NISE Network
Professional Impacts Summative Evaluation

By: Juli Goss, Ryan Auster, Marta Beyer, Leigh Ann Mesiti,
and Elizabeth Kunz Kollmann

2016

Acknowledgements

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

Special thanks to:

- Members of the Network Executive Group and Network Organizing Group (NEGNOG) including Larry Bell, Paul Martin, Rob Semper, Brad Herring, Catherine McCarthy, Vrylena Olney, Rae Ostman, Eli Bossin, and Kayla Berry, for their review and feedback throughout the creation of the study and report.
- Members of the Professional Impacts Evaluation subgroup including Amy Grack Nelson, Steve Guberman, and Melissa Laurie, for their advice and help in guiding this study.
- Members of the NISE Net Evaluation Leadership team including Marcie Benne, Marjorie Bequette, Anna Lindgren-Streicher, and Christine Reich for their support and feedback.
- Members of the NISE Net Evaluation Survey and Data Mining Sub-group including Liz Rosino, Chris Cardiel, Sarah Cohn, and Smirla Ramos-Montanez, for creating and maintaining the Annual Partner Survey.
- Members of the NISE Net Evaluation Committee of Visitors including Frances Lawrenz, Saul Rockman, and Bruce Lewenstein, for their feedback and advice.
- Additional staff at the Museum of Science, Boston who helped with this project including Emily Anstey, Sunewan Chunhasuwan, Amanda Colligan, Samantha Lubrano, Alexander Lussenhop, Sarah May, Emily Marsh, Sarah Pfeifle, and Kristina Wang.

This report was based on work supported by the National Science Foundation under Grant Nos. DRL-0532536 and 0940143. Any opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of the Foundation.

Elizabeth Kunz Kollmann
Museum of Science
1 Science Park
Boston, MA 02114
ekollmann [at] mos [dot] org

Nanoscale Informal Science Education Network
Professional Impacts Summative Evaluation

This document is an executive summary of the Nanoscale Informal Science Education Network (NISE Net) Professional Impacts Summative Evaluation. **Sections 1–4 below correspond to the points in the report's *Summary of Findings and Discussion*** (Goss et al., 2016, pp. 86-100). The icons displayed to the left of each finding indicate the related section(s) in the report. This page includes a description of the study, and the final two pages include graphs and quotes that are meant to highlight major findings; much more detail is included in the complete report.

Background of the NISE Network

The Nanoscale Informal Science Education Network is a national community of researchers and informal science educators dedicated to fostering public awareness, engagement, and understanding of nanoscale science, engineering, and technology (nano). Funded by the National Science Foundation through two consecutive grants totaling over $40 million that extended over 10+ years, NISE Net is one of the largest informal science education initiatives ever undertaken in the United States.

NISE Net Goals for Professionals

- Identify with a broader community that includes scientists and museums
- Value local research-ISE collaborations
- Understand and appreciate key concepts in nanoscale science, engineering, and technology and its relationship with our lives, society, and environment
- Understand theories, methods, and practices for effectively engaging diverse public audiences in nano
- Utilize professional resources and educational products for engaging diverse public audiences in nano

Background of this Study

This study was a longitudinal examination of individual professionals over the final three years of the NISE Network (Goss et al., 2016). Based on the NISE Network's goals for professionals, this study explored how involvement with NISE Net impacted an individual professional's sense of community, learning about nano, and use of nano educational products and practices.

This evaluation primarily included professional partners who were:

Informal Science Educators (ISE): Professionals from science museums and children's museums implementing informal science education

University professionals: Individuals from large and small universities and colleges throughout the United States including researchers, scientists, education outreach coordinators, and others

Methods

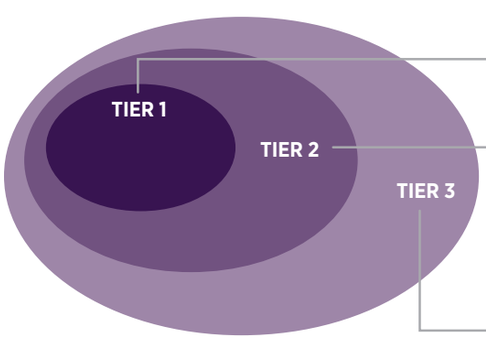
This study employed two data collection methods over three years:

- An **Annual Partner Survey** which involved a total of 597 professionals in Tiers 1-3
- **Yearly interviews** with a representative subset of 21 professionals from Tiers 2 and 3

The survey presented a broad view of how professionals were impacted by participating in the NISE Net as well as how their sense of community, learning about nano, and use of nano educational products and practices changed over time. Interviews provided a deeper understanding of professional involvement in the Network.

NISE Network Tiers of Involvement

NISE Network partners were categorized into tiers based on the roles and responsibilities of the partner institutions, their level of involvement in the Network, and the amount of NISE Net support they received. Descriptions of typical involvement are below.



Tier 1: Core Partners
- Grant-funded
- Developed products
- Created professional development opportunities

Tier 2: Nano-Infused Partners
- Received a majority of Network resources
- Experienced NISE Net in-person meetings, NanoDays, and other professional development opportunities

Tier 3: Broad Reach Partners
- Participated in NanoDays
- Used the publically accessible website

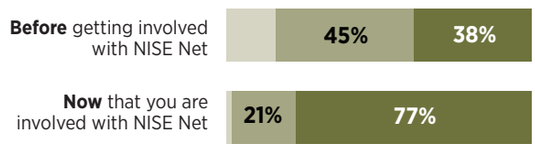
NISE Network Professional Impacts **Summative Evaluation**

COMMUNITY & COLLABORATION

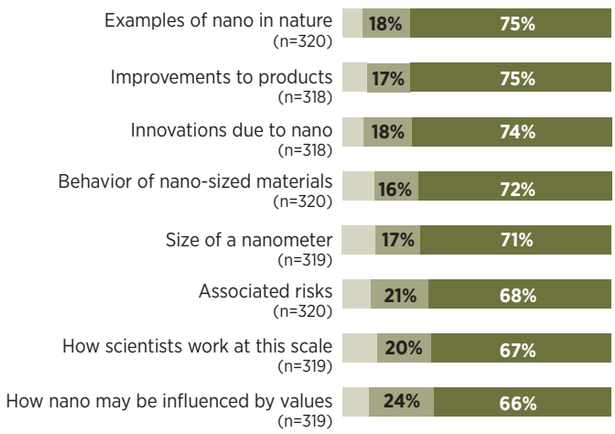
UNDERSTANDING NANO

1 NISE Net professional partners reported that their **sense of community increased** after they became involved with the Network and that **NISE Net affected their understanding of nano**.

To what extent did you identify with a broader community that includes both scientists and museum professionals? (n=321)



How much has NISE Net affected your confidence in explaining the following nano concepts to another adult?



Not at all/Very little | A little/Somewhat | A lot/A great deal

> *"I think what it's done is kind of give a catalyst to come together. Like this new person in engineering—I never would have met him. We actually put out a little news brief on campus that just said, 'Hey, are you into nano?' and he came out of the woodwork because he saw that [flyer]."*
>
> –Tier 2 University professional, Year 8 interview

> *"I didn't even know what nano was. Pretty much everything I know about nano, I know from NISE Net. And if you look at those concepts, I'm certainly able to talk about those concepts, but it is pretty much solely because of NISE Net."*
>
> –Tier 2 ISE professional, Year 10 interview

PRODUCTS

PRACTICES

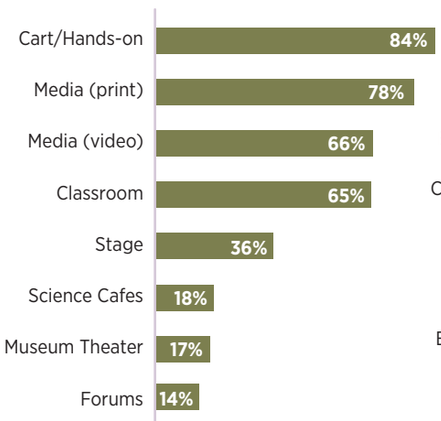
2 NISE Net professional partners reported **engaging the public with all types of Network products and practices**, though some were used less than others.

What percent of NISE Net professional partners engaged the public in nano? (n=320)

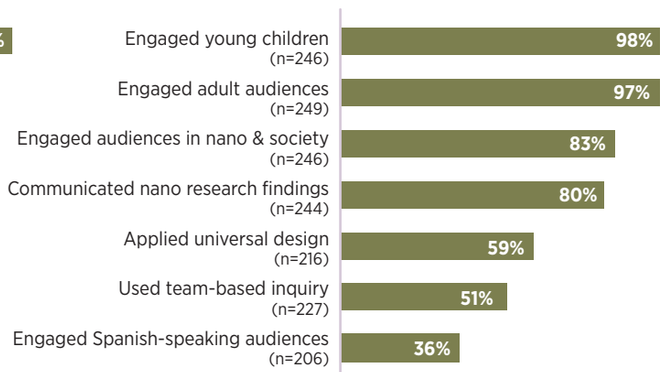
31% **BEFORE** NISE Net involvement

82% **AFTER** NISE Net involvement

Did you personally implement any of the following NISE Net educational products with the public? (n=264)



As part of your nano education efforts, have you done any of the following?



> *"I think one of the things that's really great about NISE Net is that they have different iterations [of activities] with different lengths of times, different set ups, for different aged people… we were just so impressed that [the kit] had everything, including the little plastic standup stand and the tablecloth!"*
>
> –Tier 3 University professional, Year 8 interview

> *"[W]hen we're thinking about signage or something big or small, we have focused on [universal design]… I think [in] the 2012 kit there was a nice guide to universal design [and] we've used that."*
>
> –Tier 3 ISE professional, Year 8 interview

NISE Network Professional Impacts Summative Evaluation

PRODUCTS

PRACTICES

COMMUNITY & COLLABORATION

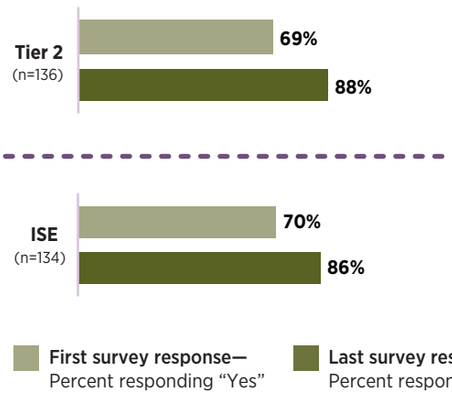
UNDERSTANDING NANO

3 While the majority of NISE Net professional partners reported gains related to the Network's goals, **Tier 2 and ISE professionals specifically reported positive change over time from their NISE Net involvement**, especially concerning nano and society content.

As of Year 10, what percent of NISE Net professional partners engaged the public in nano and society content? (n=246)

83% OF ALL PARTNERS

Across Years 8–10, as a part of your nano education efforts, have you engaged audiences with nano and society content?



"I think that the activities and kits help create a broader understanding of how it's affecting society and what research is being done in the field."

–Tier 2 ISE professional, Year 9 interview

"It's just my go-to place for knowledge… if I want to talk about nano and society, science and society, [NISE Net is] the first place I'm going to go."

–Tier 2 ISE professional, Year 10 interview

BEYOND NANO

4 Evidence indicates that a range of NISE Net professional partners **integrated aspects of NISE Net into their work that is unrelated to nano**.

To what extent has NISE Net increased the amount of ANY partnerships or collaborations between your organization and another? (n=248)

To what extent has NISE Net helped you communicate ANY science, technology, engineering, and math with the public? (n=274)

Not at all/Very little | A little/Somewhat | A lot/A great deal

"I don't know if I'd be working with the library [if it wasn't] for the mini-exhibit and NanoDays. [These opportunities have] probably opened the door [for us] and that's [going to] be a fruitful partnership I see for years to come."

–Tier 2 University professional, Year 10 interview

"[NISE Net materials have] guided the amount and kind of information that we give to the public because I think NISE Net resources are very good at giving the facilitators an appropriate amount of background information and then boiling that down to the appropriate amount of information to share with the public."

–Tier 2 ISE professional, Year 10 interview

NISE network™ NANOSCALE INFORMAL SCIENCE EDUCATION

nisenet.org

Report citation: Goss, J., Auster, R., Beyer, M., Mesiti, L.A., & Kollmann, E.K. (2016). *NISE Network Professional Impacts Summative Evaluation*. Boston, MA: NISE Network.

This report was based on work supported by the National Science Foundation under Grant Nos. DRL-0532536 and 0940143. Any opinions, findings, and conclusions or recommendations expressed in this report are those of the authors and do not necessarily reflect the views of the Foundation.

Table of Contents

Introduction

The Nanoscale Informal Science Education Network (NISE Net) is "a national community of researchers and informal science educators dedicated to fostering public awareness, engagement, and understanding of nanoscale science, engineering, and technology (nano)" (NISE Network, 2011b). Funded by the National Science Foundation through two consecutive awards that extend over 10 years and amount to a total of over $40 million, NISE Net is one of the largest informal science education (ISE) initiatives ever undertaken. Beginning in 2005, the Network has continuously expanded. By the end of Year 10, NISE Net encompassed close to 600 museum and University partner institutions across the nation.

NISE Network Professional Impacts Summative Evaluation

The *NISE Network Professional Impacts Summative Evaluation* is a longitudinal examination of individual professionals over the final three years of NISE Net funding. This investigation is based on the NISE Network goals for professionals and explores how involvement with NISE Net impacts an individual professional's sense of community, learning about nano, and use of nano educational products and practices. The following subheadings describe aspects of this study and how they relate to the Network's engagement and interaction with professionals.

This evaluation is based on the NISE Network goals for individual professionals. According to its goals for professionals (Appendix C) and logic model (Appendix B), NISE Net fostered a community of professionals in order to encourage and support nano education at the individual, organization, and field-wide levels. The NISE Network's overarching goal for professionals is to "increase the readiness of individual practitioners and the capacity of the field of informal science education (ISE) to foster public awareness, understanding, and engagement with nanoscale science, engineering, and technology and its relationship with our lives, society, and environment ("nano")."

This overarching concept is broken down into five goals stating that, as a result of participating in NISE Net professional development activities, professionals will:

1. Identify with a broader community that includes scientists and museums
2. Value local research-ISE collaborations
3. Understand and appreciate key concepts in nanoscale science, engineering, and technology and its relationship with our lives, society, and environment
4. Understand theories, methods, and practices for effectively engaging diverse public audiences in nano
5. Utilize professional resources and educational products for engaging diverse public audiences in nano

Each of the goals includes short-term goals at the individual level and medium- to long-term goals at the organization and field-wide levels.[1] This evaluation focuses on the impact on individual professionals and the short- to medium-term professional goals. This decision was made because it was felt that an evaluation studying the extent to which organizations achieved Network goals would have meant limiting the number of organizations being studied, and therefore, would have been too narrow in focus. Additionally, it was decided that an evaluation studying long-term goals was not appropriate because studying field-wide impacts would mean a need for a longer timeline including collecting data and exploring impacts months after the

[1] The full list of short-term and long-term goals is included as Appendix C.

end of grant funding, which was not possible as a part of this project. Therefore, the individual was selected as the unit of analysis, and the short- to medium-term goals were selected as the desired impacts for this summative evaluation, as they best aligned with the resources available, the Network goals for professionals, and the logic model.

Drawing on the goals for individual professionals, questions guiding the *NISE Net Professional Impacts Summative Evaluation* include:

1. How and to what extent does participation in NISE Net impact professionals' sense of community over time?
2. How and to what extent does participation in NISE Net impact professionals' understanding of key nano concepts and practices of engaging public audiences in nano over time?
3. How and to what extent does participation in NISE Net impact professionals' use, modification, and development of nano-related products and practices over time?

Table 1. Alignment of NISE Net professional impact goals and evaluation questions for the *NISE Net Professional Impacts Summative Evaluation*.

Professional Impact Goals	**Evaluation Questions**		
Professionals will:	How and to what extent does participation in NISE Net impact professionals' sense of community over time?	How and to what extent does participation in NISE Net impact professionals' understanding of key nano concepts and practices of engaging public audiences in nano over time?	How and to what extent does participation in NISE Net impact professionals' use, modification, and development of nano-related products and practices over time?
1. Identify with a broader community that includes scientists and museums	✓		
2. Value local research-ISE collaborations	✓		
3. Understand and appreciate key concepts in nanoscale science, engineering, and technology and its relationship with our lives, society, and environment		✓	
4. Understand theories, methods, and practices for effectively engaging diverse public audiences in nano		✓	✓
5. Utilize professional resources and educational products for engaging diverse public audiences in nano			✓

This evaluation uses a broad definition of NISE Network involvement and examines change over Years 8-10.
This study focuses on the impact of NISE Network involvement as a whole, rather than participation in individual meetings or initiatives.

Involvement with NISE Net means different things for different professionals. For example, one professional might have hosted NanoDays every year since 2008, while another might have hosted their first event in 2014. One professional might have applied for and received two mini-grants, while another might not be aware that mini-grants are something NISE Net provides. There are many ways to be a NISE Net partner, and most professionals have multiple opportunities to experience the NISE Net. Moreover, these experiences are intended to build on one another to the extent that a professional might start off by hosting NanoDays, then attend a NISE Net meeting to share their experience, and later apply for and receive the *Nano* exhibition—all the while using their previous experiences to inform their next experiences. Because one NISE Net experience builds upon the previous, and the different ways to be involved are so vast, this evaluation uses a broad definition of involvement in the Network and includes methods for exploring this change over time.

Although participation and involvement with NISE Net takes many forms, this study uses existing NISE Net features to explore potential differences between groups. Each NISE Net professional has an associated tier of involvement and organization type. Members of all of these tiers are a part of the summative evaluation. These are described further below and used throughout this report to investigate differences between groups.

NISE Network Tier Structure
The NISE Network organizations are categorized into tiers by the roles and responsibilities of the partner institutions and the level of NISE Net support the institutions receive. Partner institutions can move between the tiers due to staffing changes, shifting priorities, and fluctuating levels of activity in the Network. For Years 6-10, the tier definitions are as follows:

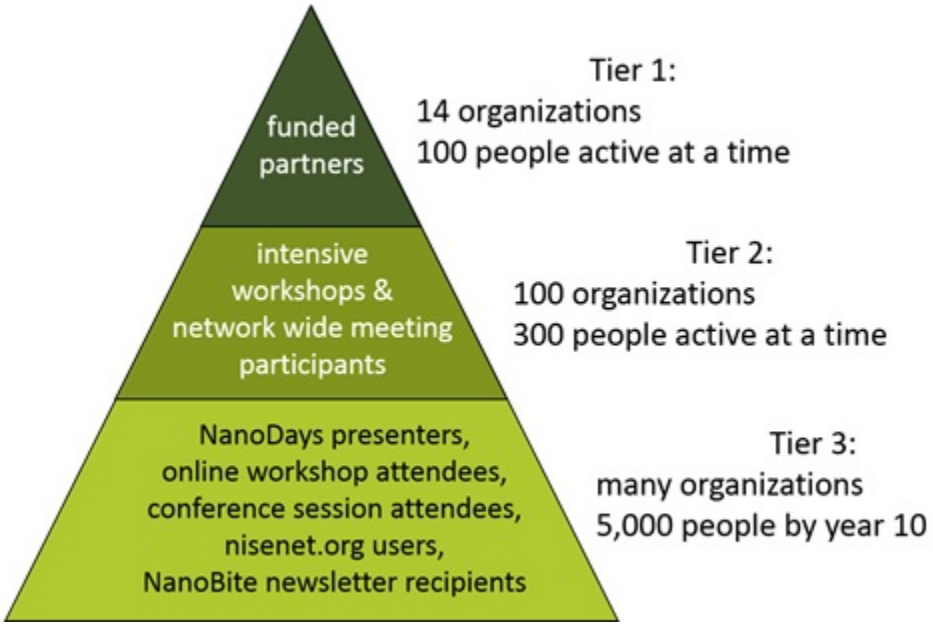
- Tier 1 - Core Partners: These grant-funded partners operate the Network. Core partner institutions are charged with leading the field in raising public awareness, understanding, and engagement with nanoscale science, technology, and engineering. This includes developing informal educational products, creating professional development opportunities, and building the capacity of other Network institutions and partners.

- Tier 2 - Nano-Infused Partners: These institutions are the primary recipients of Network resources and professional development efforts, including regional workshops, online workshops, and network-wide meetings. The goal of the Network is to have nano content be "infused" into Tier 2 institutional programming by the end of Year 10. The Network is actively working to increase the capacity of nano-infused partners to deliver nano education experiences beyond NanoDays as an ongoing, sustainable part of their institutions' programming.

- Tier 3 - Broad Reach Partners: Institutions in this tier may take materials or ideas from the Network and use them in their own activities. The Network aims to introduce nano informal education to Tier 3 organizations to the extent that these organizations can participate in, at the least, some limited form of nano educational outreach, such as participation in NanoDays. The Network uses a publicly accessible website and an open-

source library of educational materials, as well as presentations at professional conferences to broaden the reach of nano education to these institutions.

