up specifically as a comparative study between Hispanic and non-Hispanic audiences. Thus, making direct comparisons between groups was inappropriate from a methodological standpoint.

- Also, be extremely thoughtful about not overstating claims, and remind readers of this frequently. Throughout the writing of the study documents, our experienced bilingual evaluator – as well as others within the NISE Net Evaluation Team – carefully read over drafts of report sections as they were being produced and offered useful feedback in terms of framing claims appropriately in terms of scope and certainty. The main concern here was to ensure that the small sample size of the study was taken into consideration when stating claims, and that it was not at all appropriate to generalize findings from this small study to all Hispanic visitors to the mini-exhibition, let alone the broader Hispanic population writ large.

These modifications to our general audience methods strengthened and enriched our exploratory study of Hispanic audiences. Certainly, these ideas and practices are not an all-encompassing list of considerations when studying underrepresented bilingual audiences, and continued discussion – both across the Network and the ISE field – of these techniques would appear to be quite productive and worthwhile.

Study Contexts

The exploratory study of Hispanic audiences took place at two of the five partner sites that were primary data collection sites for the general audience study.

Oregon Museum of Science and Industry (OMSI); Portland, OR

The NISE mini-exhibition at the Oregon Museum of Science and Industry (OMSI) is installed in the Turbine Hall exhibit floor on the main level, 1 out of 2, of the building. This floor contains an Earthquake House, a lunch room for visitors, a group of engineering exhibits, the Physics Chemistry and the Vernier Technology Lab, Autovation exhibit, the Inventor's Ball Room, along with a spinning wheel table, probability ball drop exhibit, computer hardware exhibits, and robotic exhibits.

The mini-exhibition installation at OMSI contains all the nine components developed by NISE and a seating area including all books and materials for the seating area. The mini-exhibition occupies approximately 415 square feet and it is located in an alcove on the river side of the building right in front of the elevator located in the northwest part of the hall. The mini-exhibition is shaped in a rectangular form with the reading rail panels facing the river view wall and the rest of the components distributed throughout the rest of the alcove space. Staff are not stationed at the mini-exhibition specifically, and there were no floor staff re-setting or cleaning exhibit components while data collection was conducted.

Data from OMSI contributed to the counting study, core study, and small exploratory study of Hispanic visitors portions of the summative evaluation.

Hispanic Visitor Sample at OMSI

The Hispanic audience sample at OMSI consisted of 28 complete sets (including an observation, a survey, and an interview) of visitor data. Demographic data for this group is presented in Tables 1-14 on visitor Gender, Age, Race, Ethnicity, Cultural Background, Languages Spoken at Home, If the Household is MultiLingual, Education, Income, Disability, Type of Disability, Use of Science in Daily Work, Previous Visits to the Museum, Interest in Science, and Previous Exposure to Nano.

Table 1. Gender (n=28)

Male	Female
39.3%	60.7%

Table 2. Age (n=26)

Under 21	21-29	30-39	40-49	50-59	60+
3.8%	26.9%	54.0%	15.4%	0.0%	0.0%

Table 3. Race (n=12)

African-American	White	American Indian or Alaskan Native	Native Hawaiian or Other Pacific Islander	Asian	Not Sure	Two or More
0.0%	33.3%	8.3%	0.0%	0.0%	33.3%	25.0%

Table 4. Ethnicity (n=28)

Hispanic/Latino	Not Hispanic/Latino	Not Sure	Other
100.0%	0.0%	0.0%	0.0%

Table 5. Cultural Background (n=28)

Mexican	Puerto Rican	Salvadoran	Guatemalan	Peruvian	Other
89.3%	3.6%	3.6%	3.6%	7.1%	3.6%

Table 6. Languages Spoken at Home (n=28)

English	Spanish	Other
35.7%	92.9%	7.1%

Table 7. Is Household Multi-lingual (n=28)

Yes	No
32.1%	67.9%

Table 8. Education Level (n=27)

Less than high school	Completed high school	Some college or technical ed.	College degree	Post- graduate degree
37.0%	25.9%	18.5%	14.8%	3.7%

Table 9. Income (n=25)

Under $20,000	$20,000-$39,999	$40,000-$59,999	$60,000-$79,999	$80,000-$99,999	$100,000-$149,999	$150,000+
20.0%	52.0%	16.0%	8.0%	4.0%	0.0%	0.0%

Table 10. Disability (n=28)

Yes	No
7.1%	92.9%

Table 11. Type of Disability

Mobility (n=2)	Learning (n=1)
50.0%	100.0%

Table 12. "Do You Use Science in Your Daily Work?" (n=26)

Yes	No
42.3%	57.7%

Table 13. Visits to the Museum in the Last Two Years (n=28)

None	1-2 times	3-4 times	5 or more times
28.6%	42.9%	17.9%	10.7%

Table 14. Scale Questions Regarding Interest in Science and Previous Exposure to Nanoscience

	N	Mean	*SD*
Interest in Science (on a scale of 0-10)	28	8.46	1.48
Previous Exposure to Nanoscience (on a scale of 1-4)	28	3.18	0.91

Science Spectrum; Lubbock, TX

The NISE mini-exhibition at Science Spectrum in Lubbock is installed on the exhibit floor on the lower level, 1 out of 3 of the building. This floor contains a series of exhibits related to human health and biology, dinosaur models, a rock climbing wall and a major exhibit Texas Alive: The Brazos River Journey. There is also a computer lab, a classroom, a tinkering counter, and the birthday party room. The mini-exhibition is located in the corner occupied by the birthday party room and classroom. The reading rail panels and the natural corner of the room limit the perimeter of the exhibit.

The mini-exhibition installation at Science Spectrum contains all the nine components developed by NISE and a seating area. The reading area does not have the books and the laminated materials are incomplete. It fills out approximately 500 square feet in a square shape.

Staff are not stationed at the mini-exhibition specifically, however floor educators leading birthday party activities often re-set exhibit components, mainly the Nano Carbon Tube.

Data from Science Spectrum contributed to the counting study, core study, and small exploratory study of Hispanic visitors portions of the summative evaluation.

Hispanic Visitor Sample at Science Spectrum

The Hispanic audience sample at Science Spectrum consisted of 21 complete sets (including an observation, a survey, and an interview) of visitor data. Demographic data for this group is presented in Tables 15-27 on visitor Gender, Age, Race, Ethnicity, Cultural Background, Languages Spoken at Home, If the Household is MultiLingual, Education, Income, Disability, Type of Disability, Us of Science in Daily Work, Previous Visits to the Museum, Interest in Science, and Previous Exposure to Nano.

