Summative Study of the *Nano* Mini-exhibition

Summative Evaluation – Summary of Findings

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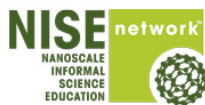
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Executive Summary

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 <u>counting study</u>, 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

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[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, <u>observations, surveys, and interviews</u> 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 <u>*Nano* mini-exhibition reporting survey</u> 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*.
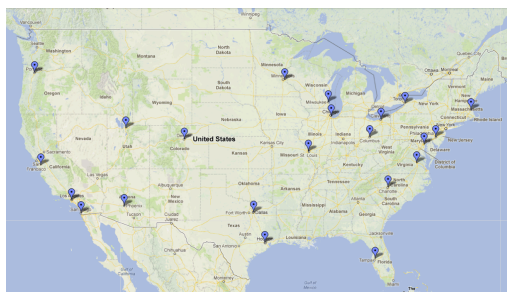

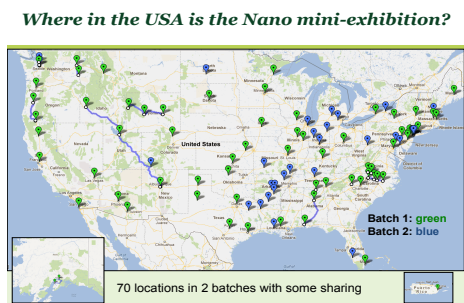*Figure 1a.*
BodyWorlds traveling exhibition tour sites.

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_success.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%

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

(a)   (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.