Figure 1. Overview of NISE Network Tier definitions as presented at the 2010 Network-wide Meeting in Year 6.



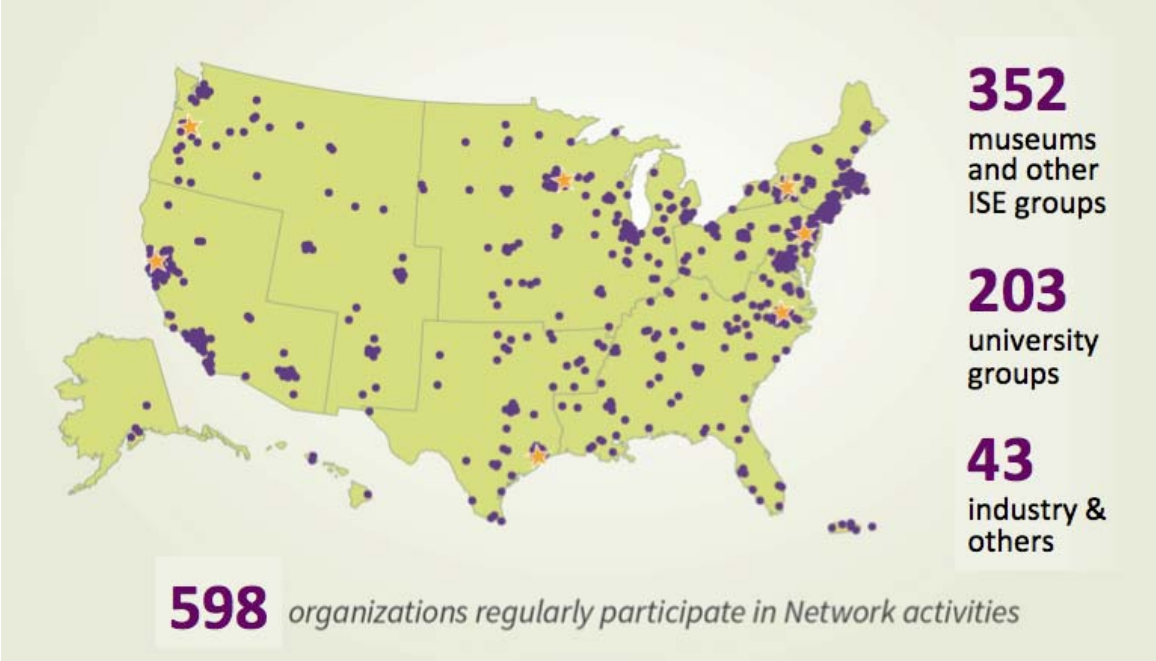
As described in the Methods section below, this study analyzes data from all survey and interview participants who were active members of the NISE Network from Tiers 1-3 between Years 8-10 of the Network and examines differences between the tiers. However, over Years 6-10 of the Network, Tier 2 increasingly became the focus of the Network as the main group who would be presenting nano to the public. Therefore, Network Leadership focused on providing more professional development programs and public resources to Tier 2. They hoped that by doing this, Tier 2 would share nano content with their visitors more often and feel better able to do so. This focus on providing support to Tier 2, in turn, meant that Network Leadership expected to have a great impact on Tier 2. Therefore, because Tier 2 professionals were the primary recipients of NISE Net resources, there is a focus on this group throughout the report and a focused series of analyses are provided in Appendix A.

NISE Network Organization Types

The NISE Network includes various types of organizations. However, it is primarily composed of museums and universities. An emphasis on connecting informal science education (ISE) institutions and universities that research emerging science and technology was part of the original NSF solicitation in 2005, and in part because of this, the NISE Net continued to focus on these groups throughout the ten years of grant funding. Therefore, this evaluation uses these distinctions between organization types to explore differences between individual professionals. Throughout the report, these groups are abbreviated as ISE and University. It is important to note that the ISE group includes professionals from science museums, as well as children's museums implementing informal science education, but not professionals from other groups

such as libraries. The University group includes individuals from large and small universities and colleges throughout the United States who may be researchers or scientists, but this group also includes education outreach coordinators and others who work for a college or university.

Figure 2. Map of all NISE Network organizational partners as of June 2015.



Note. Each purple dot represents one organization. The seven stars represent the locations of the NISE Net Regional Hubs.

Methods

This study involved data collection over Years 8-10 of NISE Net and employed two methods: the Annual Partner Survey and yearly interviews. The Annual Partner Survey was sent to all involved Tier 1-3 professionals (also known as NISE Net professional partners), and the interviews were conducted with a representative subset of Tier 2 and 3 professionals. This section includes further details about each method, sample characteristics, how data were analyzed, and limitations of the study. Copies of all the survey and interview instruments can be found in the Instrument Appendix along with specific details about the various scales that were used.

Annual Partner Survey

The Annual Partner Survey (APS) was coordinated and distributed by the Survey and Data Mining team (a subgroup of the NISE Net Evaluation workgroup). This survey was conducted in Years 8, 9, and 10 and consolidated the data collection efforts of numerous research, evaluation, and team-based inquiry studies.[2] Across the three years of the survey, there were 5-8 stakeholder groups, of which the Professional Impacts subgroup was one, who submitted questions to the Survey and Data Mining subgroup. The Survey and Data Mining subgroup was then responsible for building, testing, and distributing the survey. After the close of the survey response period, the Survey and Data Mining subgroup distributed raw data to the teams who submitted questions and provided all stakeholders with a context document. This context document contained information about the survey respondents and summary tables of responses to close-ended questions. The information that follows regarding survey participant recruitment and respondents comes directly from these context documents.

Survey recruitment and sampling

Survey stakeholders agreed that the survey would be sent to individuals considered currently active in the Network from Tier 1, 2, and 3 partner organizations located in the U.S. The only individuals from these different tiers who were excluded from taking the survey were those involved in the Research and Evaluation workgroups as well as the Network executive and operational group. The survey was conducted online via SurveyGizmo during October and November of Years 8-10, and was estimated to take 20 to 30 minutes to complete. It was promoted through various on- and off-line mechanisms, and invited participants were also sent two email reminders. After the first week that the survey was open, a targeted subset of non-responders also received phone call reminders to fill out the survey. As motivation to complete the survey, participants were automatically entered into a raffle to potentially win one of 23 incentives, which included $100 Amazon.com gift cards and sets of nano educational materials.

[2] Further information about team-based inquiry can be found at: http://www.nisenet.org/catalog/tools_guides/team-based_inquiry_guide

Table 2. Characteristics of respondents to the Annual Partner Survey.

Institutional Characteristics		2012 (Y8) N=296	2013 (Y9) N=349	2014 (Y10) N=323
		%	%	%
NISE Network tier	Tier 1	12.5%	9.7%	9.3%
	Tier 2	59.8%	62.8%	60.4%
	Tier 3	27.7%	27.5%	30.3%
Organization type	ISE	62.5%	66.5%	65.3%
	University	32.1%	28.9%	29.4%
	Other	5.4%	4.6%	5.3%

Note. ISE organizations are museums including science and children's museums. "Other" organizations include libraries and other kinds of organizations doing informal science that are not museums.

Interviews

The Professional Impacts subgroup conducted interviews with professionals in the Network during Years 8, 9, and 10. The purpose of these interviews was to supplement responses from the Annual Partner Survey by providing a deeper understanding of professional involvement. The interviews focused on professionals' sense of community with the Network, understanding of nano, and use of NISE Net products and practices. Each year, these interviews followed up on information learned about the professionals from their APS responses and previous interviews (in Years 9 and 10).

Interview recruitment and sampling

Interviews for the Professionals Impacts Summative Evaluation took place annually with 21 individuals from Tiers 2 and 3 who represented a range of NISE Net involvement. The interviews focused on individuals in these two tiers because they were the primary recipients of NISE Net products and professional development. In its later years, the Network also had an increased emphasis on these groups, especially Tier 2. The interview sample was chosen based on individual characteristics, such as tier, organization type, number of meetings attended, NanoDays participation, and if the listed contact was the primary contact person for the institution. Several institutional characteristics were also considered when sampling for individuals, including whether or not his/her organization had received a mini-grant or *Nano* exhibition.

Participants were invited over email to take part in this study and were told that participation would entail multiple phone interviews. Three researchers were involved in conducting these interviews, and when possible, the same team member interviewed the same individual across all years of the study. Most interviews were audio recorded. Consent to audio record interviews was emailed to participants and confirmed every year over the phone before the interview. When audio was not consented, a note-taker was present for the interview. Quotes used in the report have been verified with audio recordings, when available.

As an incentive for participation, Amazon gift cards were offered to participants each year. The amount of the gift cards increased each year to encourage long-term commitment ($25 in Year 8, $50 in Year 9, and $75 in Year 10). Professionals who left their current positions or

institutions during the study were still contacted by the Professional Impacts subgroup each year. By Year 10, only 1 of 21 professionals had dropped out of the sample.

Table 3. Characteristics of interview participants.

Institutional Characteristics		N=21 %
NISE Network Tier	Tier 2	71.4%
	Tier 3	28.6%
Organization type	ISE	52.4%
	University	38.1%
	Other	9.5%

Data Analysis

Quantitative data analysis

Analyzing the APS was exceedingly complex due to the longitudinal nature of the data, as well as the differing types of variables in the data set (e.g., dichotomous responses, Likert scale-style responses, and those truly continuous in nature). For almost every question, professionals provided overwhelmingly positive responses, resulting in data that were negatively skewed (i.e. bunched together near the top of the scale with few responses at the low end of the scale). Because of this, a number of different analytical approaches were employed to appropriately test for relationships in the data – including many non-parametric tests – and the variety of analyses are fully detailed in the Technical Appendix.

Within this report, overall findings from participants' Year 10 responses are presented at the beginning of each finding section. Next, findings related to changes over time for individuals in different groups are described. Overall findings discuss only those professionals from Tiers 1-3 responding to the final year of the APS. This allowed for a Network-end analysis to summarize results at the conclusion of the 10-year NISE Network. Some of these results are shown through descriptive tables or charts in order to explain the general state of these professionals in the final year of study; other results use inferential statistics to examine differences between groups of professionals (by tier or organization type) or within individuals when retrospective pre/post questions were used (Rennie & Johnston, 2007). To assist in the readability of results and to prevent lengthy footnotes in text, all charts and findings that cite a statistical test have an asterisk (*) in the title and refer to a statistically significant difference detected by the test with a *p*-value equal to or less than .05; the details of each of these tests can be found in the Technical Appendix.

Change over Years 8-10 findings discuss only those professionals who responded to the APS in multiple years. By looking at professionals who had responded more than once, we could watch for changes in individuals' responses over time. Over the three years the APS was administered, individuals could have responded multiple times in several different combinations. To enable us to collectively analyze professionals' potential changes, for *all* repeat respondents, the first year's survey responses were coded as "pre" (either Y8 or Y9), and the final year's responses were

coded as "post" (either Y9 or Y10). Thus, comparing pre-post responses provides a longitudinal analysis of professionals participating in the Network. Additional information about how and why we chose to do this process can be found in the Technical Appendix. As with the overall data, all findings described below as "significant" refer to the statistically significant difference detected by the statistical test with a *p*-value below .05, and the details of each of these tests can be found in the Technical Appendix.

Qualitative data analysis

Qualitative data from interviews and open-ended survey responses were analyzed using both inductive and deductive coding methods. Inductive coding analysis involves "immersion in the details and specifics of data to discover important patterns, themes, and interrelationships" (Patton, 2002) whereas deductive coding uses pre-defined themes based on the evaluation questions (Fereday & Muir-Cochrane, 2006). For example, evaluators used pre-defined themes guided by the evaluation questions such as "community," "learning," or "practices" as *a priori* themes while continuing to explore for emergent trends. Interview data were primarily coded using NVivo software and were often used to provide richer descriptions of trends found in the survey data. Evaluators ran queries of the data and conducted multiple rounds of coding for each of the study's main topic areas. Each coding area started broadly and narrowed as trends emerged.

After analyzing the interviews in NVivo, three Professional Impacts subgroup members produced internal documents that summarized initial findings, as well as potential changes seen over the three years of the study. Over the course of this work, the three researchers coding the qualitative data met frequently to discuss these details, as well as any connections between survey and interview analysis. Discussions such as these helped multiple team members become more familiar with the data, gain a shared understanding of the coding, and have a better sense how interpretations of the data fit within the context of the NISE Network. For the final report, interview findings were used to provide context around APS findings and to contribute to the vignettes that are included in several sections of this summative evaluation. These detailed stories provide examples of how professionals were impacted over time by NISE Net opportunities.

Interim findings from both the quantitative and qualitative data were conveyed through several types of deliverables. For instance, memos, PowerPoints, posters, and case studies were produced across Years 8-10 to provide periodic updates about the progress of the Professional Impacts Study and to inform Network decision making. These updates were directed toward NISE Net partners, Network leadership, and the external Committee of Visitors group (COV).

Reporting the findings

The Findings section of this report presents results that were relevant based on the data described above to best address the goals and evaluation questions of the Network. While each finding is discussed in detail, it is important to note that not all of the data that were collected are included in this report. Additionally, the analyses remain only a subset of possible analytical framings, and we do not describe each non-significant finding, as it was impractical to include all of this information in this report. The Technical Report provides additional clarification around these analyses.

Study Limitations

Due to the nature and size of this study, several limitations were present and are listed below. However, it is important to note that of those listed, the timing of this study and partner involvement may have played an especially large role in limiting the study's findings. This is because the timing and late start to this study may have affected, for example, whether or not participants had already learned a lot about nano by Year 8 of the Network and whether or not they were still actively participating. The fact that survey respondents were more involved with the Network may also explain some of our skewed data. The additional limitations described below present other aspects which may have factored into the findings as well.

Timing of this study

The Professional Impacts Study started in Year 8 of the Network, so it did not track involvement from the beginning of many partners' NISE Net experience. By starting in Year 8, this study may not account for all professionals' community involvement, learning and use from earlier years of the Network. Additionally, this study may be excluding the perspectives of professionals who felt less suited to the Network and dropped out prior to Years 8-10.

Partner involvement in the Professional Impacts Study

To better understand who was and was not responding to the Annual Partner Survey each year, the Survey and Data Mining subgroup performed analysis of characteristics of survey invitees and the responding sample. Across the years of the study, survey respondents were significantly ($p < .05$) more likely than overall survey invitees to have:

- Held an education-related role in their organization,
- Been in a Tier 1 or 2 organization,
- Been part of an organization that hosted at least one NanoDays event,
- Attended a Network meeting,
- Responded to the previous year's survey (Years 9 and 10),
- Been part of an organization that was awarded a mini-grant (Years 9 and 10), and
- Been part of an organization that hosted the *Nano* exhibition (Years 9 and 10).

Overall, these data suggest that individuals responding to the APS may have been more involved in the Network than non-responders, and this sampling outcome may have contributed to the generally positive survey results. Additional information about non-responders for individual years can be found in the yearly Survey and Data Mining context documents ("2012 Annual Partner Survey ", 2012; "2013 Annual Partner Survey ", 2013; "2014 Annual Partner Survey," 2014).

Attribution and the broad definition of NISE Network involvement

NISE Net provided physical materials to some partners and virtual materials to anyone that was interested in using them. Therefore, because it was not possible to control who got to use NISE Net materials, it was also not possible to find an appropriate control group for this evaluation. Additionally, involvement within the NISE Net looked different for different individuals. Therefore, this study considers a broad range of Network participation. For example, the Network developed a range of educational resources and professional development opportunities that individuals and organizations could adapt for their own needs, and the Network anticipated that partners would pick and choose resources that matched their own contexts. Therefore, while data were collected to describe *how* NISE Net experiences played a role in professionals' overall responses, this study provides a limited viewpoint of the effectiveness of individual components of the Network.

Accuracy of the NISE Net database

The NISE Net uses Quickbase to track individual and organizational partners, as well as Network meeting attendance and other aspects required for NSF reporting. This evaluation study used the NISE Net database to establish contact lists and understand the involvement of individuals participating in both the survey and interviews. As stated by the Survey and Data Mining subgroup, “While efforts were made to update the database just prior to creating the contact list [for each year’s survey], it still may not be entirely accurate or representative of individuals currently active in the Network and their characteristics. This is because many people enter the data, and also, due to the nature of the Network, there is a limit to what can be known or captured about people” ("2012 Annual Partner Survey ", 2012).

Findings

The Findings section is divided into five subsections which correspond to this study's evaluation questions and the NISE Network goals for professionals. Each of these subsections begins with a paragraph briefly describing how NISE Net engaged and provided resources to partners, as well as a chart with all findings in that subsection. This overview is followed by overall findings which focus on the impact of NISE Net on Tier 1-3 professionals as of the end of Year 10. This section focuses on descriptive statistics to show where Tier 1-3 partners as a group ended up in terms of NISE Net impact, as well as showing differences in extent of impact as of Year 10 for the various tiers and professional types. Finally, there are findings from the longitudinal analyses exploring change in individuals in different groups (tiers and professional types) over Years 8-10. While survey and interview data are woven throughout all findings, one or more descriptive vignettes based upon the interviews appear at the end of each subsection in order to highlight a longitudinal cases which further support or provide counterexamples to the Network-wide findings.

Findings for the *NISE Network Professional Impacts Summative Evaluation* are provided below in the following five subsections:

1. Community and Collaboration
2. Learning about Nano Concepts
3. Using Public Engagement Products
4. Using Public Engagement Practices
5. Expanding beyond Nano Content

The Findings section provides a limited amount of interpretation. For further explanation, see the section that follows this, "Summary of Findings and Discussion," which looks across all of these findings and describes potential reasons for them.

1. Community and Collaboration

NISE Net engaged a range of individual professionals in various ways. As stated on the NISE Net website, "research institutions, museums and informal science organizations, and other individuals who are interested in communicating with the public about nanoscale research are welcomed and encouraged to join" the NISE Network (NISE Network, 2011a). NISE Net provided various ways to foster this community including face-to-face meetings, a geographic Regional Hub structure providing a personal contact, a monthly electronic newsletter, many online resources for connecting with the community, and more. For further information about ways NISE Net involved partners in the community, see http://www.nisenet.org. For detailed information about the role that NanoDays, face-to-face meetings, the Regional Hub structure, and the website played in fostering the community, see the *Network Communication Study* conducted in NISE Net Years 6 and 7 (Morgan Alexander et al., 2012).

The "Community and Collaboration" section provides findings about professionals' identification with the NISE Net community and connections made across the Network. Table 4 provides the relevant goals and lists the findings that will be described in this section.

Table 4. NISE Net professional goals and findings related to Community and Collaboration.

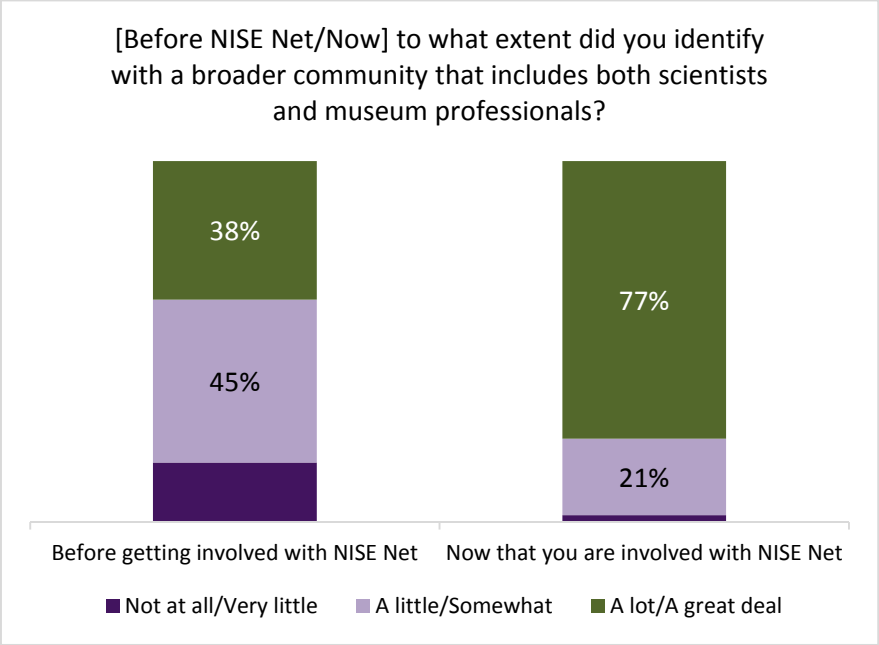
NISE Network Goals for Professionals	Community and Collaboration Findings
Goal 1 Identify with a broader community that includes scientists and museums **Goal 2** Value local research-ISE collaborations	1.1 Tier 1-3 professionals reported an increased sense of community after getting involved with the NISE Net. 1.2 As of Year 10, Tier 1-3 professionals participated in the NISE Network in a variety of ways and valued the opportunities provided. 1.3 As of Year 10, Tier 1-3 professionals felt confident initiating a partnership with an informal learning or research organization and often used NISE Net resources to do so. 1.4 Over Years 8-10, ISE professionals' confidence in initiating a partnership increased, possibly because of NanoDays. 1.5 Over Years 8-10, University professionals became less likely to initiate a partnership with an informal learning or research organization, possibly because on-going partnerships were already in place.