Table 15. Gender (n=20)

Male	Female
65.0%	35.0 %

Table 16. Age (n=21)

Under 21	21-29	30-39	40-49	50-59	60+
14.3%	43.0%	38.1%	5.0%	5.0%	0.0%

Table 17. Race (n=15)

African-American	White	American Indian or Alaskan Native	Native Hawaiian or Other Pacific Islander	Asian	Not Sure	Two or More
0.0%	53.3%	0.0%	0.0%	0.0%	13.3%	20.0%

Table 18. Ethnicity (n=21)

Hispanic/Latino	Not Hispanic/Latino	Not Sure	Other
100.0%	0.0%	0.0%	0.0%

Table 19. Cultural Background (n=20)

Mexican	Puerto Rican	Ecuadorian
100.0%	5.0%	5.0%

Table 20. Languages Spoken at Home (n=21)

English	Spanish	Other
95.2%	4.8%	0.0%

Table 21. Is Household Multi-lingual (n=21)

Yes	No
0.0%	100.0%

Table 22. Education Level (n=21)

Less than high school	Completed high school	Some college or technical ed.	College degree	Post- graduate degree
9.5%	19.0%	28.6%	38.1%	4.8%

Table 23. Income (n=19)

Under $20,000	$20,000-$39,999	$40,000-$59,999	$60,000-$79,999	$80,000-$99,999	$100,000-$149,999	$150,000+
10.5%	31.6%	31.6%	10.5%	15.8%	0.0%	0.0%

Table 24. Disability (n-21)

Yes	No
0.0%	100.0%

Table 25. "Do You Use Science In Your Daily Work?" (n=21)

Yes	No
38.1%	61.9%

Table 26. Visits to the Museum in the Last Two Years (n=21)

None	1-2 times	3-4 times	5 or more times
47.6%	19.0%	23.8%	9.5%

Table 27. Scale Questions Regarding Interest in Science and Previous Exposure to Nanoscience

	N	Mean	*SD*
Interest in Science (on a scale of 0-10)	21	7.05	2.18
Previous Exposure to Nanoscience (on a scale of 1-4)	21	3.29	0.78

Supplemental Findings – OMSI Hispanic Visitors

The data reported in the Summary of Findings for Hispanic visitors at OMSI was based on the full analysis performed on the data collected at that institution and with the Hispanic audience. Below, we provide the additional tables and information that could not be included in the Summary of Findings but still contributed in some way to the document. The format of this section will echo that of the Summary and be divided by the indicators of success outlined by the *Nano* design team.

Sustained Use

Table 28. Mini-exhibition Use (n=28)

Indicator	
Mean Dwell Time	11:08 (min, sec)
Median Dwell Time	8:05
Sweep Rate Index	49, assuming 400 sq. ft.

Once again, we are using the median dwell time in the Sweep Rate Index calculation, in order to provide a more conservative estimate of this ratio.

Interest and Enjoyment

Table 29. Interest and Enjoyment Reported by Visitors (n=28)

Interest and Enjoyment	Percent of Visitors or responses
Top two levels of interest	89%
Top two levels of enjoyment	89%
Top two levels of interest for child	72%
Top two levels of enjoyment for child	81%
As or more interesting than other exhibits	94%
Percent of positive adjectives chosen to describe experience	97%, with 86 total adjectives chosen

In addition, 32 of Hispanic visitors at OMSI (n=28) reported finding something about the mini-exhibition challenging. When asked to elaborate on what was challenging, three respondents said the content was confusing or challenging, and six respondents said that components were difficult to use.

Hispanic visitors at OMSI most commonly indicated the *Small, Smaller, Nano* component was the favorite part of the mini-exhibition, with 41% of respondents making this choice. The next most frequently identified favorite components were *Build a Giant Carbon Nanotube* (with 18% of respondents choosing this element as their favorite) and generally the panels of the exhibition (with 12% identifying at least one panel as their favorite piece.

Social Interaction, Broad Age Range, Further Exploration

Social interaction. Group interaction was noted in 86% of the observations, suggesting that one of the original design goals of the mini-exhibition – promoting group use of components during the experience – was accomplished for Hispanic visitors at OMSI.

Broad age range. *Nano* attracted Hispanic visitors at OMSI from ages 0 (infant) to 49. Almost half (49%) of visitors were also observed to be children, defined as being below the age of 18.

Table 30. Distribution of Observed Ages Within Visitor Groups (n=96 across 27 group observations)

Age Range	Percentage
0-5	19%
6-8	13%
9-12	8%
13-17	9%
18-20	5%
21-29	10%

Age Range	Percentage
30-39	26%
40-49	8%
50-59	0%
60-69	0%
70+	0%

Further exploration. Visitors did explore the mini-exhibition beyond the hands-on activities. A majority of groups (86%, n=28) had at least one group member stop at least one panel. *Where Can You Find Nano? I Spy Nano* was the most visited panel, with the majority (82%) of Hispanic visitor groups being observed using it. The other panels were also visited frequently, with 64% of Hispanic visitors being observed at the *What's New About Nano?* panel, 57% observed at the *What Happens When Things Get Smaller?* panel, and 43% at the *What Does Nano Means for Us?* panel.

Additionally, 71% of Hispanic visitors who were interviewed reported noticing the flip panels, and the majority of visitors who noticed them said they had a positive effect on their experience within the exhibition. The books and reading boards were the least

utilized of the "further exploration" components, with only 20% of Hispanic visitor groups being observed using them. However, it should be noted that all the reading boards were bilingual, but the books were only available in English.

Learning About Nano Content

The tables below were summarized in the Summary of Findings document and provide evidence to suggest that Hispanic visitors at OMSI were engaging with nano content and learning about different areas of the NISE Net content map. Table 31 shows the percentage of visitors who identified at least one area of the content map when asked two different questions about what they learned at the exhibit. Table 32 shows the distribution of responses across the different areas of emphasis within the content map.

Table 31. Visitors Who Mentioned at Least One Area of the NISE Net Content Map When Responding to Questions About Learning in the Exhibit (n=28)

Questions about Visitor Learning	Percent of visitors who mentioned at least one area of the NISE Net content map
Q3. What do you think the exhibit was about overall?	59%
Q10. If a friend asked you what you leaned at the exhibit today, what would you tell them?	68%

Table 32. Distribution of Visitor Responses to Learning Questions Across the Areas of the NISE Net Content Map (n=28)

NISE Net Content Map areas	Percent of responses, Question 3	Percent of responses, Question 10
Nanometer-sized things are very small.	8%	6%
Nanometer-sized things behave differently.	3%	3%
Nano is about manipulating things on the nanoscale.	6%	3%
New knowledge and innovation that weren't possible before.	28%	18%
Nanotechnologies have risks and benefits.	6%	3%
Nano is connected to our lives.	11%	35%
Other	8%	15%
General comments about science	11%	0%
I don't know	11%	6%
Nature/environment	8%	3%
Nothing	N/A	9%

In addition, 75% of the Hispanic visitors at OMSI answered "Yes" to the question "Did the exhibit connect to anything in your own life?", suggesting visitors found the experience relevant.

