NISE network
NANOSCALE INFORMAL SCIENCE EDUCATION

Summative Study of the *Nano* Mini-exhibition

Summative Evaluation – Appendix D: Visitors with Disabilities

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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.

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.

References

Center for Universal Design. (2002). *Definition of universal design*. Retrieved from http://www.design.ncsu.edu/cud.

NISE Network. (2010). *Universal design guidelines for NISE Net exhibits*. Retrieved from http://www.nisenet.org/sites/default/files/UniversalDesignGuidelinesExhibits_Guide_May10.pdf

NISE Network. (2011). *Nano Mini-Exhibition Audiences*. Retrieved from http://www.nisenet.org/sites/default/files/catalog/uploads/8560/nano_mini-exhibition_audiences_12-23-11.pdf.

Reich, C., Price, J., Rubin, E., Steiner, M. (2010). Inclusion, disabilities, and informal science learning. A CAISE inquiry group report. Washington, D.C.: Center for Advancement of Informal Science Education (CAISE).