Overall Findings

1.1 Tier 1-3 professionals reported an increased sense of community after getting involved with the NISE Net.

On the Year 10 survey, professionals were asked to rate the extent to which they identified with a broader community that includes both scientists and museum professionals. When comparing their retrospective pre/post responses about "before getting involved with NISE Net" and "now that you're involved with NISE Net," their ratings indicate statistically significant increases in their identification with the community over this time period. This increase holds true for all tiers and organization types.

Figure 3. Tier 1-3 professionals reported an increased sense of community.* (n=321)



*Wilcoxon Signed Ranks Test. See Instrument Appendix #11/ #12 for item format and Technical Appendix for analysis notes.

While the survey indicates an overall increase in the extent to which professionals identify with a broader community, interviews help highlight how this sense of community has increased. When describing how their community shifted, professionals said NISE Net expanded the types of organizations with which they connected and helped them focus their collaborations through the addition of a nano-themed event (NanoDays). One ISE professional noted how NISE Net gave her another topic to connect with others about, "Nano is another something to connect to other professionals about...it's just another connection, more than perhaps, really, working together around nanotechnology with that person. I guess, it's more cement for the relationship" [Y10, #1].

Another ISE professional commented in her Year 10 interview that NISE Net provided her with national connections,

> *NISE [Net] made the picture more national for me, where maybe I, you know being in Virginia, maybe I would have never thought that someone in California could be a resource to me, and then suddenly, I thought, well, heck, why not? They're doing parallel stuff over there . . . it kind of broadened my whole landscape of what constituted my colleagues and [I can] appropriately communicate and partner even beyond geography limitations.* [Y10, #9]

1.2 As of Year 10, Tier 1-3 professionals participated in the NISE Network in a variety of ways and valued the opportunities provided.

In order to understand and articulate how professionals connected with the NISE Network community, this study included survey and interview questions which asked individuals about their Network involvement. Because this study included partners in Tiers 1-3, the range of involvement for these individuals could have varied extensively. Survey data provides a broad

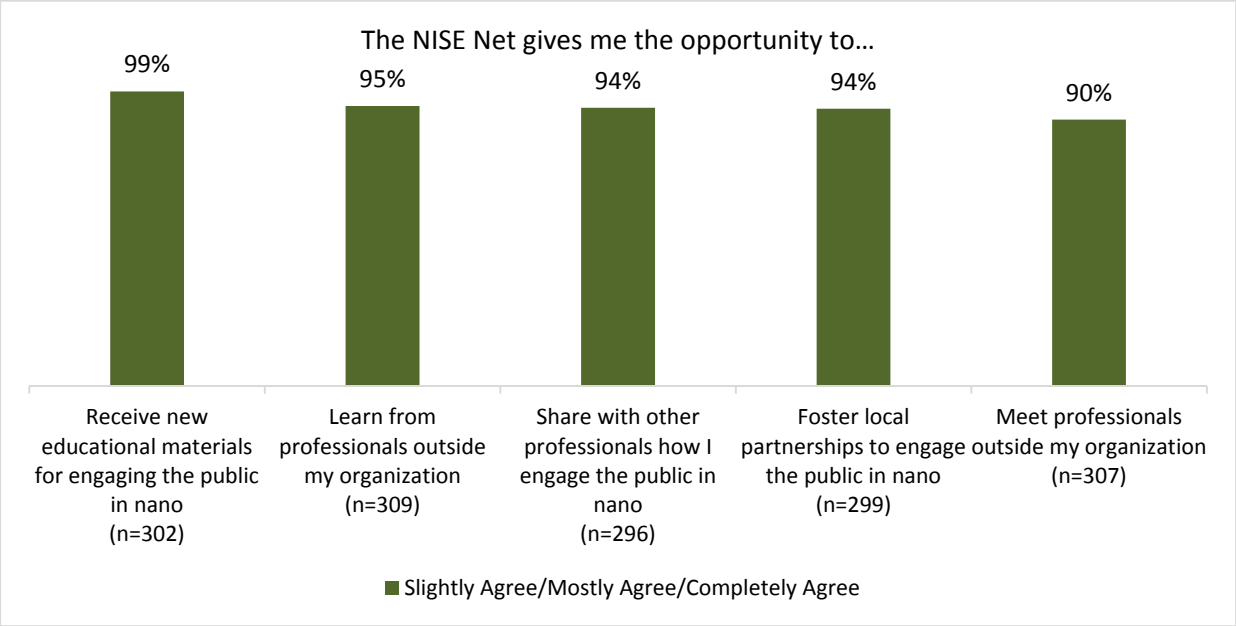
viewpoint of how professionals value involvement in general opportunities (e.g. receiving new materials or meeting other professionals) as well as very specific types of NISE Net involvement (e.g. visiting the website or connecting with the regional hub leader). Interview responses provide information regarding professionals' overall views of NISE Net and how they view their roles in this Network. Across these data, it is apparent that Tier 1-3 NISE Net professionals participated in the NISE Network in a variety of ways and valued the opportunities provided.

Two questions on the survey asked all professionals about the following five ways of being involved in the NISE Net:

a) Receiving new educational materials for engaging the public.
b) Meeting professionals outside my organization.
c) Learning from professionals outside my organization.
d) Sharing with other professionals how I engage the public.
e) Fostering local partnerships to engage the public.

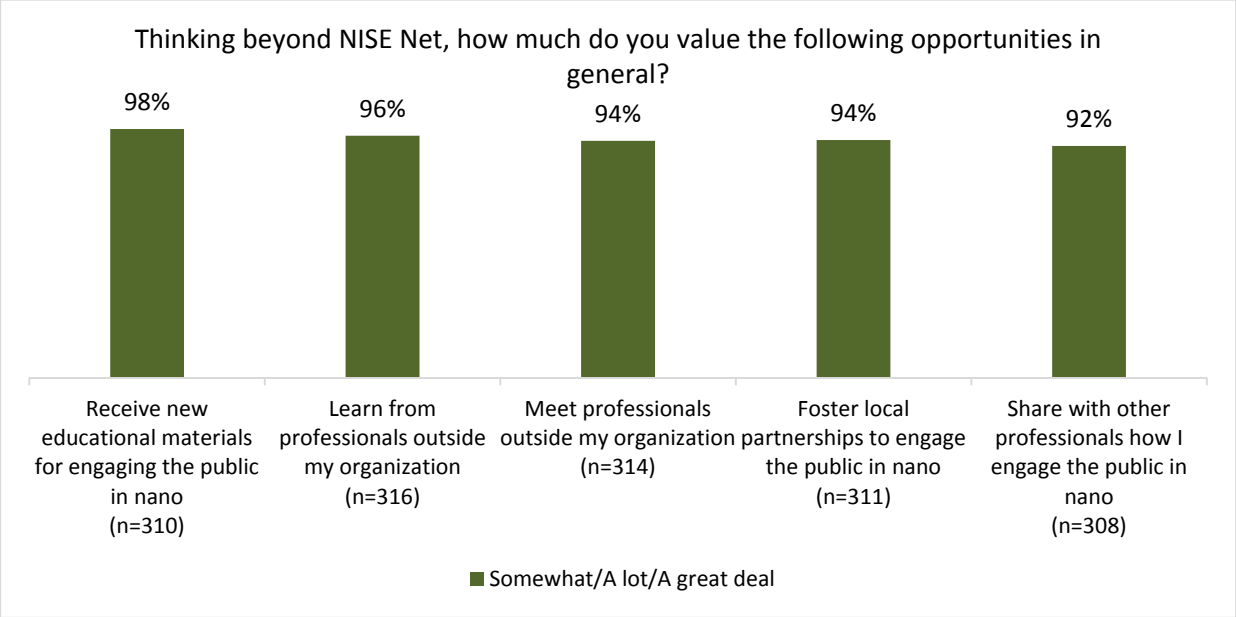
These statements represent different ways that NISE Net built connections with the Network partners and were determined in collaboration with NISE Net leadership. For example, receiving new educational materials could relate to receiving a NanoDays kit or finding public engagement materials on the NISE Net website. Opportunities for meeting, learning from, and sharing with other professionals were provided through meetings (hosted by NISE Net or professional organizations), as well as other methods. Professionals were asked two questions about these different opportunities to be involved in the NISE Net: the extent to which they agreed that NISE Net provided that opportunity and, beyond NISE Net, how much they valued the opportunity in general. While both of these questions included six-point scales, less than 10% of respondents replied to any statement on either question in the lower three response options. Figures 4 and 5 provide the percent of responses in the upper three response categories across the five statements in these two questions.

Figure 4. Tier 1-3 professionals agreed that NISE Net provided opportunities to participate in the Network.



Note. See Instrument Appendix #9 for item format and Technical Appendix for analysis notes.

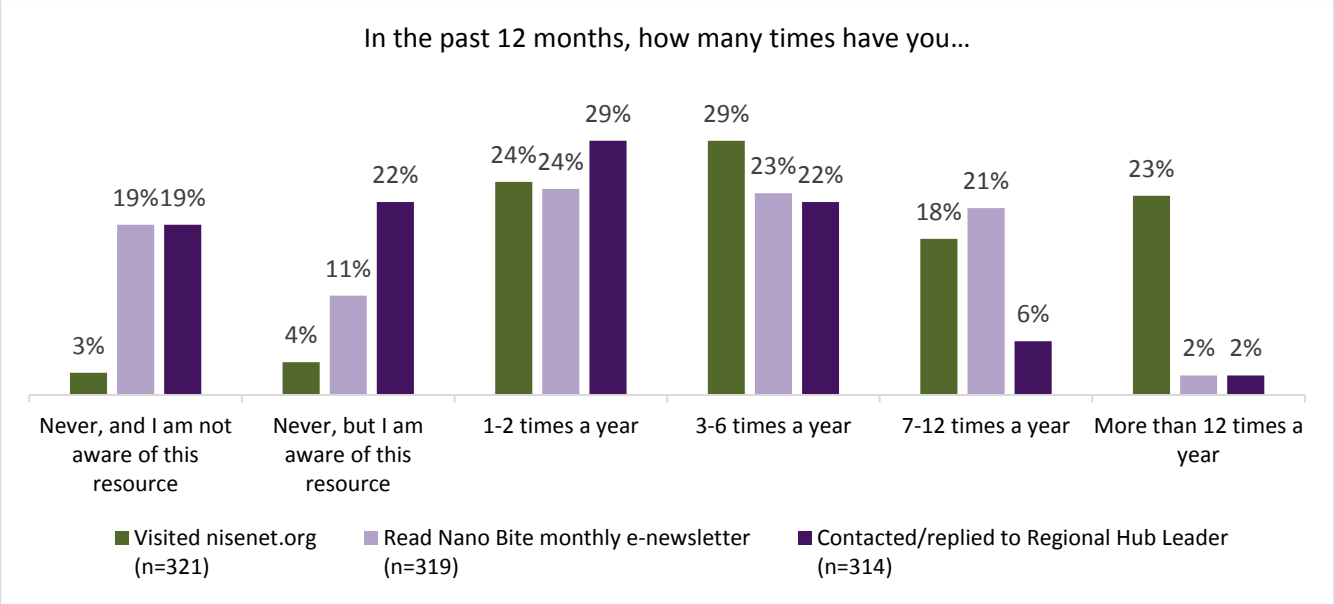
Figure 5. NISE Net provided Tier 1-3 professionals with opportunities to participate in the Network that aligned with professionals' interests in general.



Note. See Instrument Appendix #10 for item format and Technical Appendix for analysis notes.

In addition to these broad ways of being involved in NISE Net, the survey asked professionals the frequency with which they visited nisenet.org, read the Nano Bite monthly e-newsletter, and contacted/replied to their regional hub leader. These three aspects of NISE Net involvement were available to all partners, and were methods used as communication mechanisms within the Network. As shown in Figure 6, the majority of Year 10 Tier 1-3 respondents have participated in these aspects of the Network at least once in the past year (nisenet.org: 94%, NanoBite newsletter: 70%, and Regional Hub leader: 59%). Visiting nisenet.org appears to be a resource that the vast majority of Network partners are using, as only 7% responded that they never used this resource within the last year.

Figure 6. The majority of Year 10 Tier 1-3 respondents have participated in NISE Net by visiting the website, reading the monthly e-newsletter, or connecting with their Regional Hub Leader.



Note. See Instrument Appendix #3 for item format and Technical Appendix for analysis notes.

Where the survey data indicates that as of the end of the Network, Tier 1-3 partners valued the opportunities that NISE Net provided for participation and used the communication sources that NISE Net provided, interview participants provided detailed descriptions of the Network community and how they see themselves fitting into its structure. Many individuals described the NISE Net community as "supportive," "thorough," and "welcoming." For example, one Tier 2 ISE professional stated, "It's a community of educators who all seem to be very passionate about education, hands-on learning . . . and wanting to bring new things to . . . their institution, open to other ideas and willing to share their ideas" [Y8, #10]. In addition to describing the community, some professionals spoke about their diverse roles within the Network. Some professionals felt their role was to share their perspectives and knowledge with other participants, some felt that they were representatives charged with bringing information back to their institutions or own nano-related work, while others described themselves more as "users" of Network resources. Below are several examples of how professionals talked about their roles:

> *I see myself as a person that's responsible for outreach. Taking the NISE Network material and communicating science to the people in my community, that's how I see my role as. I see myself as an ambassador of NISE Net for the NISE Network in this local community. [Y8, #17]*

> *I'm definitely more of a user as opposed to somebody who's like actively giving back, but I'm benefiting from it, I think. Yeah, I guess I'm just learning from it and using it right now. [Y8, #8]*

Although individuals participating in longitudinal interviews mentioned a breadth of Network involvement, they particularly focused on NISE Net face-to-face meetings.[3] Professionals felt that face-to-face meetings were important because they provided a quality professional development opportunity. Meetings allowed participants to share ideas with other professionals and learn from one another, as well as become acquainted with others doing nano education. One Tier 2 ISE professionals elaborated that:

> *I went to the December conference, just seeing and hearing everybody talk about what they were doing in their institutions and how they might expand on some of the activities and kind of what they were hopeful for, for the future. I think . . . it does make you feel like you're a part of something bigger and interconnected, and . . . it's kind of a nice thing to be able to brainstorm and know, 'Oh! Well that worked for you, that didn't work for me' or 'have we tried this? Maybe we could do that instead.' Um, so it's nice to have a big group of people who have done so many of the same similar things to hear how it's been organized differently or modified based on audience and other groups that they've worked with. [Y8, #6]*

For some interviewees, attending a face-to-face meeting was a transformative experience and helped these individuals understand more about what the Network has to offer.

> *I got invited to the conference this year. That was huge, so I met a lot of other people. I would say that was a very valuable experience for me to see the Network that way. And becoming more aware of all of the other resources out there, and what people . . . use, how are they using them, different ways they're using them. That was a very, very powerful experience and definitely changed [me]. [Y8, #13]*

Additionally, a few professionals who participated in none of the NISE Net face-to-face meetings recognized their potential importance. For example, one Tier 3 University professional who never had the opportunity to attend a NISE Net face-to-face meeting spoke about how useful it would be for him to participate in an opportunity to meet others in the Network,

> *[It would be nice if] A bunch of people who received a grant from NISE Network, we [could] meet, and we [could] share our experiences. We do talks, we present posters, and exchange ideas for making the NanoDays even better. I would appreciate that. I think I could learn a lot. [Y8, #17]*

Another Tier 2 ISE professional, who had previously attended a NISE Net face-to-face meeting but was no longer able to participate, shared the difference he felt in his connectedness to the community and knowledge of Network resources due to his colleague's participation in a meeting:

> *It's a matter of staffing. Sending two people to the conference instead of one, I don't think was feasible. And because [my manager] became more involved by going to the conferences, she was more comfortable placing the orders for the physical kit and also*

[3] The NISE Net invited individual professionals to participate in face-to-face meetings which were paid for by the Network. Network-wide meetings were held in Years 6, 8, and 10 and each hosted around 200 professionals. Regional meetings were held in Years 7 and 9, and across the seven regions, around 200 professionals attended each year. In addition, NISE Net hosted workshops with a topical focus such as engaging bilingual audiences, applying principles of universal design to public programs, or engaging audiences with nano and society content.

was more knowledgeable about the application processes for the mini-grants and stuff like that. [Y9, #7]

In addition to the face-to-face meetings hosted by NISE Net, where a subset of Network professionals were invited, the NISE Net also developed sessions and events at conferences hosted by professional organizations. For example, at times, individuals who developed public engagement products for NanoDays kits were a part of panel presentations with other Network partners at the Association of Science-Technology Centers (ASTC) Conference. There were also instances of pre-conference workshops, Networking happy hours or breakfasts, or a booth in a conference's Expo area which provided examples of hands-on demonstrations and a NISE Network contact to speak with. These other ways to connect with the NISE Net occurred with professional organizations targeting museum professionals or university researchers such as ASTC, the Association of Children's Museums (ACM), American Alliance of Museums (AAM), Materials Research Society (MRS), and more. According to the Year 10 survey, this NISE Net strategy matched professionals' interests because 90% were engaged with a professional organization through membership or by attending events. Of those Tier 1-3 individuals who had attended a professional conference, 66% reported that they attended a session or event about or by NISE Net while there. Moreover, data collected through interviews suggest that having a NISE Net presence at ASTC was an effective method for getting partners initially involved as well as keeping partners connected.

I found out about the NISE Network when I attended an ASTC conference, and that's when we were encouraged to apply for the NanoDays kits. [I was interested] because we do a couple of science nights and I was looking for connections with materials science and how it related to [the focus of my institution]. [Y8, #12]

Just being able to go to ASTC and you see the nano, the NISE Net group, it's like, "Oh! I belong to that!" and getting to even walk up and say "Hey, I'm so-and-so. I'm one of the [partners], you know, we use your stuff all the time." And everybody is just very thoughtful and passionate about what they do and very inclusive with everybody else. [Y8, #4]

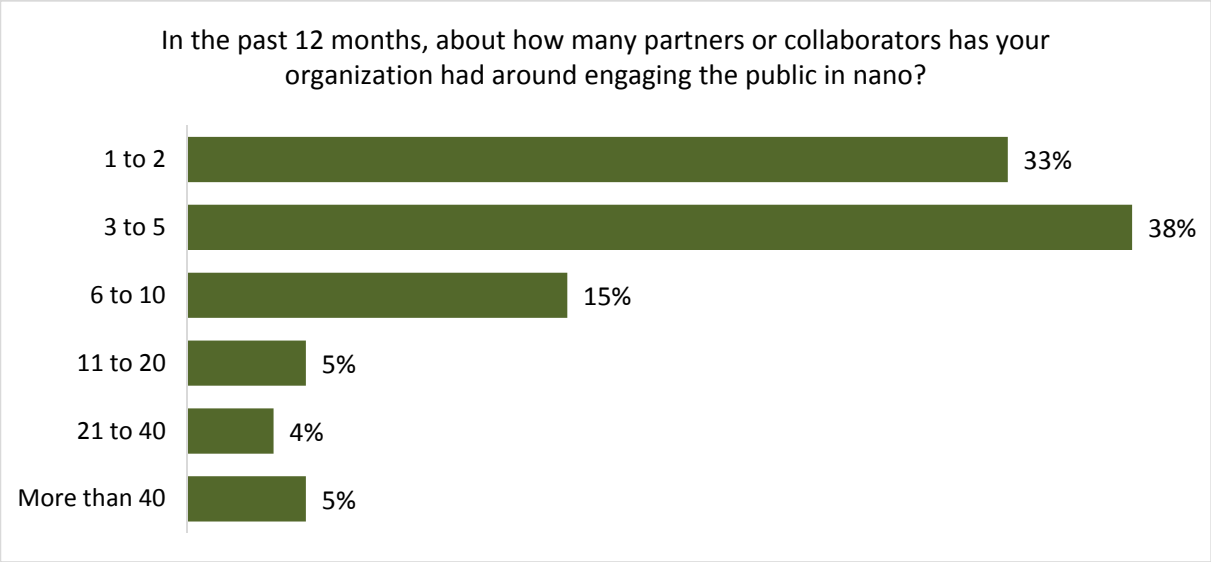
1.3 As of Year 10, Tier 1-3 professionals felt confident initiating a partnership with an informal learning or research organization and often used NISE Net resources to do so.

This finding provides data collected from Tier 1-3 individuals about their organization's partnerships, about their own confidence in pursuing collaborations, and about their use of NISE Net materials and resources as a part of those partnerships. By approaching the topic of partnership through these lenses, this study provides insight into the achievement of the NISE Net goal that "professionals will value collaboration between researchers and informal science educators."