Table 33 reports the non-parametric Wilcoxon Ranked Sign Test performed on the confidence scores of Hispanic visitors, showing a statistically significant increase in confidence from retrospective pre- to post scores.

Table 33. Difference in Visitor's Reported Confidence Levels Based on Retrospective Pre and Post Answers (n=28)

Confidence Items	Percent of visitors reporting top two levels of confidence after visiting the mini-exhibition	*Mean confidence score, pre*	*Mean confidence score, post*	*Z*
Talk about how scientists are able to build things atom by atom at the nanoscale.	36%	1.68	2.32	-3.626**
Describe one example of how nanoscale objects behave differently than other objects.	39%	1.64	2.25	-3.494**
Name a product, technology, or example in nature that involves nanoscale science.	61%	2.00	2.71	-3.256**
Identify at least two factors to consider when thinking about using new nanoproducts or nanotechnologies.	47%	1.75	2.43	-3.275**
Identify at least one way that nano will impact my life in the future.	61%	2.04	2.75	-3.256**

***p<0.01, Wilcoxon Signed Rank Test; Scale goes from 1-4.*

Spanish Translations and Language Preferences

All but one Hispanic visitor at OMSI (96%, n=28) who was interviewed for the study reported noticing the Spanish translations. Of those who noticed, 85% said the translations had a positive impact on their experience. One visitor reported a neutral impact, and one reported a negative impact.

Of the 23 Hispanic visitors who reported a positive impact on their experience, the most common theme in their responses was that they felt the translations helped make *Nano* feel more inclusive. For example, one visitor said, "I read the ones that are in Spanish because it's what I understand. In English, I don't understand English." Another visitor reported the opportunity to learn more about a particular language, saying "For someone who is bilingual, sometimes we don't understand a word in Spanish or in English, and I compared both languages. It helped me." The one Hispanic visitor who reported a negative impact said, "There are confusing words in Spanish".

In addition, the majority of Hispanic visitors at OMSI preferred to use Spanish versions of the survey and interview, as seen in Table 34.

Table 34. Language Preference (n=28)

Preferred Language	Percent of Visitors
English	14%
Spanish	61%
English and Spanish	25%

Also, there was one noted instance of a visitor who preferred to do the survey and interview in English who was observed using Spanish within the mini-exhibition. Although the use of English was not specifically noted during the observation, anecdotal evidence from our data collectors suggest the converse also occurred – that a few groups who preferred to do the survey and interview in Spanish were also observed using English within the mini-exhibition.

Supplemental Findings – Science Spectrum Hispanic Visitors

The data reported in the Summary of Findings for Hispanic visitors at Science Spectrum was based on the full analysis performed on the data collected at that institution and with the Hispanic audience. Below, we provide the additional tables and information that could not be included in the Summary of Findings but still contributed in some way to the document. The format of this section will echo that of the Summary and be divided by the indicators of success listed outlined by the *Nano* design team.

Sustained Use

Table 35. Mini-exhibition Use (n=21)

Indicator	
Mean Dwell Time	7:29 (min, sec)
Median Dwell Time	5:43
Sweep Rate Index	69, assuming 400 sq. ft.

Once again, we are using the median dwell time in the Sweep Rate Index calculation, in order to provide a more conservative estimate of this ratio.

Interest and Enjoyment

Table 36. Interest and Enjoyment Reported by Visitors (n=21)

Interest and Enjoyment	Percent of Visitors or responses
Top two levels of interest	95%
Top two levels of enjoyment	95%
Top two levels of interest for child	93%
Top two levels of enjoyment for child	93%
As or more interesting than other exhibits	47%
Percent of positive adjectives chosen to describe experience	97%, with 79 total adjectives selected

In addition, 14% of Hispanic visitors at Science Spectrum (n=21) reported finding something about the mini-exhibition challenging. When asked to elaborate on what was challenging, one respondent said the content was confusing or challenging, and one respondent said that components were difficult to use.

Hispanic visitors at Science Spectrum most commonly indicated the *Small, Smaller, Nano* component was the favorite part of the mini-exhibition, with 46% of respondents making this choice. The next most frequently identified favorite components were *Build a Giant Carbon Nanotube* (with 23% of respondents choosing this element as their favorite) and generally the panels of the exhibition (with 9% identifying at least one panel as their favorite component.

Social Interaction, Broad Age Range, Further Exploration

Social interaction. Group interaction was noted in 81% (n=21) of the observations, strongly suggesting that one of the original design goals of the mini-exhibition – promoting group use of components during the experience – was accomplished.

Broad age range. *Nano* attracted Hispanic visitors at Science Spectrum from ages 0 (infant) to 49. Almost half (49%) of visitors were also observed to be children, defined as being below the age of 18.

Table 37. Distribution of Observed Ages Within Visitor Groups; (n=74 across 21 group observation)

Age Range	Percentage
0-5	22%
6-8	19%
9-12	7%
13-17	1%
18-20	7%
21-29	16%

Age Range	Percentage
30-39	28%
40-49	0%
50-59	0%
60-69	0%
70+	0%

Further exploration. Visitors did explore the mini-exhibition beyond the hands-on activities. A majority of groups (86%, n=21) had at least one group member stop at least one panel. *Where Can You Find Nano? I Spy Nano* was the most visited panel, with the majority (76%) of Hispanic visitor groups being observed using it. Two other panels were also visited frequently, with 57% of Hispanic visitors being observed at the *What's New About Nano?* panel, and 33% observed at the *What Happens When Things Get Smaller?* panel.

Additionally, 71% of visitors who were interviewed reported noticing the flip panels, and the majority of visitors who noticed them said they had a positive effect on their experience within the exhibition. The books and reading boards were the least utilized of the "further exploration" components, with only one visitor group being observed using these pieces. Once again, it should be noted that all the reading boards were bilingual, but the books were only available in English.

Learning About Nano Content

The tables below were summarized in the Summary of Findings document and provide evidence to suggest that Hispanic visitors at Science Spectrum were engaging with nano content and learning about different areas of the NISE Net content map. Table 38 shows the percentage of visitors who identified at least one area of the content map when asked two different questions about what they learned at the exhibit. Table 39 shows the distribution of responses across the different areas of emphasis within the content map.

Table 38. Visitors Who Mentioned at Least One Area of the NISE Net Content Map When Responding to Questions About Learning in the Exhibit (n=21)

Questions about Visitor Learning	Percent of visitors who mentioned at least one area of the NISE Net content map
Q3. What do you think the exhibit was about overall?	48%
Q10. If a friend asked you what you leaned at the exhibit today, what would you tell them?	57%

Table 39. Distribution of Visitor Responses to Learning Questions Across the Areas of the NISE Net Content Map (n=21)

NISE Net Content Map areas	Percent of responses, Question 3	Percent of responses, Question 10
Nanometer-sized things are very small.	12%	16%
Nanometer-sized things behave differently.	4%	8%
Nano is about manipulating things on the nanoscale.	8%	12%
New knowledge and innovation that weren't possible before.	4%	20%
Nanotechnologies have risks and benefits.	4%	0%
Nano is connected to our lives.	19%	8%
Other	19%	12%
General comments about science	23%	16%
I don't know	7%	4%
Nature/environment	0%	0%
Nothing	N/A	4%

In addition, 52% of the Hispanic visitors at Science Spectrum answered "Yes" to the question "Did the exhibit connect to anything in your own life?", suggesting visitors found the experience relevant.

Table 40 reports the non-parametric Wilcoxon Ranked Sign Test performed on the confidence scores of Hispanic visitors, showing a statistically significant increase in confidence from retrospective pre- to post scores.

Table 40. Difference in Visitor's Reported Confidence Levels Based on Retrospective Pre and Post Answers (n=21)

Confidence Items	Percent of visitors reporting top two levels of confidence after visiting the mini-exhibition	*Mean confidence score, pre*	*Mean confidence score, post*	*Z*
Talk about how scientists are able to build things atom by atom at the nanoscale.	24%	1.38	1.95	-3.207**
Describe one example of how nanoscale objects behave differently than other objects.	24%	1.29	1.95	-3.071**
Name a product, technology, or example in nature that involves nanoscale science.	52%	1.57	2.24	-2.640**
Identify at least two factors to consider when thinking about using new nanoproducts or nanotechnologies.	28%	1.43	2.00	-2.585*
Identify at least one way that nano will impact my life in the future.	67%	1.86	2.62	-2.724**

**p<0.05; **p<0.01, Wilcoxon Signed Rank Test; Scale goes from 1-4.*

Spanish Translations and Language Preference

The majority of Hispanic visitors at Science Spectrum (76%, n=21) reported noticing the Spanish translations. Of those who noticed, 31% said the translations had a positive impact on their experience, and the remaining 69% reported a neutral impact. None reported a negative impact.

Of the five visitors who reported a positive impact, the main theme in their responses was that they felt positively about the ways the Spanish translations made the exhibition feel inclusive. For example, one visitor said, "[They are] helpful for other people that cannot read English. There [are] a lot of people that speak other languages here."

In addition, the majority of Hispanic visitors at Science Spectrum preferred to use English versions of the survey and interview, as seen in Table 41.

Table 41. Languages Preference (n=28)

Preferred Language	Percent of Visitors or responses
English	86%
Spanish	5%
English and Spanish	9%

At Science Spectrum, there was at one noted instance of a visitor who preferred to do the survey and interview in English who was observed using Spanish within the mini-exhibition.

Discussion and Future Questions For the ISE Field

Although the findings from this exploratory study should not be generalized broadly to all Hispanic audiences, there are three key findings related to the small groups we did study at OMSI and Science Spectrum:

- *Nano* appeared to be successful for these visitors, where success was measured against the indicators set forth by the Network and the *Nano* design team.

- At the two sites, Hispanic visitors had different language preferences when engaging with our data collectors. At OMSI, most Hispanic visitors preferred to conduct the survey and interview portions of the study in Spanish. At Science Spectrum, the vast majority of Hispanic visitors preferred to conduct the survey and interview in English. However, at each location, there was evidence of at least one group that preferred to do the survey and interview in one language, but were observed using the mini-exhibition in the other language. This suggests that having the exhibit be in both languages can be quite useful even if one language is more commonly used than another within a particular group.

- When visitors reported the translations having an impact on their experience with *Nano*, more visitors reported a positive impact than a negative impact within these two study groups as well as the general audience overall (as seen in Appendix A). However, at OMSI, the vast majority (85%)of Hispanic visitors who reported noticing the Spanish translations said that the translations had a positive impact on their experience; at Science Spectrum, it was only 31% – the same proportion as seen in the general audience (as seen in Appendix A). Potential reasons for this could be the differences in language preferences of Hispanic visitors from OMSI and Science Spectrum, or perhaps the familiarity of seeing bilingual translations within a particular institution or community.

In addition to providing findings about the Hispanic visitors that participated in our study, we feel that this work points to three questions for future inquiry:

1. What is the broader impact of a bilingual exhibition? Bilingual exhibitions can do more than provide language support to a target audience. These pieces can also impact the perception of the institution, both internally (among the institution staff) as well as externally (within the local community). In particular, exploring the perceptions of the public and the professionals about why bilingual experiences are being developed, and the perceptions about what motivations – such as inclusion, intentions to reflect the community's demographics and increase accessibility of science content to minorities and underserved communities, etc. – may be behind these efforts, may be quite interesting and fruitful.

2. What might contribute to notable findings from the Hispanic visitor data? Though our sample was quite small, there were several findings that stood out and warrant further exploration, such as the lengthy dwell times of Hispanic groups at both sites, and the differences in the ways they described their experiences to our data collectors. What might be are some elements that might cause these findings to exist?

What are the cultural considerations that come into play, such as (a possible lack of) familiarity with museums and science content, levels of education, etc.? What are the connections between measured outcomes and other factors?

3. What are the different cultural responses to our standard evaluation methods, and how can we be more culturally appropriate in our work? In this study, we were fortunate to have an experienced bilingual/bicultural evaluator working with us on our team every step of the way in order to develop culturally appropriate instruments, protocols, and interpretations of data. However, a broader question of methods – particularly data collection methods – still exists for the ISE field. To what extent do different cultural groups resonate with our common data collection practices, such as surveys and interviews? How comfortable are different groups with these data collection methods? And how do we balance the notion of 'rigor' with the notion of culturally responsive evaluation, such as when the desire for appropriate sampling of one adult per group conflicts with the cultural norm of answering questions together as a family unit?