The majority (78%) of Tier 1-3 professionals responding to the Year 10 survey reported that their organization has partnered or collaborated with another around engaging the public in nano. This high percentage of partners who reported their institution was involved in partnering was similar across tiers and organization types, with no tier or organization type being more or less likely to have partnered. Of those Tier 1-3 professionals who reported that their organization has nano-related partnerships, the majority (71%) reported that they have had 1-5 collaborators in

the last 12 months, and that most often that partnership included a university/college (Figures 7 and 8).[4]

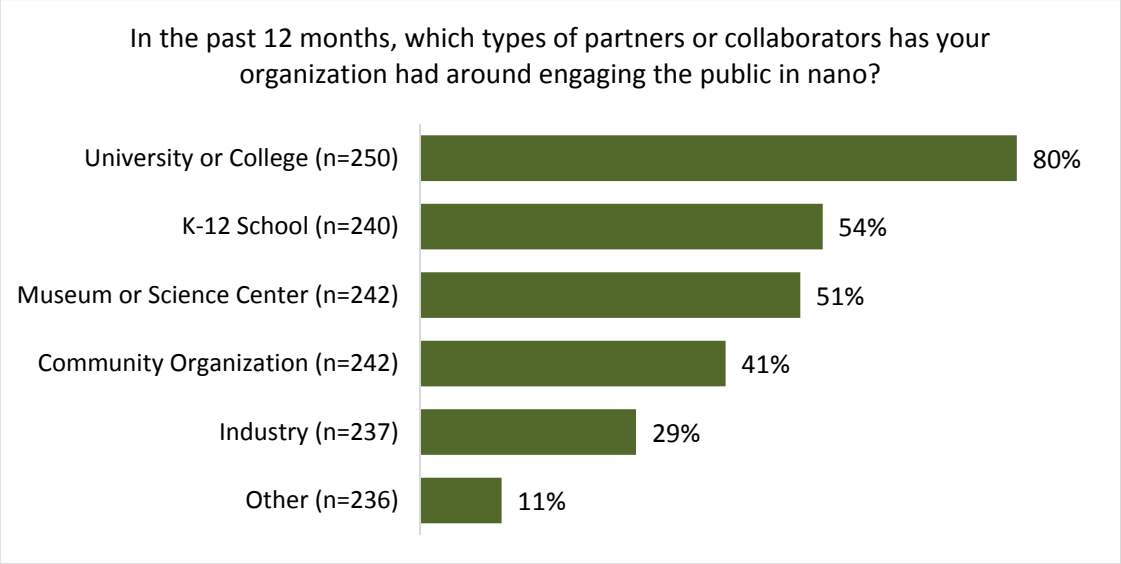
Figure 7. Of the Tier 1-3 professionals who responded that their organization has partnered, the majority of Year 10 respondents reported between 1 and 5 collaborators in the previous year. (n=228)



Note. See Instrument Appendix #17 for item format and Technical Appendix for analysis notes.

[4] It is important to remember that data were collected from individuals, and some organizations had multiple staff members respond to the survey. Therefore, these data do not represent the frequency of partnering among NISE Net institutions. This applies to Figures 7 and 8.

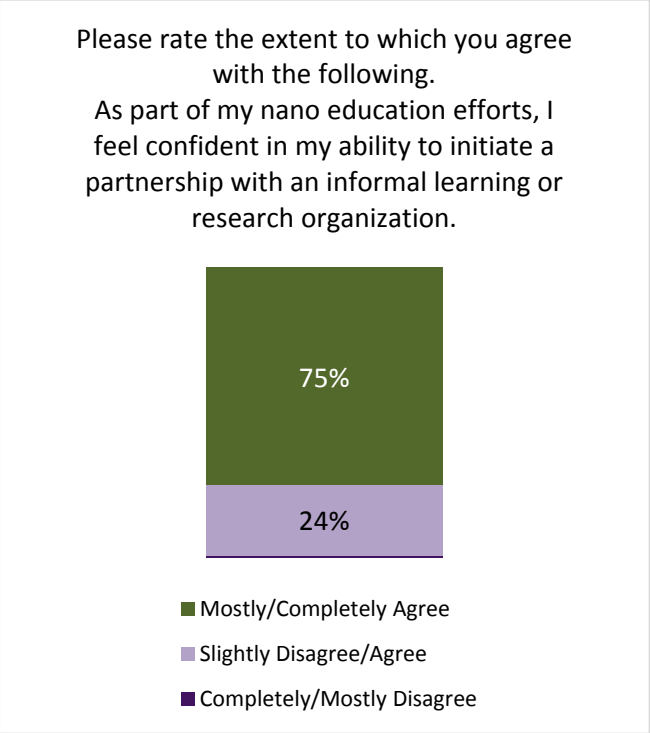
Figure 8. Of the Tier 1-3 professionals who responded that their organization has partnered, the majority of Year 10 respondents reported that their organization has partnered with Universities to engage the public in nano.



Note. See Instrument Appendix #18 for item format and Technical Appendix for analysis notes.

After asking professionals about their organization's partnerships, this study collected data from Tier 1-3 individuals about their confidence in partnering and use of NISE Net resources to help with partnering. As shown in Figure 9, the majority of Tier 1-3 professionals reported high levels of confidence in their ability to initiate a partnership with an informal learning or research organization, with 75% of respondents responding in the top two levels of agreement with the statement. These high levels of confidence in partnering were similar across tiers and organization types in that there were no differences in groups' levels of confidence. This confidence in initiating partnerships might be explained in part by the prestige that comes from being associated with NISE Net. For example, one Tier 2 ISE interviewee commented that she felt like NISE Net gave her more credentials which could have increased her confidence in approaching potential partners. She said, "We have incredible clout to be able to reference it as part of our credentials; it's like having a special degree by having that behind you. Being a full-fledged member, experienced, we can speak to it" [Y8, #9].

Figure 9. The majority of Tier 1-3 professionals feel confident in their ability to initiate a partnership with an informal learning or research organization. (n=252)



Note. Respondents were allowed to select a "Not Applicable" response option. See Instrument Appendix #25h for item format and Technical Appendix for analysis notes.

Not only were professionals confident in initiating partnerships, the majority reported using a NISE Net resource to help start a partnership or help with an existing partnership. Of those Tier 1-3 individuals who reported initiating a partnership, 79% (134 of 169) incorporated a NISE Net resource into their work with others. This percentage of partners using a NISE Net resource is similar across tiers and organization types in that no group was significantly more likely than another to use a NISE Net resource. One University partner discussed how planning the NanoDays event caused her to meet a colleague on her own campus:

> *I think what it's done is kind of give a catalyst to come together. Like this new person in engineering, I never would have met him. We actually put out a little news brief on campus that just said, "Hey, are you into nano? We're starting to plan our 2012 activities," and he came out of the woodwork because he saw that. So it was a reason to meet him. . . . And then, you know, it adds some legitimacy, I guess. It's like, "Hey! We're part of this thing. We think you should be part of this big thing too!" It's just a nice way to approach somebody to be part of a team. [Y8, #19]*

Another University researcher shared how he used NISE Net resources as a part of school partnerships that existed prior to his involvement with NISE Net, saying that NISE Net activities encouraged a more hands-on presentation style. He felt that this change in presentation style helped him connect more with students.

> *The basic idea stayed the same, but . . . the most significant change, really was going from more of a demonstration mode for interacting with the schools, to more of a*

hands-on, interactive role. [I used to] go 45 minutes, give a talk, show different demonstrations, where now, [I] have the ability through NanoDays kits and the NISE Net activities to be able to have the students experience it in smaller groups, with them actually doing the demonstration, instead of me showing them how it works . . . that's been a very positive result because kids as young as kindergarten, but you typically get more 4 through 6th grade. . . . they're going to learn a lot more and be more impacted by the hands-on activities than me telling them things. [Y10, #15]

Change Over Years 8 Through 10

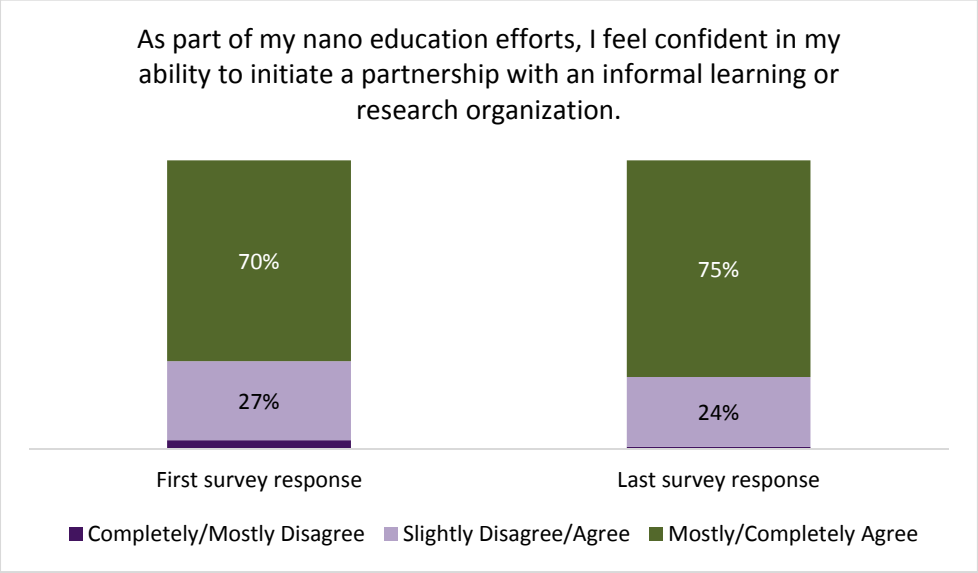
This study included methods for tracking NISE Net's impact on individuals over the final three years of grant funding, allowing the study to reflect the way that Tier 1-3 professionals' involvement with NISE Net builds over time. Findings in this section help to illustrate how an individual's sense of community or the extent of collaboration might have changed as a result of more NISE Net exposure, both of which are related to Network goals one and two. While the overall findings present data from all professionals combined or illustrate differences *between* groups as of the final year of the NISE Net, the findings exploring change over Years 8-10 provide findings *within* a group (e.g. examining the individuals within ISE or examining the individuals who are Tier 2 professionals and showing how these individuals changed over time).

There were two Network-wide survey questions related to collaboration that were a part of this phase of analysis. These questions asked Tier 1-3 professionals about their confidence in initiating a partnership with an informal learning or research organization and whether they had implemented these partnerships. These questions were explored across all respondents as well as by tier and organization type. As is true throughout the entire report, all findings described below refer to the statistically significant difference detected by the statistical test with a *p*-value below .05. Non-significant findings are not described as it was impractical to include all of this information in this report. The Technical Appendix provides additional clarification around these analyses.

1.4 Over Years 8-10, ISE professionals' confidence in initiating a partnership increased, possibly because of NanoDays.

When tracking individual survey respondents over Years 8-10, it was found that ISE professionals became more confident in initiating partnerships. As shown in Figure 10, in response to the survey question "As part of my nano education efforts, I feel confident in my ability to initiate a partnership with an informal learning or research organization," ISE professionals felt more confident in their abilities to initiate partnerships as the Network neared the end of grant funding than they did in Year 8.

Figure 10. Over Years 8-10, ISE professionals' mean confidence in initiating partnerships increased.* (n=128)



*Wilcoxon Signed Ranks Test. See Instrument Appendix #25h pre/post for item format and Technical Appendix for analysis notes.

This sentiment that their confidence in partnering had improved by the end of the Network was echoed by several of the ISE interview participants. For example, one Tier 2 ISE professional spoke during her first interview in Year 8 about how her gains in confidence are due to the NISE Net resources:

> *If it's the activities or the exhibit, the quality of the resources that are available and my confidence and knowledge of the topic has grown because of the resources that are available. I think it just has made me more confident to reach out and know what I'm asking for. Not be so vague about how, "Well, we'd love to just have you come and talk about science to us." It gives us a way to be more knowledgeable and say, "You know, we want you to come and talk about how you're using nanotechnology to target cancer cells." It's just given me more confidence to talk with them. [Y8, #4]*

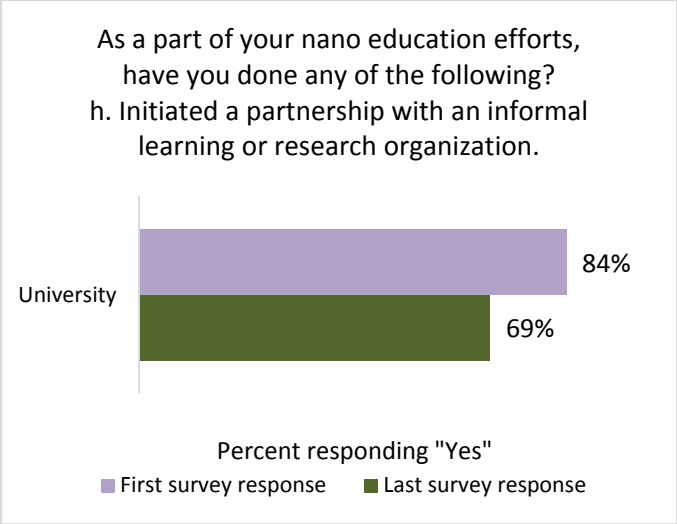
In particular, ISE professionals mentioned NanoDays as being one of the main NISE Net initiatives that increased their work and confidence around partnering. NISE Net encouraged organizations to partner with others for this event and provided several resources to facilitate this process. As one professional explained about NanoDays, "It gave me opportunities to connect with others in our community, it was a nice launch for all of that" [Y8, #9]. While another ISE partner, in describing their work with universities, said "I think that since that initial NanoDays of working together, there's definitely a greater level of trust on both sides in terms of knowing that we will work together to best deliver programming and content to the audience" [Y8, #3].

1.5 Over Years 8-10, University professionals became less likely to initiate a partnership with an informal learning or research organization, possibly because on-going partnerships were already in place.

Responses from University professionals show that they became significantly less likely to initiate a new partnership with an informal learning or research organization between Years 8-10. Figure 11 illustrates that there is a significant difference in the proportion of University

respondents at the beginning and end of this evaluation who reported initiating partnerships, in that 85% of University respondents reported initiating partnerships on their first survey response, compared to only 70% of these same University respondents in their final survey response.

Figure 11. University professionals became less likely to initiate partnerships over Years 8-10.* (n=61)



*McNemar's Test. See Instrument Appendix #26h pre/post for item format and Technical Appendix for analysis notes.

One possible reason for a decrease in initiating partnerships may be that University professionals were continuing previous, on-going partnerships instead of initiating new ones by the end of the NISE Net. This was the case for the majority of University professionals participating in the interviews. For example, one University researcher described in his Year 10 interview how NISE Net helped an existing partnership last for the previous three years of NanoDays events:

> *NanoDays has been now recurring there since we started with them, so it makes it easy. It's a well-rehearsed activity and also, the museum is showing or telling us that they're interested in us, so we are contributing something I think to them and our students like it. [Y10, #20]*

Another University researcher commented about her on-going relationship with the science club on campus whose members staff the NanoDays event. She provides some suggestions related to activities to use, but is not in charge of the club:

> *Well, I think [the activities are] a perfect match with the science club because [the] science club, when they organize any activities, there must be some focus, and all those are related with science topics – biology, chemistry, or whatever the topics. And, they love to show students the science process, so [the] material from NISE Net is the best to do this job . . . Right now, I don't need to ask around and students just come to me. I believe they are going to keep coming to me to ask about the material. They really did borrow those things. [Y10, #16]*

Taken together, these data suggest that while the Network-wide sample of University respondents have become less likely to initiate a partnership over Years 8-10, it does not necessarily mean that their on-going partnerships have declined.

Interview Vignettes

Vignette #1: Becoming a part of the NISE Net community

Clare's involvement and sense of community illustrates the ways in which many professionals valued opportunities provided by the NISE Net. Clare, a director of a Tier 2 Children's Museum, described how her interactions with NISE Net evolved over time and how being part of the Network afforded their smaller museum a national presence they did not have before NISE Net.

> *We're part of this much bigger network that is a nationwide outreach on nanotechnology. . . . I think it brings a level of credibility to what we do. It shows that we're engaged in something much bigger than our little community.*
>
> *-Tier 2 ISE professional, Year 8 interview*

In her first interview, Clare discussed how her organization's introduction to the Network came from an existing university partnership. A member of their museum's board was also a professor at a local university and had applied for NISE Net kits so that both organizations could share activities. Clare explained that the kits were a nice addition to their hands-on exhibits and that using these materials helped their educators become more "literate in nano" [Y8, #13].

Clare described the Network as "vibrant, very active, and engaging" [Y8, #13]. She spoke about how attending the 2012 Network-wide Meeting enabled her to meet educators from other institutions. Being part of this meeting helped her become more aware of NISE Net's resources, in addition to potential ways of implementing these resources at her own institution:

> *I got invited to the conference this year. That was huge, so I met a lot of other people. I would say that was a very valuable experience for me to see the Network that way. And becoming more aware of all of the other resources out there, and what people are us[ing]- how are they using them, different ways they're using them. That was a very, very powerful experience and definitely changed [me]. [Y8, #13]*

In Year 2, this partner reiterated the importance of meetings, and spoke about the regional meeting she had recently attended. This opportunity allowed her to meet with others in her area and hear from scientists. She also spoke about how the meetings inspired her to shift their museum's level of engagement with nano, particularly through partnerships. When talking about her role in this endeavor, she explained, "Yeah, I definitely do a lot of the, you know, establishing collaborations and working with our collaborators and partners, trying to figure out what kind of programming that would work to fulfill both of our organizations' needs" [Y9, #13].

In her final interview, Clare emphasized how NISE Net provides a great example of professionalism in their resources. Again, being part of a larger community helped her smaller Museum connect with others across the country and in her local community to support their work:

> *Learning about other small museums and how they were founded, [was] important . . . we're one of the small places [in the Network]. It's been helpful when I went to the large conference one year to just meet these other people and learn about their organizations and how they kind of evolved. It's nice to know that you're on the right path and you're not that crazy . . . I mean, I do everything. It's a small museum, so I end up doing a lot of different things and sometimes [it's] a little overwhelming, so it's nice to know that other groups have been down this road before and they've come out the other side. [Y10, #13]*

Vignette #2: Fostering nano partnerships

Wade's experience with partnerships exemplifies how the Network helped facilitate connections between partner institutions around nano. His story illustrates how the Network helped some professionals feel more confident in their abilities to partner with other organizations, and how NISE Net resources were used to forge relationships. For Wade, a Tier 3 University researcher, the Network encouraged him to collaborate with his local children's Museum, and over the three years of this study, the partnership grew into a beneficial connection for both institutions.

> *I've always identified with the community of scientists because, you know, that's my background, but I've never really had any interactions with people more associated on the museum side of things. So through NISE Net, I became involved with the local children's museum.*
>
> *-Tier 3 University researcher, Year 10 interview*

In this first interview, Wade described how encouragement from the NISE Net led him to reach out to his local children's museum. He explained how he had previously contacted the Museum, but did not receive a response. His regional hub leader suggested contacting a different individual, and this time he was connected with someone excited about collaborating.

> *I submitted a grant proposal for a small grant through NISE Net and . . . didn't get it, but the critique on it was that it would be nice to collaborate with the local children's museum which, you know, was a great idea but it was something we had actually tried the year before. We contacted them and didn't even get a response, however, by the . . . [regional hub leader] saying "you should try that." It was, like, "ok, we will try someone else." So I sent an email and it is all who you talk to. The person who was in the programming area immediately returned the email and we are coordinating. [Y8, #15]*

In his interview the following year, Wade described some changes they made to NanoDays through their partnership with the children's museum. Because the museum had recently expanded, the event took place at the museum. Wade aided with the event coordination and brought students to the museum to lead the activities.

> *We [had] a huge amount of space, more than we could even fill, but we set up about probably about 20 to 25 of the different stations and the students here, the material science majors from [our university] manned the station or staffed the stations and so it worked extremely well. So we immediately are doing it again this year. [Y9, #15]*

In this interview, Wade also shared his experience attending his first NISE Net meeting. He felt this provided him with a greater understanding of who was part of the Network, saying, "I've always looked at it from my perspective because I'm working with K-12 and more recently with the children's museum . . . I didn't realize how museum-oriented it really was" [Y9, #15]

In his final interview, Wade spoke about how he has worked with the children's museum to develop further opportunities for University students to engage the public with nano, and how he felt the relationship could develop into presenting topics beyond nano.