Certainly, these questions merely scratch the surface of what might be useful to explore further when thinking about conducting culturally appropriate bilingual evaluations. We hope the documentation of our process and the questions we pose here – along with an in-depth examination of current literature on engaging Hispanic Audiences in museums and other informal learning environments – can contribute to the advancement of ongoing conversation about this type of work in our field.

Appendix D: Exploratory Study of Visitors with Disabilities

This appendix of the *Nano* mini-exhibition summative evaluation will explore the extent to which *Nano* is inclusive of visitors with a broad range of abilities and disabilities.

As described in *"Nano* Mini-Exhibition Audiences" (NISE Network, 2011),

> The NISE Network is committed to making our exhibits and programs as accessible as possible for all museum visitors, including many ages, multiple languages, and a broad range of abilities and disabilities.

One component of this commitment is using a universal design approach during the design and development phases for all NISE Net educational products. The findings included in this appendix represent data collected from visitors with disabilities who used the *Nano* mini-exhibition at Port Discovery Children's Museum in Baltimore, MD, and the Museum of Science, in Boston, MA.

These data provide evidence that the multi-sensory elements and physical design of components are aspects of the mini-exhibition which promote inclusion. These aspects facilitate visitors' user experiences as well as their learning. These data also provide evidence of potential barriers to inclusion. Specifically, the low height of some exhibition components was identified as difficult for visitors with physical disabilities and the challenging content of nanotechnology was particularly difficult for younger visitors.

Finally, an analysis of the audio description will be provided as it represents a specific feature of the *Nano* mini-exhibition added to increase accessibility for visitors who are blind or have low vision.

Universal Design Approach

The universal design framework holds that all people fall on the spectrum of ability as a result of a combination of individual needs and environmental surroundings. Therefore, using a universal design approach, products and the environment can be designed to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design (Center for Universal Design, 2002).

Both the NISE Network (2010) and the Center for Advancement of Informal Science Education (CAISE) (Reich, Price, Rubin, & Steiner, 2010) hold that learners at all locations on the spectrum of ability should be able to interact with and engage with materials physically, cognitively, and socially. In order to ensure that exhibits and programs are as welcoming and accessible as possible to a broad range of visitors, key design questions are included in the development process to ensure visitors have the ability to:

> **Physically interact with/perceive the space:** Is the space set up so that a diversity of individuals can move around the space comfortably and safely? Is the information in the space conveyed in a variety of formats so that a diversity of

individuals can perceive it? Can a diversity of individuals manipulate or cause things to happen within the space?

Cognitively engage with the materials: Is the information conveyed using a range of media to allow a diversity of individuals to engage with the materials? Do the materials take into account a diversity of individuals with a range of learning and cognitive skills? Do the materials take into account a diversity of individuals with ranges of experiences and sets of background knowledge?

Socially interact with one another: Is the environment generally safe and welcoming for a diversity of individuals? Is the space set up to comfortably and safely to foster and facilitate encounters and engagement among a diversity of individuals? Are the materials designed to provide meaningful reasons to foster and facilitate interactions and discussion among a diversity of individuals?

Details of how NISE Net has incorporated universal design into the development of *Nano* are available in the resource "*Nano* Mini-Exhibition Audiences" (NISE Network, 2011). This document outlines design elements of the mini-exhibition which were included in an effort to increase accessibility and provides an overview of *Nano*'s iterative review process and formative evaluation.

Methods

In an effort to evaluate the extent to which *Nano* is inclusive of visitors with a broad range of abilities and disabilities, data collection took place at two sites including Port Discovery Children's Museum in Baltimore and Museum of Science, Boston (MOS).

Port Discovery
Data collected at Port Discovery includes observations of 28 school groups which included at least one child with a disability. Interviews were not conducted as a parent or guardian was not present for all children in the group. Observations suggest that there were three components of the *Nano* mini-exhibition that were used most often at Port Discovery: *Small, Smaller, Nano*; *Build a Giant Carbon Nanotube*; and *Balance our Nano Future tippy table exhibit*.

Museum of Science
At MOS, twelve family groups who included at least one person with a disability were recruited. These groups were observed as they used *Nano* and then presented with a survey and interview. All surveys and interviews were conducted with visitors over 18 years of age. Survey questions were identical to those asked of all visitors in the core study. Interviews included all questions posed to visitors in the core study as well as additional probes about exhibit usability and inclusion. If the group included a person with a disability who was a child, further interview questions were added that asked the adult caregiver or parent about their child's experience. Of the 14 people interviewed, 8 were adults with disabilities and the remaining 6 were the caregiver or parent of a child with a disability. The additional questions asked about the child's learning, the child's

favorite part of the exhibition, and parts of the exhibition that were challenging for the child.

The average dwell time for groups at MOS was 17:51. Because these groups were recruited to attend the museum and participate in this study, it is possible that this time is longer than groups would have spent in the mini-exhibition on a visit that was not part of data collection.

Observations show that visitors most frequently utilized components with an interactive and visual element. The most utilized component was *Small, Smaller, Nano* which was used by all groups (12 of 12). *Static vs. Gravity* was the second most visited component. *Build a Giant Carbon Nanotube* and the *Where Can You Find Nano? I Spy Nano* panel were the third most visited components.

1. Aspects of the Mini-Exhibition Promoting Inclusion

Data collected at Museum of Science, Boston (MOS) and Port Discovery suggest several aspects of the mini-exhibition promoting inclusion. Specifically, the multi-sensory elements and physical design of exhibit components contributed to positive experiences for visitor groups who included at least one person with a disability. During interviews, visitors were asked about their enjoyment and their favorite part of the mini-exhibition, as well as questions about what they had learned. These interviews with recruited family groups, supplemented by observations of their exhibition usage and observations of school groups using the exhibition provide evidence about the elements of the exhibition contributing to inclusion and how these elements facilitated visitor engagement and learning. This section presents the following findings:

1.1 Multi-sensory elements of the mini-exhibition promoted inclusion by allowing visitors to engage in the content in more than one way.
1.2 The physical design of certain mini-exhibition components promoted inclusion by allowing for easy reach, cognitive engagement, and a social experience.
1.3 Elements of the mini-exhibition promoting inclusion facilitated visitor learning.

1.1 Multi-sensory elements of the mini-exhibition promoted inclusion by allowing visitors to engage in the content in more than one way.

In keeping with NISE Net's commitment to universal design, the mini-exhibition was designed to incorporate multi-sensory opportunities for engagement (NISE Network, 2011). Visitors' responses suggest the effectiveness of this strategy as many of the multi-sensory elements were identified as particularly enjoyable by visitors. In particular, visitors utilized and appreciated tactile elements such as the magnetic wands at *Small, Smaller, Nano* or the carbon atoms at *Build a Giant Carbon Nanotube*. Aspects which engaged other senses such as the smelling interactive on the *Where Can You Find Nano?*

I Spy Nano panel or the sound of the beads on *Static vs. Gravity* were also called out as enjoyable.

When asked about their favorite part, visitors at MOS most frequently mentioned *Small, Smaller, Nano* (8 of 12 groups). This exhibit component was visited by all of the recruited MOS family groups and 16 of the 28 school groups at Port Discovery. *Small, Smaller, Nano* provides an example of how groups utilized the tactile element of the magnetic wands in order to maximize the visual experience. Visitors commented that they "enjoyed the challenge" or liked "throwing the liquid." For example, one adult with a disability said that this component was her favorite part because of the visual elements saying, "The magnets were very interesting. The liquid looks like a solid with a magnet, then like a liquid again without." Another parent suggested that this component was her daughter's favorite part commenting, "My daughter really enjoyed the magnets [at *Small, Smaller, Nano*]. We would bring the glob up and down and had a nice conversation." Not only was this mentioned as enjoyable during interviews, family and school groups were observed taking advantage of these aspects. For example, the magnetic wands were either grasped or placed into the hands of individuals in school groups at Port Discovery. Most school groups were observed using two or three of the sizes of carbon and often made comments suggesting a connection between the exhibit content and their previous knowledge such as comparing the ferrofluid to ink.

Static vs. Gravity was another mini-exhibition component which provided visitors a multi-sensory experience. At MOS, this exhibit was visited by 11 of 12 groups and selected by 6 groups as their favorite part of the mini-exhibition.[1] When asked why this component was their favorite, MOS visitors answering on behalf of their children with disabilities often mentioned that their children enjoyed the visual aspect of *Static vs. Gravity*. Several adults with disabilities agreed, commenting that this exhibit "clearly shows the difference" that size can make. Another adult responded, "[It's] common sense that heavier falls more, but you really see it." *Static vs. Gravity* was also visited by 3 of 28 school groups at Port Discovery. Adult chaperones in all three school groups exhibited similar behaviors in that they commented to their students about the difference in bead size. For example, while watching the beads spin, one adult said aloud to the student with her, "The large ones fall and the small ones stick."

These data suggest that using a universal design approach assists in developing an exhibition that is inclusive of visitors with a wide range of abilities and disabilities. Future exhibitions should continue to consider the potential of multi-sensory engagement and how to convey ideas through multiple means. Future evaluations should take note of how these features of exhibitions can impact and potentially deepen engagement of all visitors.

[1] This was the second most frequent response.

1.2 The physical design of certain mini-exhibition components promoted inclusion by allowing for easy reach, cognitive engagement, and a social experience.

In addition to multi-sensory elements within the *Nano* mini-exhibition, the physical design of individual exhibit components promoted inclusion. This is especially apparent in the social experiences provided by the three larger interactive components: *Build a Giant Carbon Nanotube*; *Balance our Nano Future tippy table exhibit*; and *Small, Smaller, Nano*. For example, *Build a Giant Carbon Nanotube* was used by 12 of the 28 school groups at Port Discovery. Of those 12, six groups were observed working together by either helping their fellow group members to reach pieces or by building the structure together.

Balance our Nano Future tippy table exhibit was visited by 9 of 12 groups at MOS and identified by 2 groups as their favorite part of the exhibition. One adult with a disability mentioned the socially inclusive atmosphere provided by the mini-exhibition through this component because it allowed for "good interactions with the people I was with." Eleven of the 28 school groups at Port Discovery visited this exhibit, many of which were observed balancing the table with visitors outside of their visitor group. During these interactions, one chaperone facilitating this experience demonstrated the social inclusiveness of this exhibit component when she said, "Let's see if we can't help him out." After the group tilted the table, the chaperone continued, saying, "Oh! You need our help!" and then after balancing the table, "You did it!"

The exhibit component which most highlighted the interconnectedness of physical, cognitive, and social inclusion was *Small, Smaller, Nano*. This exhibit allowed visitors to easily reach and manipulate the magnet wands. In fact, most visitors were observed using two or more sizes of carbon without needing to switch stools or move around the component. This physical design aided social experiences between group members and assisted in the cognitive goal of identifying the differences between different sizes of carbon.

For example, one school group observation at Port Discovery illustrates that the physical setup of *Small, Smaller, Nano* facilitated cognitive engagement and social inclusion by allowing two visitors to work together and create a shared game of moving the ferrofluid to the top of the cylinder, causing the visitor to exclaim, "Yes! I did it!"

Another observation at MOS highlights a similar experience for a family of four. One parent uses a wheelchair and the other uses a scooter; they visited the mini-exhibition with two of their three sons. Observation notes illustrate their experience with *Small, Smaller, Nano*:

> At *Small, Smaller, Nano*, one son (age 12) tells his mother about the three tubes which each include a different size of carbon. They talk to the people next to them using the ferrofluid or "nano" size even though they are from a different visitor group. Later, while at *Balance our Nano Future tippy table exhibit*, the son notices that the other visitors have left the "nano" size and says "Mom, the nano's open so you can look at it now." Both sons (age 6 and 12) use the magnets while

> their mother pulls alongside the component in her scooter. "Let me try" says the mother. Meanwhile, the first son notices their father and brings him over saying, "Dad, you gotta see this." The son explains the different sizes to his father.

As highlighted in the Summary of Findings, social interaction between visitors within the mini-exhibition was an intentional element of the design on the part of the *Nano* design team. These data suggest that the physical design of certain mini-exhibition components, which aided in group interaction, allowed for the inclusion of visitors with a range of abilities and disabilities. Future exhibitions should consider the potential of these designs which seem to allow for individual as well as group engagement. Future evaluations would benefit from further consideration of how to effectively observe and measure the complexity of social interaction.

1.3 Elements of the mini-exhibition promoting inclusion facilitated visitor learning.

Although data collected from visitors with disabilities is included in the larger analysis of visitor learning, a targeted examination of interview responses suggests that elements promoting inclusion, such as multi-sensory opportunities for engagement or the group-oriented physical design of components, facilitated visitor learning. During interviews, adults with disabilities not only referenced gaining a general understanding of nano and applications it allows, but several visitors identified specific facts from the exhibition like how particles of different sizes behave differently and how scientists are modeling what they see in nature to develop nanotechnology. Adults with disabilities also mentioned connections they saw in the exhibit to their own lives such as owning some of the technology highlighted or wondering if there was a nano connection to the cochlear implants the visitor was wearing.