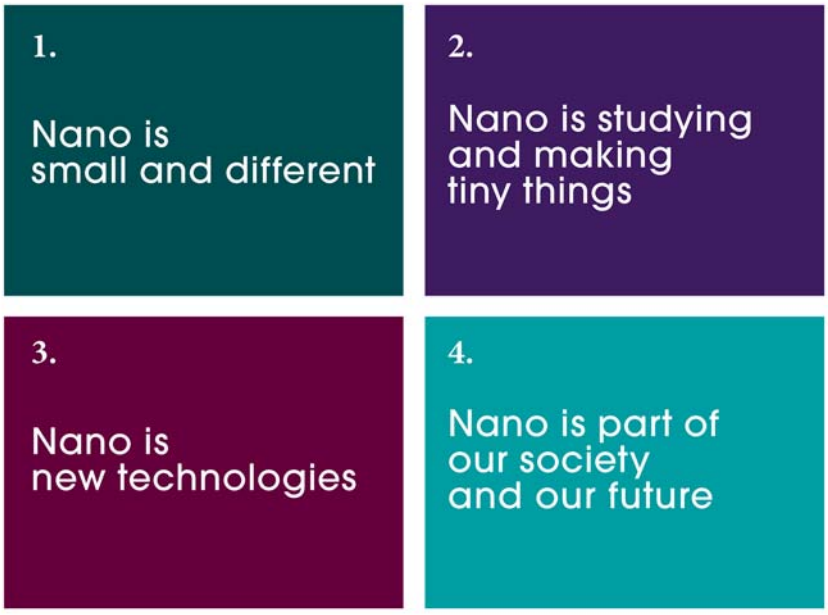
> *One of the things we have been trying to do was get one of the museum displays actually permanently displayed there. . . . We've talked about other projects as far as having more interactions than just NanoDays, [but] it really hasn't progressed beyond that yet. [Y10, #15]*

UNDERSTANDING NANO

2. Learning about Nano Concepts

For Years 6-10, the NISE Net developed the Content Map, which "presents the content knowledge the Network has identified as the most important for engaging the public in learning about nanoscale science, engineering, and technology"(Bequette et al., 2012). These four key concepts (see Figure 12) and embedded subtopics guided the development of all public engagement products for the NISE Net.

Figure 12. Four key concepts of the NISE Network Content Map (Bequette, et al., 2012).



While the Network developed a range of products and resources connecting to any of these four key content ideas, there was a series of 2012 workshops and professional development resources developed around concept 4, "Nano is part of our society and our future." Topics covered in these resources relate to how "nanotechnologies—and their costs, utility, risks, and benefits—are closely interconnected with society and with our values." Since Year 6, NISE Net has used the phrase "nano and society" when referring to these areas of the Content Map and its corresponding professional resources. This phrase will be used throughout this report when referring to professionals' learning of these specific concepts and use of related materials.

For the purposes of the *NISE Net Professional Impacts Summative Evaluation*, professionals were asked about their use and understanding of eight different nano concepts on the survey and interviews. These eight concepts were selected in collaboration with developers of the NISE Net Content Map, with two concepts per Content Map area. The following table details the eight concepts included in this evaluation and how they align with concepts driving all NISE Net public engagement product development.

Table 5. Nano concepts used for the *NISE Net Professional Impacts Summative Evaluation* and their alignment with the NISE Network Content Map.

Content Map Key Concepts	Nano Concepts used in this study
1. Nano is small and different.	a. The size of a nanometer. b. How nano-sized materials behave compared to macro-sized materials.
2. Nano is studying and making tiny things.	c. How scientists work at the nanoscale. d. Examples of nano in nature.
3. Nano is new technologies.	e. Innovations that are possible because of nanotechnology. f. Ways that nanotechnology improves existing products.
4. Nano is part of our society and our future.	g. Risks or potential risks of nanotechnology. h. How the future of nanotechnology may be influenced by political, economic, and personal values.

The "Learning about Nano Concepts" section will focus on professionals' understanding of key nano concepts and the extent to which they attribute their learning to NISE Net. Table 6 provides the relevant goals and lists the findings that will be described in this section.

Table 6. NISE Net professional goals and findings related to learning about nano concepts.

NISE Network Goals for Professionals	Learning about Nano Concepts Findings
Goal 3 Understand and appreciate key concepts in nanoscale science, engineering, and technology and its relationship with our lives, society, and environment	2.1 As of Year 10, the majority of Tier 1-3 professionals rated highly both their confidence in their ability to explain nano to another adult and the amount that NISE Net has affected this confidence. 2.2 As of Year 10, Tier 2 and ISE professionals were more likely than Tier 3 or University partners to attribute NISE Net with impacting their confidence in nano. 2.3 Tier 1-3 professionals reported that NISE Net resources such as NanoDays kits, face-to-face meetings, and the website were particularly useful for their learning, though they also reported learning about nano through methods outside of NISE Net. 2.4 Over Years 8-10, Tier 2 professionals and ISE professionals became more confident in nano and society concepts and increased the extent to which they attributed NISE Net with that confidence.[5]

Overall Findings

2.1 As of Year 10, the majority of Tier 1-3 professionals rated highly both their confidence in their ability to explain nano to another adult and the amount that NISE Net has affected this confidence.

As detailed in Figure 13, the survey included two questions intended to help articulate the extent to which professionals understood nano concepts and how much NISE Net affected this

[5] Other findings related to engaging the public with nano and society concepts can also be found in the sections on "Using Public Engagement Products" and "Using Public Engagement Practices."

understanding. Each question used a six-point scale and included the eight nano concepts used in this study.

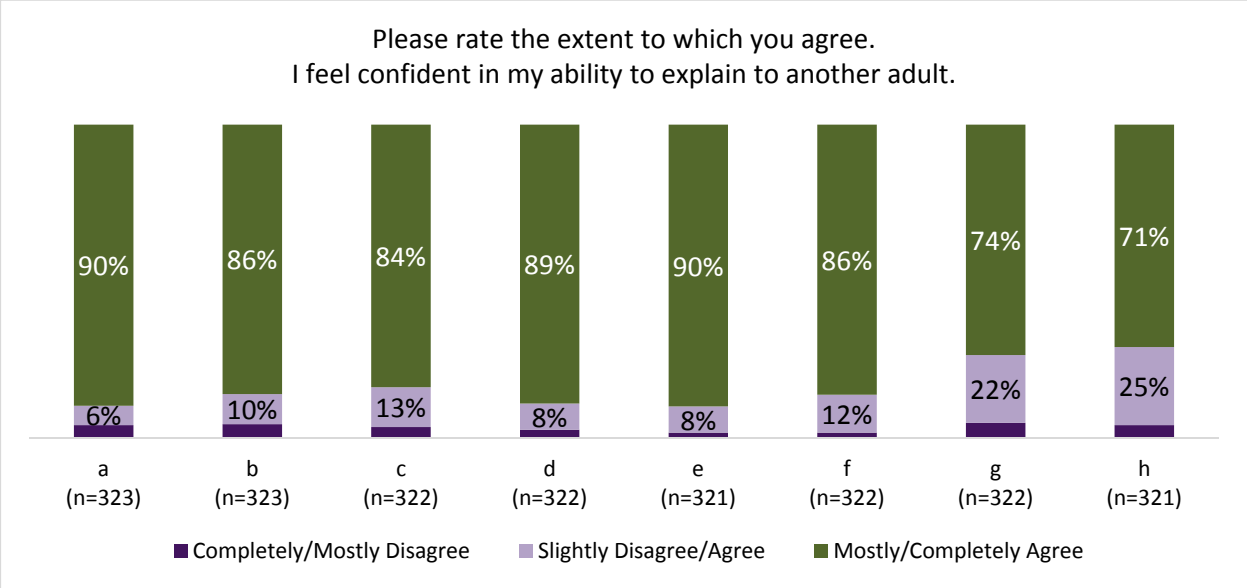
Figure 13. Survey questions related to learning about nano and the list of concepts used.

I feel confident in my ability to explain to another adult. . .					
Completely Disagree	Mostly Disagree	Slightly Disagree	Slightly Agree	Mostly Agree	Completely Agree
How much has NISE Net affected your confidence in explaining to another adult…					
Not at all	Very Little	A Little	Somewhat	A Lot	A Great Deal

Eight nano concepts used for both survey questions
a. The size of a nanometer.
b. How nano-sized materials behave compared to macro-sized materials.
c. How scientists work at the nanoscale.
d. Examples of nano in nature.
e. Innovations that are possible because of nanotechnology.
f. Ways that nanotechnology improves existing products.
g. Risks or potential risks of nanotechnology.
h. How the future of nanotechnology may be influenced by political, economic, and personal values.

On the Year 10 survey, most Tier 1-3 professionals rated their confidence in explaining any of the eight nano concepts highly on the six-point scale. They responded the lowest about the two concepts related to nano and society (g and h). Still, even in these cases, almost three-quarters of Tier 1-3 respondents reported being in the top two categories of agreement (see Figure 14).

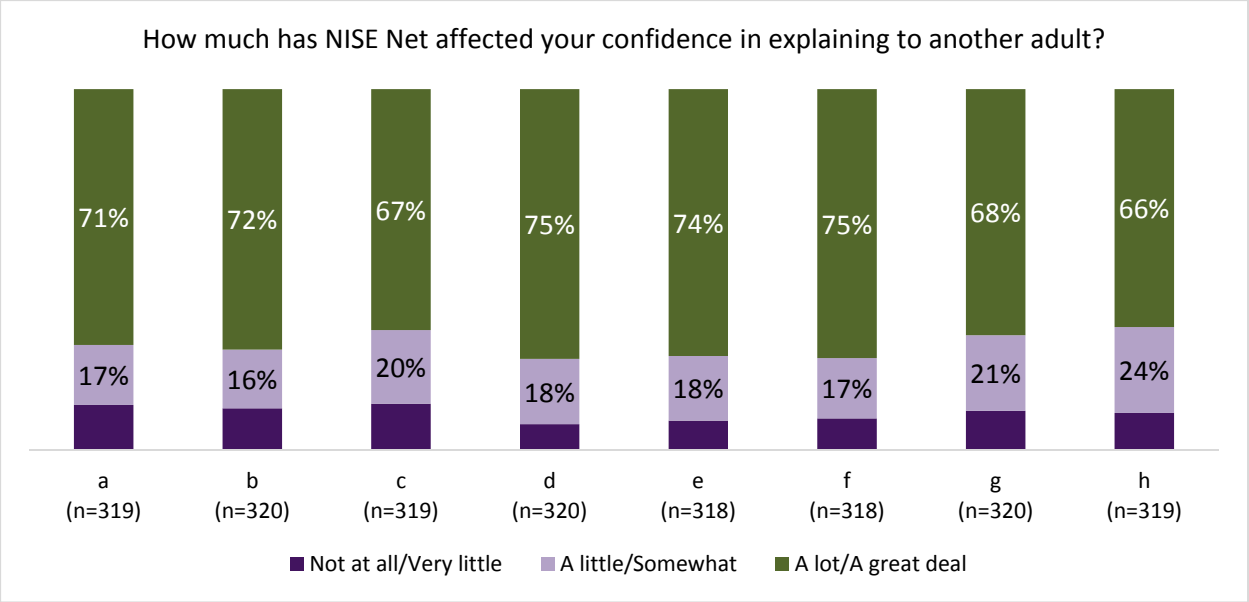
Figure 14. On the Year 10 survey, the majority of Tier 1-3 professionals reported that they felt confident in explaining nano concepts.



Note. See Instrument Appendix #20 for item format and Technical Appendix for analysis notes.

Not only did professionals report high levels of confidence in their understanding of nano, but they also reported that NISE Net had affected this confidence. As shown in Figure 15, the majority of Tier 1-3 professionals responded in the top two categories ("a lot" or "a great deal") for any of the eight nano concepts.

Figure 15. On the Year 10 survey, the majority of Tier 1-3 professionals reported that NISE Net had affected their confidence in explaining nano concepts a lot or a great deal.



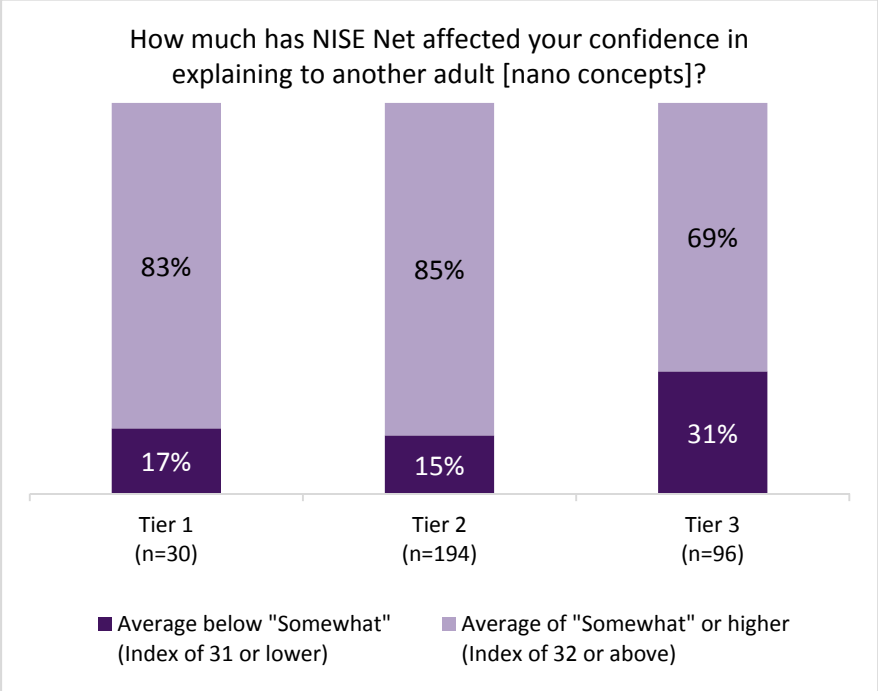
Note. See Instrument Appendix #21 for item format and Technical Appendix for analysis notes.

2.2 As of Year 10, Tier 2 and ISE professionals were more likely than Tier 3 or University partners to attribute NISE Net with impacting their confidence in nano.

In order to examine Tier 1-3 professionals' understanding of nano concepts as a whole, rather than by the eight individual concepts, responses from the Year 10 survey were aggregated across the eight concepts to create an index. Please see the Technical Appendix for more information on how this index was created.

Respondents' indexed responses were analyzed for differences between tiers and between organization types. These analyses were performed by comparing those who scored 32 or higher (averaging "slightly agree" or higher) with those who scored 31 or below. Based on these groupings, it was found that there were no differences between tier or organization type groups for the question related to overall confidence in nano, yet there were differences between groups for the question about how much NISE Net had affected their confidence. Tier 3 professionals were significantly less likely than Tier 1 or 2 professionals to attribute their understanding of nano to NISE Net. Figure 16 illustrates this, showing that 69% of Tier 3 respondents responded an average of "somewhat" or higher (indexed score of 32 or higher), compared to 83% of Tier 1 respondents and 85% of Tier 2 respondents.

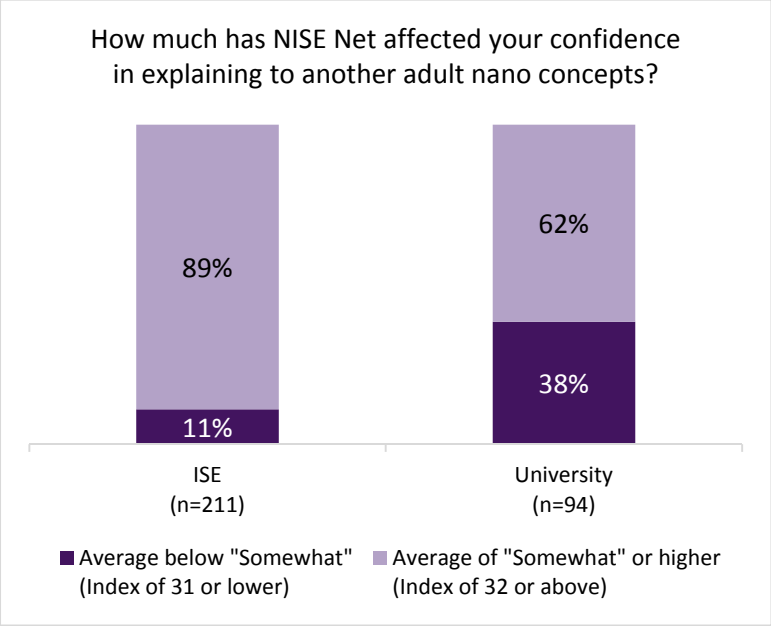
Figure 16. Tier 3 professionals were less likely than Tier 1 and 2 professionals to attribute their understanding of nano to NISE Net.*



* Chi-Square Test. See Instrument Appendix #21 index for item format and Technical Appendix for analysis notes.

There were also differences between organization type groups, where ISE professionals were significantly more likely than University professionals to attribute their understanding of nano to NISE Net. As shown in Figure 17, 89% of ISE respondents rated the amount that NISE Net affected their confidence in explaining nano as an average of "somewhat" or higher (indexed score of 32 or higher), compared to 62% of University respondents who did so.

Figure 17. ISE professionals were more likely than University professionals to attribute their understanding of nano to NISE Net.*



* Chi-Square Test. See Instrument Appendix #21 index for item format and Technical Appendix for analysis notes.

Interview data provided examples of how professionals felt NISE Net affected their understanding of nano. In particular, responses from professionals working in ISEs indicated that NISE Net had a large influence on their learning. For example, one ISE professional from a Tier 2 organization explained,

> *I didn't even know what nano was. Pretty much everything I know about nano, I know from NISE Net. And if you look at those concepts, I'm certainly able to talk about those concepts, but it is pretty much solely because of NISE Net. [Y10, #4]*

Another Tier 2 professional working in an ISE described how NISE Net has "tremendously" affected her understanding of nano, saying,

> *I couldn't have answered the first of those [concepts], you know, what is a nanometer, before I got involved. I only knew the term 'nano' as it was used loosely, such as [for] a nano iPod and so forth. So it gave me my basic scientific understanding of nanoscale science. [Y10, #1]*

During interviews, University professionals were more likely to reference their previous or outside academic work when explaining why they felt they already had knowledge of nano. As one University professional in Tier 3 described,

> *I've been working [sort of] in the nano area for quite a while, even before NISE Net having been doing research and things like that so my understanding has been pretty good for a long time. . . . So through some of the MRSEC things, I had been doing presentations on nano before that. [Y8, #15]*

Nonetheless, although University professionals were less likely to attribute NISE Net materials with increasing their understanding of nano, interviewed University professionals reported that the materials were useful when talking to different audiences. A different University professional in Tier 3 articulated that NISE Net is a good resource for finding different types of activities,

> *[NISE Net is] a good resource for an activity related to this or I need an activity that a teacher in an incredibly impoverished school district without a lot of resources can easily do, or I need an activity that incorporates nano plus field X. [Y8, #21]*

2.3 Tier 1-3 professionals reported that NISE Net resources such as NanoDays kits, face-to-face meetings, and the website were particularly useful for their learning, though they also reported learning about nano through methods outside of NISE Net.

In order to further understand how Tier 1-3 professionals learned about nano concepts, this study collected both survey and interview data. After seeing how highly respondents rated NISE Net as affecting their confidence in nano on the first survey in Year 8, an open-ended response question was added to the Year 9 survey as a follow-up.[6] This question asked,

> *For the nano concept(s) from the table above that you feel the most confident about, what has helped you reach this level of confidence? This could be a NISE Net resource or something outside of NISE Net.*

Tier 1-3 partners reported relying on both NISE Net and non-NISE Net related resources to learn more about nano. As shown in Figure 18, almost three-quarters (74%) of professionals mentioned a NISE Net resource as all or part of their response, whereas 50% of respondents mentioned a resource outside of NISE Net as all or part of their response. Table 7 further describes these responses and provides example quotes.

[6] Because of the large number of expected responses, and in order to limit adding another survey question to an already long survey, this question was only given to 50% of respondents, selected at random.

Figure 18. When asked what most impacted their level of confidence in nano concepts, the majority of Year 9 survey respondents from Tiers 1-3 mentioned a NISE Net resource as part or all of their response. (n=145)

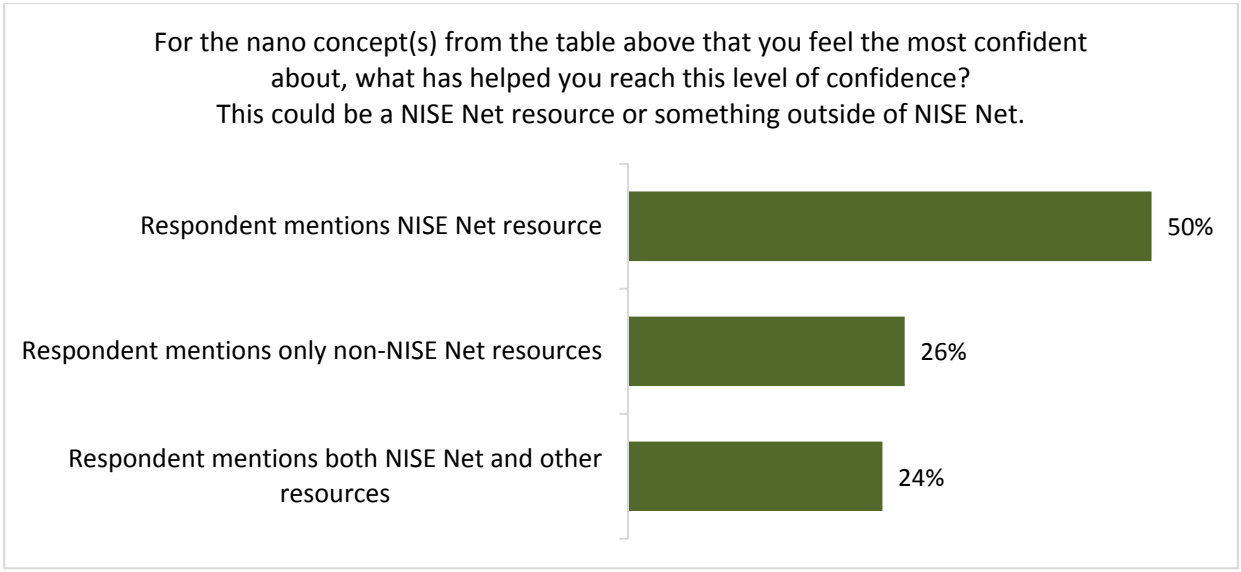


Table 7. Coded response categories for the Year 9 survey question asking Tier 1-3 professionals what has affected their confidence in nano. (n=145)

	NISE Net resource	Count	% of respondents	Example quote
NISE Net Resources Mentioned	**NanoDays kits and events**	69	48%	"Through working with the kits, I best understand the general definition (size) and natural examples."
	NISE Net websites (nisenet.org & whatisnano.org)	29	20%	"The very thorough activity outlines available on the NISE Net website and the provided background information."
	NISE Net professional development (i.e. face-to-face meetings)	28	19%	"The NISE regional meeting was an incredible resource for both learning about nano itself and how other institutions teach and communicate about nano."
	General NISE Net & its resources	17	12%	NISE Net resources have contributed in each case.
	***Nano* exhibition**	6	4%	"Our museum also received a *Nano* exhibit which has reinforced my understanding of the content."
	Training others to use NanoDays kit activities	3	2%	"Our institution delivers programs from the NanoDays kit throughout the year, so training staff, coaching staff, and delivering the program has made me confident with most of the concepts."
	Nano mini-grant	2	1%	"Through a mini-grant… we have developed a stage presentation for school groups and public visitors."
Non-NISE Net Resources Mentioned	**Existing background/personal research**	34	23%	"My professional training as a researcher."
	Outside sources	20	14%	"Outside reading on applications of nanotechnology in the future."
	Partnerships/discussions with other educators or scientists	16	11%	"Through my job I have had contact with Professors who have told me about this."
	Other	7	5%	"Knowing the metric system."
	Learning through practice	5	3%	"Practice!"

Note. Responses could be coded into multiple categories.

Data collected through interviews support these broader survey trends. The most prevalent code mentioned by professionals was that their understanding of nano was impacted by the NanoDays kits and events (48% of respondents). Many interviewees also discussed the value of the kit activities to conveying nano concepts. One ISE professional noted that, "I think the visuals that come with the kits are very helpful in illustrating the concepts" [Y8, #7]. Another professional from a University offered that, "NISE Net makes understand[ing] the nano concept easier. . . . For me, in terms of teaching, I use the models from the NISE Net [so] I can more easily explain to students how scientists work at the nanoscale" [Y10, #16].

Other NISE Net resources mentioned by respondents included the NISE Net websites (20% of respondents) and NISE Net professional development (19% of respondents). Regarding the website, one ISE professional shared, "I have been on the website a number of times and every time it's a wealth of information and really helpful and in helping me understand" [Y8, #10]. Additionally, interviewees referenced NISE Net professional development and how face-to-face meetings helped them learn about nano. For example, one ISE professional appreciated that going to conferences was more than "just educators talking pedagogy. It was also researchers talking about breakthroughs and connections, and you know, just kind of the world in general, how it's being impacted, and things about risk, and politics, and stuff" [Y10, #9]. Another ISE professional spoke about her experience watching the juggling show during a meeting she attended:

> *I think I've gained some from both of the meetings that I've gone to and this might be the appropriate place to talk about how spectacular the juggling act was . . . [my friend and I] talked about that performance and we both felt that it was one of the best science performances we have ever seen. It was not just a lot of whizz, bang stuff and an explanation. They really drove home the point. And I do feel like that particular presentation, I . . . it strengthened my understanding. [Y8, #1]*

Half of survey respondents (50%) mentioned a resource outside of NISE Net as part or all of their answer to the open-ended survey question. These resources included their existing background or own research about nano, outside resources related to nano, partnerships or discussions with other educators or scientists, and learning through practice. For example, one University researcher shared the following about his understanding of nano before being involved in NISE Net, "My research was studying electrical and nanoscale properties of materials. So, I would say I pretty much . . . I had plenty of knowledge about nano, I would say" [Y8, #17]. Another ISE professional spoke about how her partnership with a local lab helped her learn more about nano, "Some of the partners that I've worked with have helped . . . informed me about what was going on currently in nano. . . . it was helpful just to learn about the scope in which things could be considered nano" [Y8, #2].

Finally, some Tier 1-3 professionals have integrated NISE Net offerings into their experience of learning nano, and have learned from both NISE Net and non-NISE Net resources (24% of survey responses). One interviewed ISE professional detailed that she used, "some NISE Net materials, but also I was looking at various companies' websites and looking at existing products and doing research into, um, the technology that they incorporated" [Y9, #3].

Another ISE professional discussed website use, along with journal articles,

> *It's mostly the website . . . there are certainly journals that I read or magazines that I read, whether they're the popular magazines, Discover and Scientific American, and all of those. I'm more in tune when I see something nano, I'm certainly more ready to read it and understand it better. [Y10, #4]*

A Tier 2 University researcher explained how he's able to use NanoDays kits, along with his own research, to educate the public about nano:

> *I think how NISE Net has affected [us] is through, potentially, the kits or the opportunities at NanoDays. Trying to explain concepts which we either do in our research or which I am sort of, you know, familiar with from research to very broad audiences...[it's a] relatively simple means [to] describe complex situations and also*

just simply understanding how to convey this idea of nanoscale science, I guess, to an audience. [Y10, #20]

Change Over Years 8 Through 10

This study included methods for tracking NISE Net's impact on Tier 1-3 individuals over the final three years of grant funding, allowing the study to reflect the way that professionals' involvement with NISE Net builds over time. Findings in this section help illustrate how an individual's learning about nano concepts might have changed as a result of more NISE Net exposure, which relate to Network goal three. While the overall findings present data from all professionals combined or illustrate differences *between* groups, the findings exploring change over Years 8-10 provide information about changes *within* individuals in a group (e.g. examining the individuals within ISE or examining the individuals who are Tier 2 professionals).

There were two Network-wide survey questions related to learning that were a part of this phase of analysis. These questions asked Tier 1-3 professionals about their confidence in explaining nano concepts and the extent to which they attribute NISE Net with impacting that confidence. These were explored across all respondents as well as by tier and organization type. As is true throughout the entire report, all findings described below refer to the statistically significant difference detected by the statistical test with a *p*-value below .05. Non-significant findings are not described, as it was impractical to include all of this information in this report. The Technical Report provides additional clarification around these analyses.

2.4 Over Years 8-10, Tier 2 professionals and ISE professionals became more confident in nano and society concepts and increased the extent to which they attributed NISE Net with that confidence.

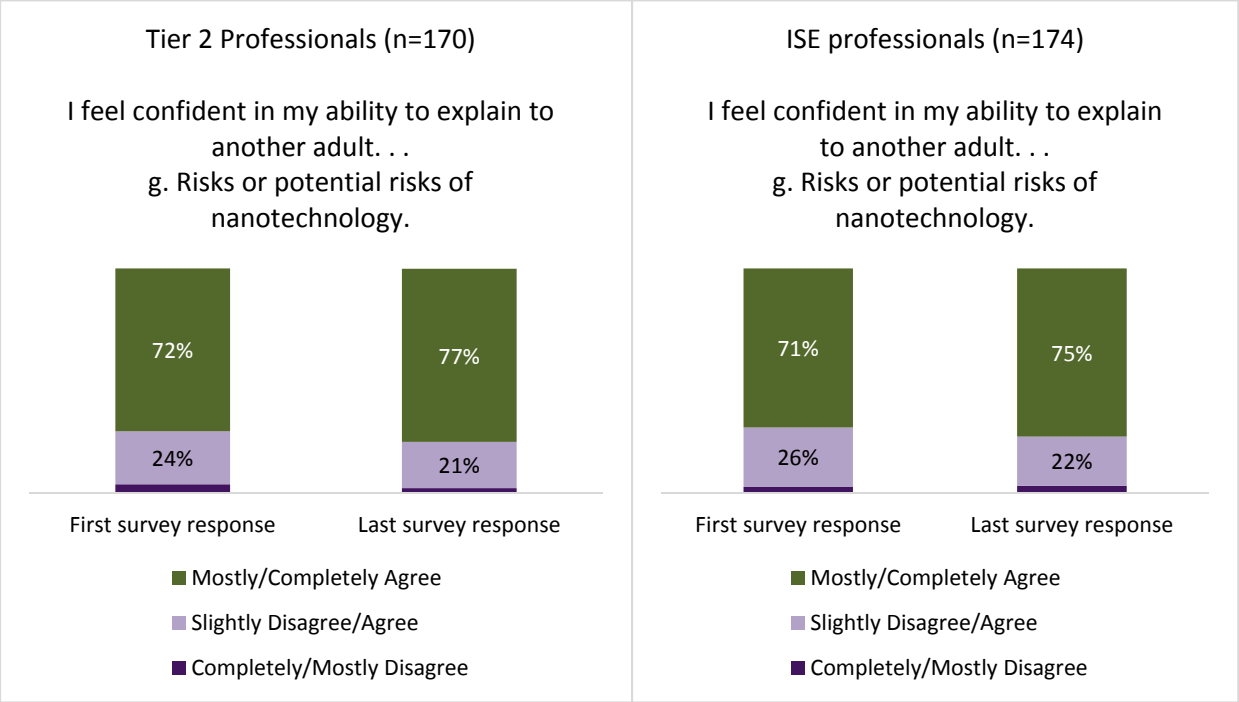
This finding focuses on nano and society concepts, or concepts g and h in the table below. Concepts g, "risks or potential risks of nanotechnology" and h, "how the future of nanotechnology may be influenced by political, economic, and personal value" were areas where there was an emphasis in Years 8-10 to support professionals' learning and public engagement efforts. These included public engagement resources and a series of workshops focusing on the content and delivery methods for engaging audiences with the societal implications of nano.

Table 8. Nano concepts used for the *NISE Net Professional Impacts Summative Evaluation* and their alignment with the NISE Network Content Map.

Content Map Key Concepts	Nano Concepts used in this study
1. Nano is small and different.	a. The size of a nanometer. b. How nano-sized materials behave compared to macro-sized materials.
2. Nano is studying and making tiny things.	c. How scientists work at the nanoscale. d. Examples of nano in nature.
3. Nano is new technologies.	e. Innovations that are possible because of nanotechnology. f. Ways that nanotechnology improves existing products.
4. Nano is part of our society and our future.	g. Risks or potential risks of nanotechnology. h. How the future of nanotechnology may be influenced by political, economic, and personal values.

Survey responses over Years 8-10 illustrated that for Tier 2 professionals and ISE professionals, NISE Net's efforts related to nano and society topics supported individuals' learning. As shown in Figure 19, over Years 8-10 individuals within Tier 2 and ISE significantly increased their agreement with their confidence in explaining the risks or potential risks of nano.

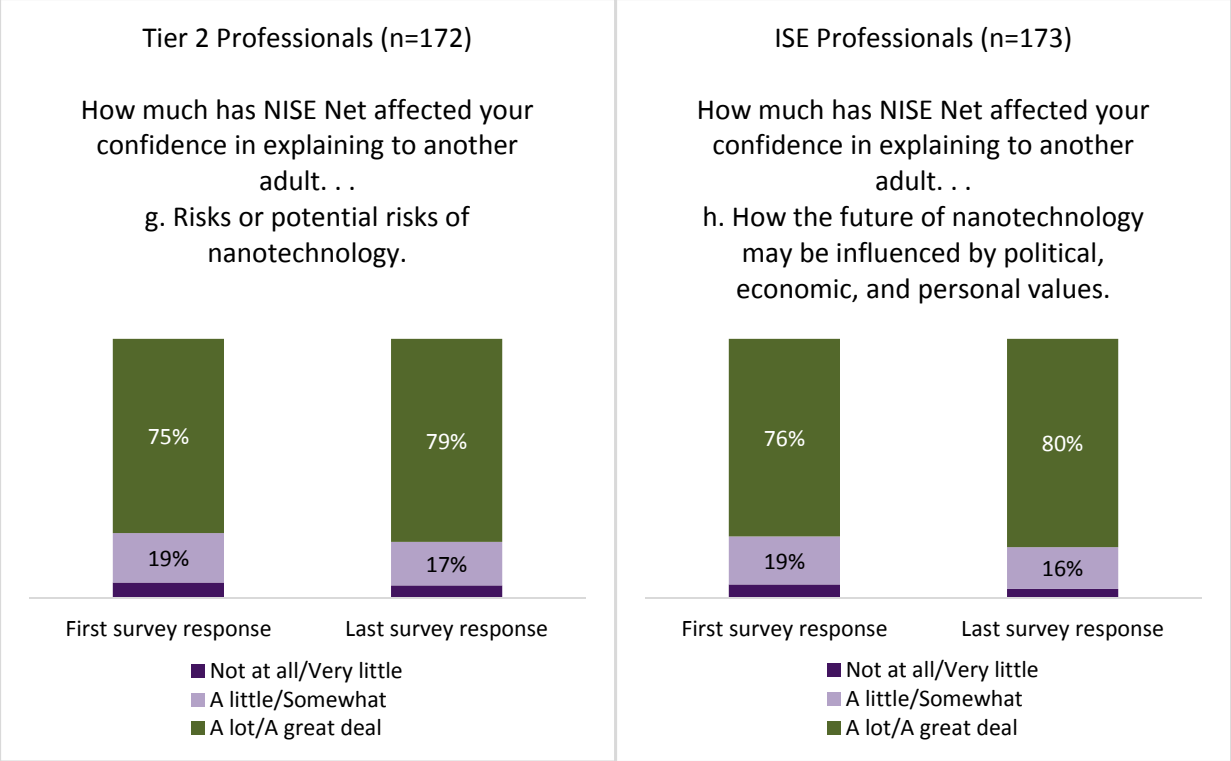
Figure 19. Over Years 8-10, Tier 2 professionals and ISE professionals reported an increase in their ability to explain a nano and society concept.*



* Wilcoxon Signed Ranks Tests. See Instrument Appendix #20 pre/post for item format and Technical Appendix for analysis notes.
Note. Tier and organization types are not mutually exclusive. Tiers 1, 2, and 3 consist of professionals from both ISE institutions and Universities.

Not only did Tier 2 professionals and ISE professionals report an increase in confidence in nano and society concepts, but they also reported an increase in the amount that NISE Net affected this confidence. Figure 20 depicts this significant increase over time.

Figure 20. Over Years 8-10, Tier 2 professionals and ISE professionals increased the extent to which they attributed their confidence in nano and society concepts to NISE Net.*



* Wilcoxon Signed Ranks Tests. See Instrument Appendix #21 pre/post for item format and Technical Appendix for analysis notes.
Note. Tier and organization types are not mutually exclusive. Tiers 1, 2, and 3 consist of professionals from both ISE institutions and Universities.

In addition to nano and society concepts, survey responses over Years 8-10 show an increase in Tier 2 and ISE individual professionals' reported confidence in explaining concept b, or "how nano-sized materials behave compared to macro-sized materials." For this concept, Tier 2 and ISE professionals reported significantly higher levels of confidence in their final survey than in their first survey (the Tier 2 mean increased from 5.30 to 5.47; the ISE mean increased from 5.28 to 5.44). Moreover, Tier 2 professionals' responses also significantly increased over time regarding how much NISE Net affected their confidence (from 5.20 to 5.40). The only other statistically significant changes over time were found for the question related to confidence in nano concepts. Specifically, Tier 2 and ISE professionals' mean confidence increased for concept c "how scientists work at the nanoscale" (the Tier 2 mean increased from 5.10 to 5.24; the ISE mean increased from 5.01 to 5.18) and ISE professionals' mean confidence increased for concept a "the size of a nanometer" from 5.48 to 5.60. Additional information about these analyses can be found in the Technical Appendix. Because professionals' reported confidence increased for concepts a and c, but a similar increase was not found for the question asking the extent to which NISE Net affected that confidence, it might imply that professionals' understanding of concepts a and c was affected by resources outside of NISE Net over Years 8-10.

Interview data provide further information to describe this Network-wide trend of increased confidence in nano and society concepts, and also shed light on the barriers that exist for

learning about and implementing this type of content with the public. Interviewees shared the majority of barriers during their first interview in Year 8. For some, these remained constant over the three year period, whereas others reported how NISE Net supported their learning and eventual use of nano and society concepts across Years 8-10.[7]

Interviewees reported difficulties around nano and society content such as feeling unsure about the audience suitability of the topic, their own level of knowledge, and whether or not it aligned with their institutional philosophy.

Several of the ISE professionals, in particular, noted that nano and society content was not always appropriate for their audience. One individual shared how his organization's focus on young children does not easily lend itself to discussions around risks and potential risks of nano, though he is able to cover these topics with slightly more advanced audiences. As he said,

> *We're the children's museum . . . So when we start getting into wider societal concepts, ethical debates and things like that, it can cause some difficulty. For children, they're still just learning the concepts. For adults, with those children, introducing some of the more controversial aspects is not something that they want to see necessarily. That's not to say we don't bring those things up. I do have a program where we talk about the genetic manipulation of the food supply, changing the DNA of plants and animals that we eat. That can be controversial and I explain that it's controversial when we talk about it to students that we know are a little bit more advanced.* [Y8, #7]

Other professionals, including some of the University professionals, talked about their limited knowledge of possible risks as a barrier for engaging the general public in these conversations. As one scientist pointed out, this information is always changing while another said, "I don't feel I can do that by myself. If I engage a colleague from social science—I mean, I would be happy to help, but I don't feel I can do that by myself" [Y8, #18]. An ISE professional commented on her discomfort saying,

> *And the risks, you know, that could change every day. If I read the paper tomorrow, I might find something new about nanotechnology. And I don't work in nanotechnology, so I wouldn't want to say what the cutting edge—what the current risks or potential risks would be.* [Y8, #5]

Other interviewees talked about how the topic of nano and society did not align with their institutional philosophy or the general content areas they cover. As one professional described, "We try not to bring up controversy because of our ties with [a certain company]. I have to be really careful about what is said, and in what form. So that's probably not something that will change" [Y8, #12]. Similarly another professional explained, how "because we're state government we try to be really balanced in how we approach things. And not appear as if we're taking a position" [Y9, #9].

Other barriers such as lack of resources, including staff and budget constraints, were also mentioned as reasons why professionals did not always implement nano and society content. One individual, in describing how staffing considerations impacted his use of these resources, recalled that,

---

[7] For a descriptive case illustrating change over Years 8-10 around engaging the public with nano and society content, see Vignette #6 in the "Using Public Engagement Practices" section.

It's one of those things where we have so many good things to use and most of the stuff is used in NanoDays at the Children's Museum, and you know we have 15-20 stations. I run out of students to staff everything, there's so many good things. . . . I tend to use the same stuff over and over again, I guess. [Y10, #15]

In Year 9, ISE professionals shared in their interviews an increased awareness about nano and society concepts and how they felt more knowledgeable about the subject. For example, one ISE professional said, "I think that the activities and kits help create a broader understanding of how it's affecting society and what research is being done in the field" [Y9, #2]. Yet even though some ISE professionals in Year 9 indicated increased awareness, they were not necessarily implementing these concepts with the public and still cited barriers.

By Year 10, more professionals indicated increased awareness, as well as use of nano and society concepts with the public. For example, two ISE professionals shared how they've been able to incorporate this more into their work:

With [our older program], we have talked about risks and nano in society . . . the middle school students are older and are starting to care about those sorts of things and because we have done more extensive content learning with them, we feel like they have the background knowledge and the maturity to think about those issues. [Y10, #3]

I'm trying to get my staff to be more in tune with bringing the science and society aspect into the nano program . . . I feel like I've been leading that charge and trying to set the role, be the role model, for the rest of the staff that these are important things to be talking about as well, besides just content. [Y10, #4]

Interview Vignettes

Vignette #3: Learning about nano communication from the perspective of a scientist

Like other University professionals, Rohan felt that he already had a strong grounding of nano concepts before joining NISE Net, but that through the Network he learned how to better communicate his work. Rohan's experience highlights one area where many University-affiliated professionals in particular felt they gained knowledge by participating in the Network.