Adults with children with disabilities were asked about their children's learning. Three adults were not sure if their child had learned anything new. One parent thought her son might have learned about teamwork at the *Build a Giant Carbon Nanotube* exhibit. One child with a disability said she noticed that the *Balance our Nano Future tippy table exhibit* was more than a balance game and that it was about "city planning." In addition, two parents made comments suggesting that the exhibit content was cognitively engaging in that it was relevant to their lives and their child's disabilities. These connections include the cellular connection to leukemia and the potential medical applications of nano which could benefit those with Down syndrome.

As an example, *Static vs. Gravity* appears to have facilitated visitor learning through both the visual, written, and aural information available. During the interview, one parent of a child with a disability discussed how she had discussed the exhibit content with her son at *Static vs. Gravity* saying, "I wanted to see if he could explain to me how they were different, and he did! At first, he said they were the same. But then he noticed that some stayed at the top." Another adult referenced the exhibit label as something that helped him learn about nano saying, "There was also a really, really good explanation on the spinning wheels. (*Static vs. Gravity*)" Finally, the aural information provided through the audio description contributed to visitor understanding of nano as shown in an observation of a group with a man who is blind:

> A fellow group member sits in the chair while the man using the audio description stands next to *Static vs. Gravity* and spins the beads. As they finish, the man turns to his group member and says, "The smaller ones are more influenced by static electricity where the big ones are more influenced by gravity."

These data suggest that elements of the *Nano* mini-exhibition which promoted inclusion facilitated visitor engagement and learning. Because design impacts all three areas of inclusion (physical, cognitive, and social), future evaluations should continue to investigate this relationship between design elements and learning.

2. Barriers to Inclusion within the Mini-Exhibition

Data collected at Museum of Science, Boston (MOS) and Port Discovery suggest several aspects of the mini-exhibition which were challenging to visitors with disabilities and therefore represent barriers to inclusion. Specifically, the low height of several exhibit components and the content of nanotechnology were identified as aspects of the mini-exhibition which were challenging. Therefore this section presents the following findings:

2.1 The height of some mini-exhibition components was challenging, especially for visitors using wheelchairs.
2.2 The content of nanotechnology was challenging, especially for younger visitors.

In addition to these challenges mentioned across multiple groups, individual visitors also mentioned other challenges including difficulty hearing the cell phone sounds at *Where Can You Find Nano? I Spy Nano*, flipping the flip labels located on the panels, and lifting the magnet wands at *Small, Smaller, Nano*. Three visitors mentioned difficulty reading the large panels because of light reflection or the size and contrast of the text.

2.1 The height of some mini-exhibition components was challenging, especially for visitors using wheelchairs.

As mentioned, the physical design of several mini-exhibition components fostered greater inclusion of groups including visitors with disabilities. However, observations of school groups at Port Discovery and observations and interviews of groups at MOS illustrate how the height of some components created a barrier to inclusion. This was evident with groups with individuals using wheelchairs or motorized scooters, especially at the graphic panels, *Balance our Nano Future tippy table exhibit*, and *Build a Giant Carbon Nanotube*.

Visitors both at MOS and Port Discovery using motorized scooters were not able to pull under the graphic panels or two of the three sizes at *Small, Smaller, Nano*. Visitors often attempted to adjust the leaning settings on their scooter, but tended the pull alongside these components to access them. The *Balance our Nano Future tippy table exhibit* was too low for all of the individuals using wheelchairs who were observed. Instead, many visitors pulled alongside this component and had other group members pass blocks to them.

During visitor interviews at MOS, several visitors using wheelchairs mentioned their difficulty with engaging with *Build a Giant Carbon Nanotube*. Because of its low base, people using wheelchairs pulled next to the structure. During the interview, one parent of a child using a scooter commented, "That one [points to *Build a Giant Carbon Nanotube*]. It's not even usable. It's too low." A similar experience was observed during a school group at Port Discovery when a child with a physical disability had difficulty supporting herself while standing and building with one hand.

Observations both at MOS and Port Discovery illustrate how many groups structured their activities to further include all group members. Sometimes group members handed individual carbon atoms to individuals using wheelchairs to build or hold. At other times, group members would build together as one group member would hold a carbon atom while another pushed the "bond" portion into the hole. Future exhibition design might consider including suggestions on the exhibition label for other ways of engaging in exhibits which are potentially low in height for larger wheelchairs or scooters.

2.2 The content of nanotechnology was challenging, especially for younger visitors.

During interviews at MOS, visitors with disabilities mentioned the aspects of the mini-exhibition they found challenging or difficult. Several visitors, especially adults speaking about their child's learning, mentioned that they found the content of nanotechnology particularly challenging. For example, two different family groups who included a child with an Autism Spectrum Disorder had a parent mention the difficulty of discussing the content with their children.

> *[It was challenging] content-wise. Just the whole concept. I didn't feel like I could reword concepts for [my son].*

> *[At Small, Smaller, Nano, my son] started to fight with his sister and got frustrated and moved to the other particle size, but it didn't move as much. For that to go well, I need that knowledge. I could have prepped them with 'One of these is gonna be hard, and one is easy' and then he has that task to do.*

Another parent of a child with dyspraxia, dyscalculia, and attention deficit-hyperactivity disorder mentioned providing additional support to facilitate the difficult content.

> *I had to prompt them a lot. For instance, at the panel [Where can you find nano?], they wouldn't know it was I Spy. But they love I Spy, we play all the time. Also at the magnets.*

In addition to data collected from visitors with disabilities, the challenging content was also mentioned by visitors interviewed as a part of the larger data collection efforts. As reported in Appendix A:

> "29% of visitors across all five sites (total n=318) reported finding something about the mini-exhibition challenging. When those visitors were asked to

elaborate on what was challenging, 31% of those respondents said the content was confusing or challenging…"

It is important to note that this challenge was not unforeseen by the exhibit development team. As mentioned in the "*Nano* Mini-Exhibition Audiences" document (NISE Network, 2011), it was acknowledged that young children, early readers, or non-readers may find complex concepts not accessible and require adults in the group to interpret (p. 3). Visitor interviews at MOS and observations of school groups at Port Discovery show that many adults in groups are providing this type of additional facilitation for younger visitors.

Engaging visitors in the content of any emerging technology can be a daunting task. While *Nano* presented complex content that required additional facilitation, several aspects of the exhibition appeared to contribute to visitors' understanding of nanotechnology, such as how size can affect materials' properties and how nano connects to our lives. Future exhibitions should draw upon these elements, such as the multi-sensory opportunities for engagement or group-oriented physical design, which could also assist adults in interpreting for younger learners.

3. Audio Description

In order to increase access for visitors who are blind or have low vision, *Nano* has an audio description which accompanies the experience. Audio files are available at a website listed on numbered labels which include the "AD" symbol for audio description and are placed on all mini-exhibition components. According to "*Nano* Mini-Exhibition Audiences" (NISE Network, 2011), there were two goals behind using this approach for access including:

- Make the experience *accessible* for visitors with low vision, and for blind visitors with a sighted companion
- Help visitors *understand and appreciate* the exhibition's most important messages

Because this strategy for providing an audio description is an adaptation of previous NISE Net exhibit design which included an audio phone at each component, questions were added to the interview conducted with all visitors in the core study about how the audio description affected their experience. In addition, two of the twelve groups of visitors with disabilities at MOS used the audio description as a part of their *Nano* experience. One of these groups included one man who is blind, while the other included a woman who has low vision. Both groups were observed using the audio description and asked about their experience in the interview.

The results of these data collection efforts provide evidence that the audio description was rarely used by visitors in the exhibition. An investigation of the larger dataset that does not include the recruited visitor groups of people with disabilities indicates that only one person of 418 visitor groups (.2%) was observed to have used the audio description during

their visit to *Nano*.[2] During the interviews, when visitors in the core study were asked if they had noticed the audio description (as identified by a picture of the label available on each exhibit component), about one-fourth (79 of 309; 26%) of visitors replied yes.

Exploring the comments of these visitors from the core study who had noticed, but not used, the audio description labels illustrates that visitors were generally neutral about the presence of this feature. The majority of these comments indicate that visitors did not feel either positive or negative about the audio description because they did not use it (45%). Additionally, many visitors commented that they did not know what the audio description labels were (27%). A few visitors said that they did not know how to use them or thought they required special equipment (9%). Finally, several visitors responded positively about the presence of the audio description (9%). There were not any negative comments. Table D1 provides examples of visitors' responses.

Table D1. Core study visitors' responses to the question, "How did the audio description affect your exhibit experience?" (n=66)

	# of Visitor Responses	% of Visitor Responses	Example Quotes
It didn't affect me in general.	30	45%	"It didn't [affect me]." "I saw them, but I didn't use them."
It didn't affect me because I didn't know what it was.	18	27%	"I didn't know what it was for." "I was wondering what it was."
It didn't affect me because I didn't know how to use it.	6	9%	"We didn't know how to use it." "Not that tech savvy."
I felt positively about seeing it.	6	9%	"They were all handy. Didn't use them, but glad to see they're there." "No, but I like that it was available."
Other	2	3%	"I am not hearing impaired." "Pointed it out to child."

*Responses could be coded into more than one category

When exploring the use of the audio description by people who are blind or have low vision, this small sample presents divergent opinions. Two of the recruited groups included a person who is blind or has low vision. These individuals were told about and provided access to the audio description before they arrived to the museum. While neither group chose to listen to the audio beforehand, both were provided with an iPod touch with all audio files downloaded to use as a part of their visit. Data collected from these individuals has been included in the previous analysis about inclusion. For example, the audio tour was one aspect of the exhibition facilitating visitor learning. Although a limited sample, these experiences can also provide insight into the usability of the audio description and this method for delivery. These two individuals represent diverging perspectives regarding the success of the audio description.

[2] The discussion of this data in *Appendix A: Description of Methods and Supplemental Findings* includes the responses of recruited groups of visitors with disabilities. This appendix has split the groups because of the additional context about this recruited sample.

One woman who is 18 years old with low vision felt positively about the audio description. When asked how it affected her exhibit experience, she replied that she "liked this iPod idea." She continued, saying:

> *The audio was good for interactives. It's good if someone wants it. With the panels, it's hard because I can't skip around in the audio file. With the panel, I wish it read off of it exactly. I had my dad read it to me. I could read the big text on the titles but not the smaller text.*

The experience was different for a man who is blind who felt confused by the connections between his position in the museum and the audio description. During the interview, he said:

> *The audio was disconnected from the exhibit. I wasn't sure if what I was hearing was what I was in front of. It was hard for me to know where I was. I was like ok, great, I could listen to this at home. It didn't help to be here. I couldn't see it. I was just listening to someone describe. It didn't provide anything that I couldn't get from a textbook.*

These represent a limited viewpoint of the use of the audio description in the *Nano* mini-exhibition. It is possible that the experience could have been improved with further orientation to the audio description by the evaluation staff. However, as that orientation is not available to visitors using *Nano* outside of the evaluation efforts, it is also possible that future users could have similar experiences to those mentioned.

This approach for providing audio description and increasing accessibility for visitors who are blind or have low vision would benefit from further investigation. For example, a larger sample of study participants might provide suggestions for how to successfully orient visitors to the audio description or elicit trends regarding how visitors use the audio description as an individual or with other group members, or before or after their exhibition visit. Because this audio description was intended for visitors who are blind or have low vision, the "audio description" label was used. However, because many visitors from the core study either did not notice or did not understand the audio description label, future exhibitions interested in providing audio content for all visitors should consider a different label or means of conveying the availability of this content.

Conclusion

Although this exploratory study represents a small sample, these findings suggest ways in which *Nano* is facilitating inclusion and creating potential barriers to inclusion of visitors with a broad range of abilities and disabilities. In addition, data from the core study and this exploratory study suggest limited use and potential challenges of the audio description. In summary, this study presents three overarching findings:

- *Nano* successfully promoted inclusion by incorporating multi-sensory elements and a group-oriented physical design of certain mini-exhibition components.

These elements contributed to a positive visitor experience and facilitated visitor learning.

- *Nano* caused barriers to inclusion due to the low height of some mini-exhibition components and the challenging nature of the nanotechnology content. Specifically, the low height of graphic panels, *Balance our Nano Future tippy table exhibit*, and *Build a Giant Carbon Nanotube* was identified as a challenge for visitor groups including a person using a wheelchair or scooter. The content of nanotechnology was especially challenging for younger visitors.

- The audio description which accompanies *Nano* was rarely used by visitors in the core study. When visitors noticed the presence of the audio description labels, they most frequently viewed its presence in a neutral way saying that it did not affect their exhibit experience. Visitors who are blind or have low vision who used the audio description as a part of the exploratory study offered differing opinions with one woman viewing it positively and another man viewing it negatively.

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