> *"I learned a lot about how to communicate the idea of a nanometer to these students and not only just about the idea of a nanometer, but also how nano affects what we do in real life."*
>
> - Tier 3 University professional, Year 8 interview

In his initial interview, Rohan explained that as a professor and researcher of nanoscale properties, he "had plenty of knowledge about nano" [Y8, #17]. Although there were still areas of nano research he wanted to explore, such as nanomedicine, he felt that through NISE Net his learning had evolved in terms of engaging public audiences with nano. Before joining NISE Net, his organization had not done nano outreach with the general public. The kit materials provided a means for presenting these topics to others and helped him improve his presentation skills. When summarizing what he had learned in regard to communication, Rohan said that, "On [sharing information at] the level that is knowledgeable to the general public audience or maybe K-12 students, my capabilities are much more improved because I was involved in the NISE Network, because I know how to explain" [Y8, #17].

During the second interview, while Rohan described recently reading journals that taught him more about how scientists work on the nanoscale, he also mentioned learning from his nano outreach. By interacting with the public, Rohan gained a better understanding of what others might know about nano. As he described, "I learned that people are becoming more and more aware of nanotechnology and nanoscale experiments. That is a good thing to know. So that just changed my perspective on what people know about nanotechnology" [Y9, #17].

By the third interview, Rohan had continued to learn about nano through his own research, but again emphasized how NISE Net impacted his science communication because,

> *[The] NISE Network not only gives you the materials but also talks about how to present the materials for different sets of people. . . . [When] talking about the size of a nanometer, it talks about it [in terms of] how tall you are and what is the size of your pinky finger . . . I mean these are things that I would never have thought about because as professor, you know, nano is something like my second nature . . . But [the] NISE Network did provide me [with] a perspective for how to present this material to people who know absolutely nothing about nanotechnology. [Y10, #17]*

Besides learning new techniques, NISE Net also provided Rohan with real world examples that could help him convey his work to the public and his students.

> *I never really paid much attention to what the sunscreen's made of and so on, but now after the NISE Network, I know that there are some nano materials in the sunscreen, it essentially makes the sunscreen more effective. So now when I talk to my students, not only my students but also somebody else, you know, an outsider who does not know about nanotechnology, I tend to give these grain of examples. [Y10, #17]*

Vignette #4: Learning about nano concepts from the perspective of an ISE educator

Being part of NISE Net allowed Mark to gain new knowledge about nano content and specific real-world examples. Like many ISE partners, he attributed this increase in learning to using NISE Net products and resources.

> *[NISE Net] greatly expanded my personal knowledge and it's actually made me more aware of nano in the news and it's like, this is daily life.*
>
> - Tier 3 ISE professional, Year 10 interview

In the first interview, Mark, who was in charge of programming at his small science center, described being somewhat familiar with what the concept of nano meant in terms of scale. However, before NISE Net he was less aware of how the topic related to everyday life. As he said,

> *I didn't really know any specifics. I knew vaguely about how big a nanometer was . . . and I knew vaguely some of the technology applications of nanotechnology, like the practical applications of it, but I didn't have any real specific knowledge. [Y8, #8]*

In recalling why he wanted to get involved in the Network, Mark noted how he was driven to gain a deeper understanding of the topic and new ideas for including nano into his work. During the first interview, he felt his knowledge of nano was "much, much stronger" due to resources like the website and NanoDays videos. Mark said "now I have talking points that I can really describe what nanotechnology is and . . . why it's important. To the environment and to humans" [Y8, #8].

However, Mark pointed out that his learning was not uniform across all the nano concepts encouraged by the Network. When filling out the first yearly survey, he rated the nano and society concept, "how the future of nanotechnology may be influenced by political, economic, and personal values," lower because

> *I don't see how it's easy to convey information in that line because it seems like there's so much there. I mean, how can nanotechnology be influenced by the politics? Yeah, who knows? There's all sorts of stuff there. But umm, yeah, I don't know . . . it seems to be such a broad topic that I wouldn't know where to begin with it. [Y8, #8]*

By the second interview, Mark had learned more practical examples from the kits and felt he knew more details about a range of the nano concepts identified by the Network. While it was still "hard to really engage people" in concepts related to future influences of nanotechnology, he personally felt more conscious of nano and excited to talk to people about the topic. Mark explained how his increased knowledge was useful even in social interactions saying,

> *I'm just more aware of it and I talk to more people about it. You know, I [was] just at a cocktail party, [and I found] myself talking to people about the benefits and potential dangers of nanotechnology in the things we use. [Y9, #8]*

In the final interview, Mark felt that he had learned more about nano risks and innovations and that, overall, the most important thing he gained from participation in the Network was his "awareness of issues surrounding nanotechnology." He felt that the structure of NISE Net's content map with the four areas related to "size, the things we can create with it, the impacts, the dangers, and then how it might influence things in the future [was how he] always think[s] about nano . . . [and that's] given [him] a framework to understand these things" [Y10, #8].

3. Using Public Engagement Products

The NISE Network developed hundreds of open-source educational resources including exhibits, programs, and media which are all available for download on nisenet.org. In addition to the website, since 2008 a total of 1,650 NanoDays kits were disseminated to 468 unique NISE Net organizational partners.[8] Each kit provided all of the public engagement and professional development materials needed to host a NanoDays event. Understanding the extent to which these products are used is important because it relates to the overall theory driving the NISE Net. According to the NISE Net logic model, the NISE Net reached the public through its community of professionals. If professionals are not aware of NISE Net products, or view them negatively, use of NISE Net products would be limited, which would, in turn, limit the public impact of NISE Net. This study sought to understand how and to what extent professionals used the public engagement products developed by the NISE Net.

The following categories of public engagement product types was decided upon, in collaboration with Network leadership, and used for this study:[9]

- Cart demonstrations and hands-on activities
- Stage presentations
- Museum theater
- Classroom activities
- Forums
- Science cafes
- Media (videos, multimedia, images)
- Media (print, posters)

The "Using Public Engagement Products" section will focus on Tier 1-3 professionals who reported engaging the public in nano and provide findings about their use of NISE Net public engagement products. Table 9 provides the relevant goal and lists the findings that will be described in this section.

[8] The number of kits distributed is higher than the number of organizations because organizations could receive kits more than one year.

[9] Another type of product that is not the focus of this study is the 400-square foot modular *Nano* exhibition. The use of this exhibition is broad, as 93 copies were disseminated by the Network and hosted by over 100 organizations. For more information about the public impact, see the summative evaluation (Svarovsky et al., 2013) which also provides insight into professionals' viewpoints on how *Nano* catalyzed additional public programming.

Table 9. NISE Net professional goal and findings related to Using Public Engagement Products

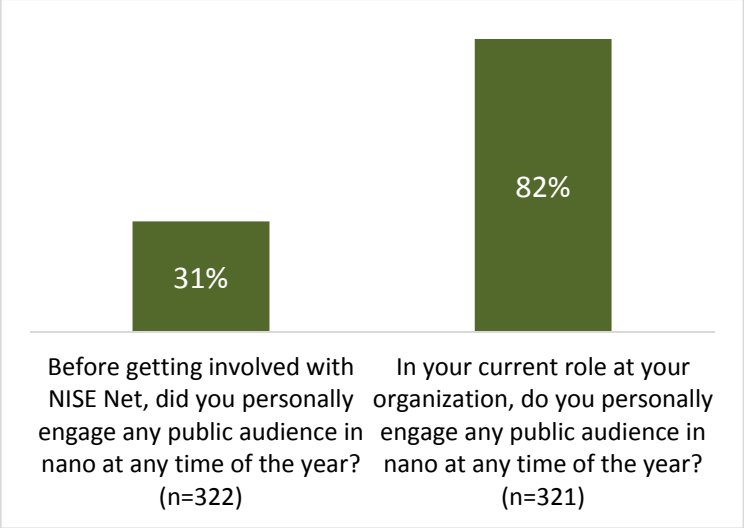
NISE Network Goals for Professionals	Using Public Engagement Products Findings
Goal 5 Utilize professional resources and educational products for engaging diverse public audiences in nano	3.1 On a retrospective pre/post question, Tier 1-3 professionals reported they were significantly more likely to engage the public in nano as of Year 10 than they were prior to Network involvement. 3.2 As of Year 10, the majority of Tier 1-3 professionals engaged the public in nano throughout the year and used NISE Net cart demonstrations and hands-on activities, media, and classroom activities more than other types of products. 3.3 As of Year 10, although Tier 1-3 professionals were not using some product types as often (including museum theater and forums), Tier 1 and 2 professionals were still more aware of these products than their Tier 3 counterparts. 3.4 Since joining NISE Net, in order to integrate nano into their existing educational offerings, the majority of Tier 1-3 professionals reported adapting a NISE Net product, and many reported developing a new nano educational product. 3.5 Over Years 8-10, the types of public engagement products used by all individual professionals was fairly consistent, but the content being covered shifted for Tier 2 and ISE professionals.

Overall Findings

3.1 On a retrospective pre/post question, Tier 1-3 professionals reported they were significantly more likely to engage the public in nano as of Year 10 than they were prior to Network involvement.

In Year 10, all Tier 1-3 professionals were asked two survey questions: one about whether they personally engaged the public in nano before their NISE Net involvement and one about whether they do this as a part of their current role.

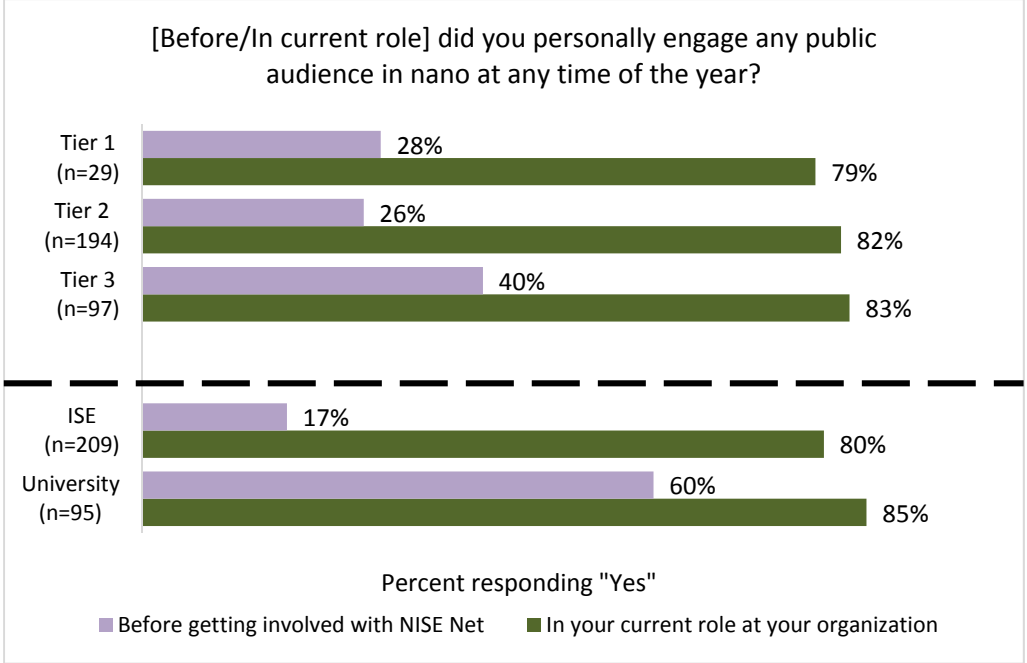
Figure 21. Before getting involved with NISE Net, 31% of Year 10 Tier 1-3 respondents were personally engaging the public in nano, whereas 82% of respondents are doing so in their current role.



Note. See Instrument Appendix #22/ #23 for item format and Technical Appendix for analysis notes.

Significantly more professionals reported that they engage the public in nano now than before they were involved with NISE Net. As shown in Figure 22, this holds true for all tiers and organization types.

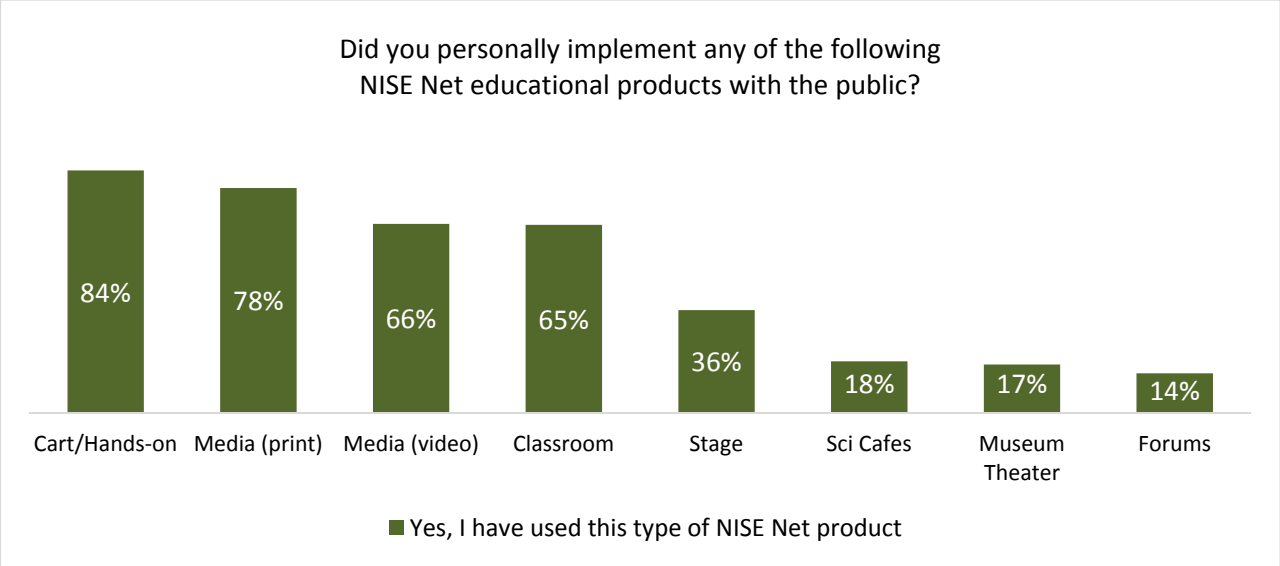
Figure 22. There was an increase in the percentage of professionals who reported they personally engaged any public audience in nano from before getting involved with NISE Net to their current role in Year 10. This is true for all tiers and organization types.*



* McNemar's Test. See Instrument Appendix #22/ #23 for item format and Technical Appendix for analysis notes.
Note. Tier and organization types are not mutually exclusive. Tiers 1, 2, and 3 consist of professionals from both ISE institutions and Universities.

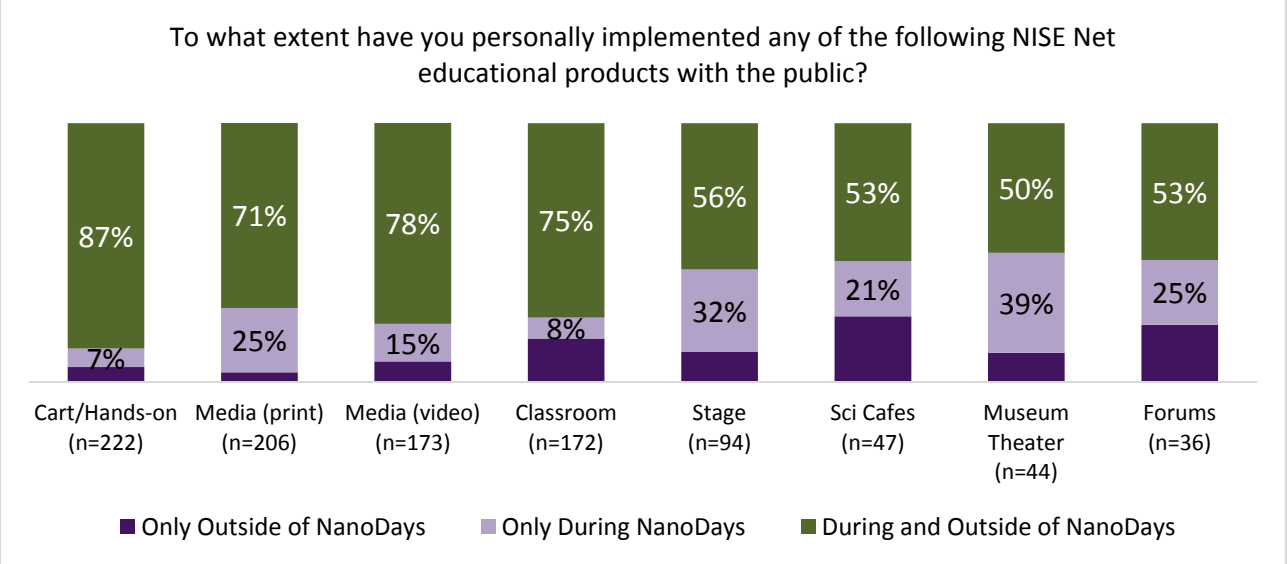
3.2 As of Year 10, the majority of Tier 1-3 professionals engaged the public in nano throughout the year and used NISE Net cart demonstrations and hands-on activities, media, and classroom activities more than other types of products.
On the survey, Tier 1-3 professionals were asked to report whether they have used the eight types of NISE Net products included in this study. If they replied "Yes, I have used this type of NISE Net product," professionals were then asked when they implemented a product type. This allowed evaluators to learn whether Tier 1-3 professionals' use of NISE Net products was isolated around NanoDays or occurred throughout the year. Figures 23 and 24 illustrate which product types are being used by Year 10 survey respondents and whether they are used during NanoDays, outside NanoDays, or throughout the year.

Figure 23. More than 50% of Year 10 respondents are using cart demonstrations/hands-on activities, print media, video media, or classroom activities. (n=264)



Note. See Instrument Appendix #31 for item format and Technical Appendix for analysis notes.

Figure 24. Of the Year 10 respondents who reported using these public engagement products, 50% or more report implementing them during and outside of NanoDays.

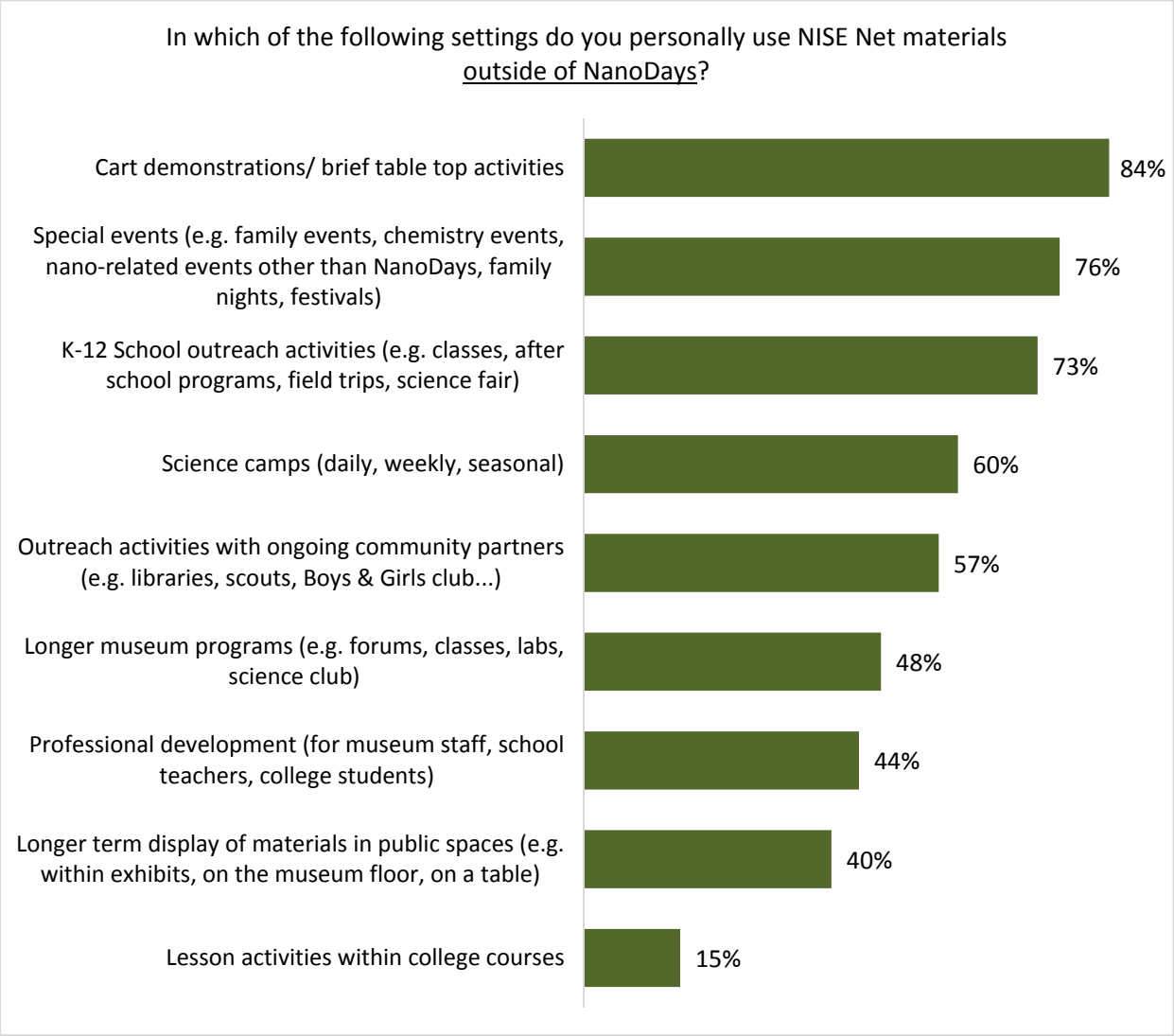


Note. See Instrument Appendix #31 for item format and Technical Appendix for analysis notes.

While the majority of Tier 1-3 professionals are using cart demonstrations/hands-on activities, the two categories of media, and classroom activities, it is interesting to see *when* the remaining product types are being used. For example, while only 18% of all Tier 1-3 respondents report using science cafes (see Figure 23), the proportion of those 47 professionals using science cafes only outside of NanoDays (21%) is greater than the proportion of any other product type (see Figure 24). In order to further understand how NISE Net products are used outside of

NanoDays, professionals were asked an additional survey question. According to the Year 10 survey, and shown in Figure 25, Tier 1-3 professionals used NISE Net materials in a range of ways outside of NanoDays. The most frequent ways were brief table-top activities, K-12 school outreach, and special events. This highlights the varying nature of the product types and how formats for public engagement products supported a range of settings and goals.

Figure 25. Of the Tier 1-3 professionals using products throughout the year, the most frequent settings are brief table top activities, special events, and K-12 outreach. (n=227)



Note. See Instrument Appendix #32 for item format and Technical Appendix for analysis notes.

Interviews provided insight into reasons why Tier 1-3 professionals chose to use or avoid certain NISE Net products. Professionals stressed, in particular, that they often included NISE Net materials in their work when the products connected with other content they were covering. As one ISE professional explained when talking about why she chose to present some of the NISE Net media offerings,

Video is something that is very helpful for me to use with our public because we have a lot of areas where we can play videos. I was looking for anything new that might relate to the topics I was creating for the school demo, any new training materials and just anything that related to our topic . . . [of] consumer products. [Y10, #2]

Age and audience appropriateness also factored heavily into whether or not Tier 1-3 professionals selected NISE Net products either during or outside of NanoDays. Sometimes the age level for the activities was deemed to be a good fit, but at other times professionals mentioned that their audiences might be too young for the content or the format. The following quote shows how one ISE professional took into account her organization's young audience when deciding on the types of NISE Net activities to employ.

[T]here was one about—chromatography of butterfly wings. That was kind of a new thing. We also have other butterfly artifacts that we can bring in, so we could supplement that a little bit and it made more sense. It's just really hard because our family group here is skewed to the young side. So we tend to use things that are either sensory or tactile, there's an activity that uses balloons, you know, they have a scent inside them and you can see it coming out of the pores of the latex, and that's a big hit. That makes sense, so the more that kids can connect to, those are the kits that we tend to put out. [Y9, #5]

Similarly, delivery format, ease of use, and quality of materials all played a role into whether or not professionals used certain NISE Net materials for specific activities. Other factors such as space availability, staff capacity, visitor enjoyment/learning considerations, or staff preferences also, at times, affected whether or not specific NISE Net products were used for programming. One University researcher commented that the quality and contents of the NISE Net resources made them easy to use in various settings:

I think that's one of the things that's really great about NISE Net is that they have different iterations with different lengths of times, different set ups, for different aged people. So, you know, initially I was really looking for ideas and then I think it evolved into really just ease of use. I mean, the NanoDays kit in particular, we were just so impressed that it had everything, including the little plastic standup stand and the tablecloth! [Y8, #21]

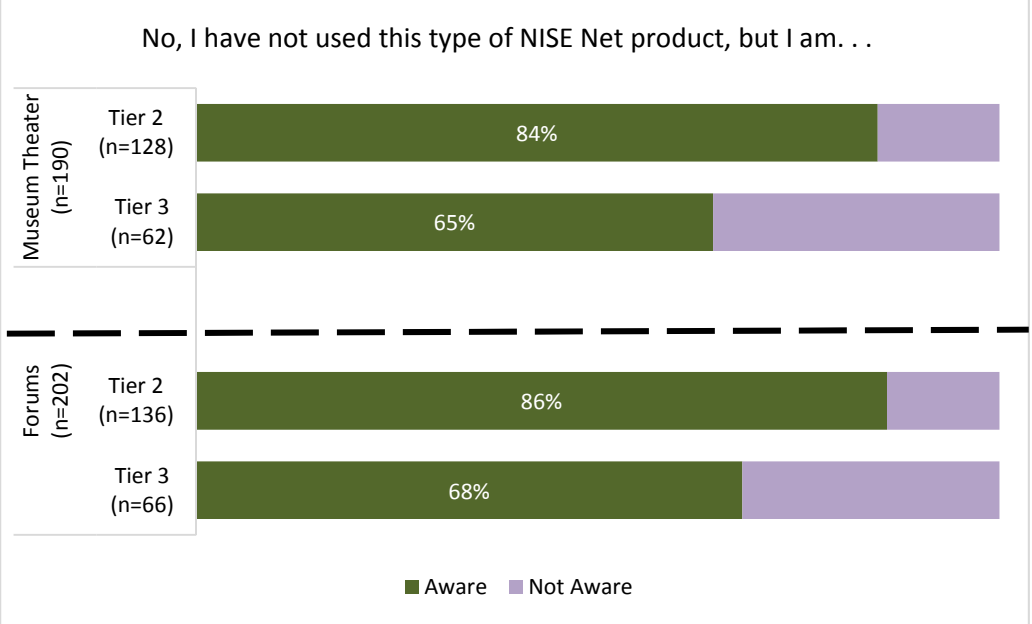
As of Year 10, while some product types were used more than others, data collected through the survey and interviews illustrate how NISE Net products were used throughout the year in a variety of settings for a range of reasons. High usage from the survey data suggests that Tier 1-3 professionals found at least one type of NISE Net product that worked for their setting.

3.3 As of Year 10, although Tier 1-3 professionals were not using some product types as often (including museum theater and forums), Tier 1 and 2 professionals were still more aware of these products than their Tier 3 counterparts.

In addition to asking about product use, Tier 1-3 professionals were asked about their awareness of products if they replied "No, I have not used this type of NISE Net product." Among Tier 1 professionals, all respondents were aware of products even if they are not using them personally. However, there were Tier 2 and 3 professionals who did not know NISE Net offered some product types. As shown in Figure 26, Tier 2 professionals were more aware of all of these less-used product types than Tier 3 professionals. There were no statistical differences between ISE and University professionals' awareness.

This difference in awareness by tier suggests that the ways Tier 2 professionals engaged with NISE Net provided them more or different opportunities to become aware of NISE Net products. For example, Tier 2 professionals were more often invited to NISE Net face-to-face meetings than Tier 3 professionals, where products are often showcased, shared, and discussed among attendees. These meetings or other aspects of NISE Net involvement, such as using the website or connecting with the regional hub leader, could have contributed to higher awareness even if the individual was not interested in using that type of public engagement product.

Figure 26. Of the respondents who are not using these product types, Tier 2 professionals are more aware than Tier 3 professionals of museum theater and forums.*

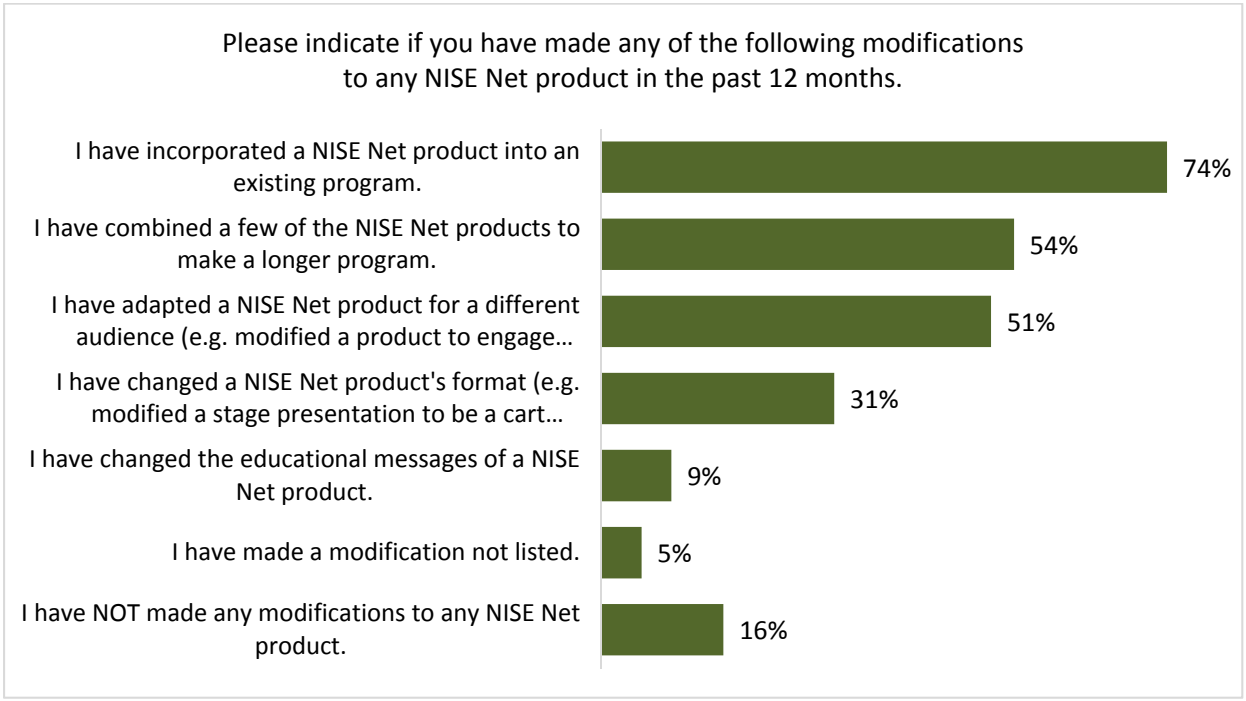


* Chi-square Tests. See Instrument Appendix #31 for item format and Technical Appendix for analysis notes.

3.4 Since joining NISE Net, in order to integrate nano into their existing educational offerings, the majority of Tier 1-3 professionals reported adapting a NISE Net product and many reported developing a new nano educational product.

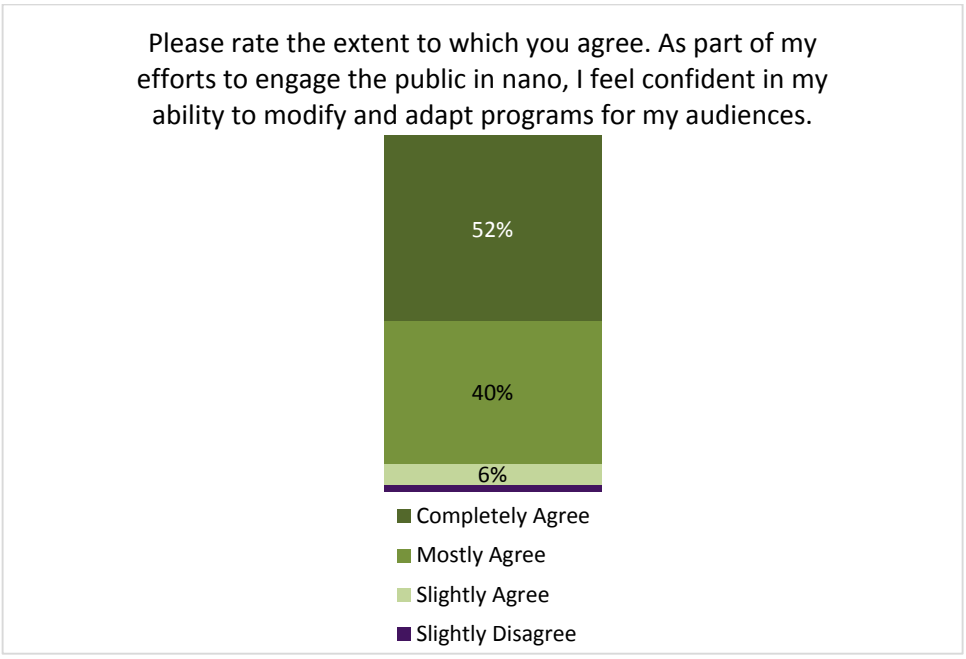
In keeping with the NISE Net commitment to open-source products, all professionals were encouraged to modify and adapt public engagement products to suit their needs. As shown in Figure 27, the majority of Tier 1-3 professionals have done so, as only 16% of Year 10 respondents reported not making any modifications to any NISE Net product. The most frequent modification made (74% of respondents) was incorporating a NISE Net product into an existing program. Furthermore, as highlighted by Figure 28, these Tier 1-3 professionals feel confident in their ability to modify and adapt programs for their audiences. This is similar across tiers and organization types, with no group reporting a statistically significant higher level of confidence in adapting programs. In fact, when asked to respond about their confidence in modifying, only 2% said that they disagreed with the statement (any of the lower three response options of a six-point scale.) As shown in Figure 29, almost one-third of Year 10 Tier 1-3 respondents had developed a new nano educational product with many of these (28%) occurring since professionals joined NISE Net.

Figure 27. The majority of Year 10 survey Tier 1-3 respondents who engage the public in nano have made modifications to NISE Net products. (n=259)



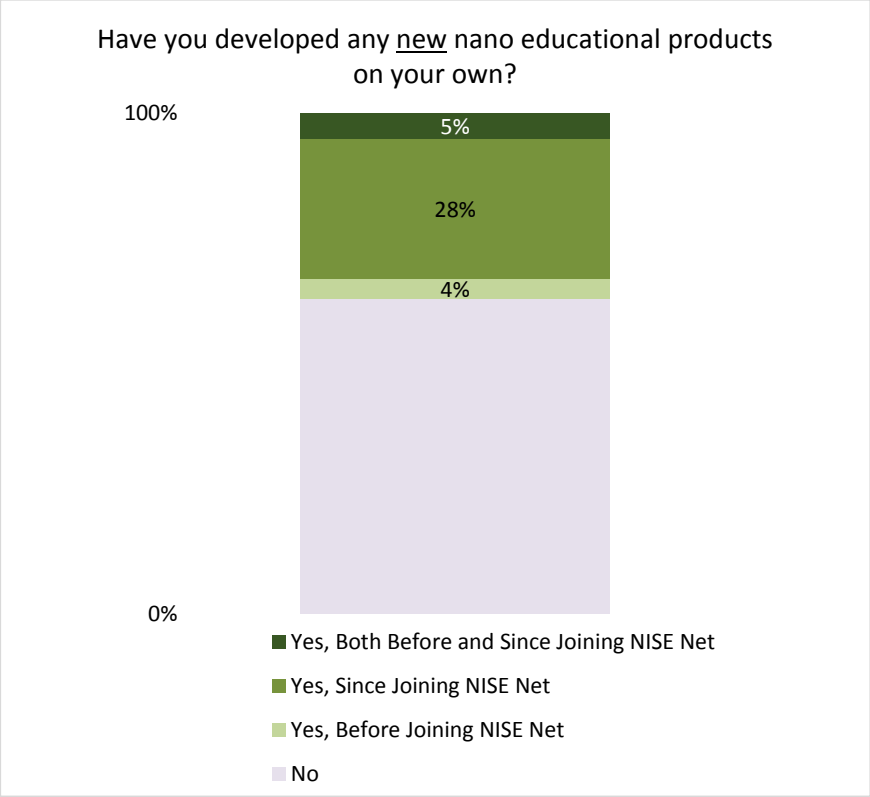
Note. See Instrument Appendix #34 for item format and Technical Appendix for analysis notes.

Figure 28. The majority of Year 10 Tier 1-3 respondents agreed that they are confident in modifying programs. (n=259)



Note: Less than 1% of respondents chose "Mostly Disagree" and no one chose "Completely Disagree."
See Instrument Appendix #35 for item format and Technical Appendix for analysis notes.

Figure 29. Over one-third of Year 10 Tier 1-3 respondents have developed a new nano educational product, many of whom started after joining NISE Net. (n=261)



Note. See Instrument Appendix #36/ #37 for item format and Technical Appendix for analysis notes.

Change Over Years 8 Through 10

This study included methods for tracking NISE Net's impact on individuals over the final three years of grant funding, allowing the study to reflect the way that professionals' involvement with NISE Net builds over time. Findings in this section help to understand how an individual's use of NISE Net public engagement products might have changed as a result of more NISE Net exposure, which relates to Network goal five. While the overall findings present data from all professionals combined or illustrate differences *between* groups, the findings exploring change over Years 8-10 provide findings *within* individuals in a group (e.g. examining the individuals within ISE or examining the individuals who are Tier 2 professionals).

Two Network-wide survey questions related to product use were a part of this phase of analysis. These questions asked professionals about which types of products they used and, within their nano education efforts, what proportion of time they spent on each of the nano concepts. These were explored across all respondents as well as by tier and organization type. As is true throughout the entire report, all findings described below refer to the statistically significant difference detected by the statistical test with a *p*-value below .05. Non-significant findings are not described, as it was impractical to include all of this information in this report. The Technical Report provides additional clarification around these analyses.

3.5 Over Years 8-10, the types of public engagement products used by all individual professionals was fairly consistent, but the content being covered shifted for Tier 2 and ISE professionals.

In terms of product usage, the longitudinal survey analyses exploring change over Years 8-10 found few statistically significant differences. This means that during these final three years of NISE Net grant funding, the extent to which various product types were used was similar. As mentioned above, the most used product type was cart demonstrations/hands-on activities (see Figure 25 above).

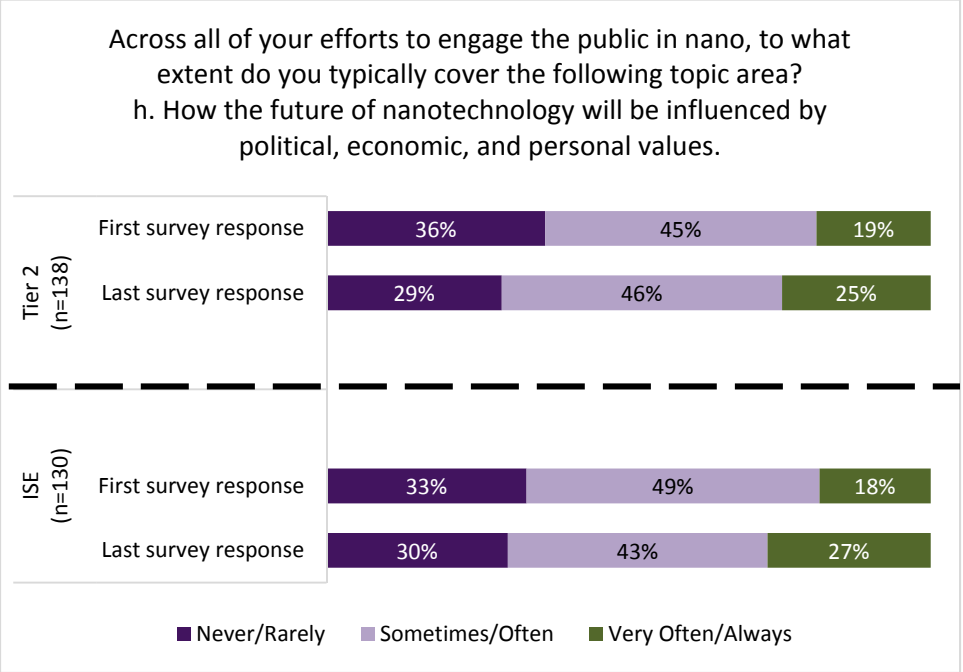
However, over Years 8-10, Tier 2 and ISE professionals increased the proportion of time they typically covered a nano and society concept as a part of their overall nano education with the public. Professionals who engage the public were asked the following question and provided with six response options:

Across all of your efforts to engage the public in nano, to what extent do you typically cover the following topic area?

Never (I don't cover this content)	Rarely (less than 25% of the time)	Sometimes (between 25-50% of the time)	Often (between 51-75% of the time)	Very often (more than 75% of the time)	Always (all of my efforts cover this content)

Professionals responded about the proportion of time they cover each of the eight nano concepts included in this study. As of Year 10, at least 25% of professionals covered each of the content areas "often" or "very often" as part of their efforts to engage the public in nano. When analyzing differences within tier and organization type group, it was found that both Tier 2 professionals and ISE professionals reported they were more frequently covering one of the eight content areas as a part of their overall nano education in their final survey response than they were at the beginning of the study (see Figure 30). This content area or "how the future of nanotechnology will be influenced by political, economic, and personal values" relates to the fourth area of the NISE Net Content Map and was an area where the Network had added additional resources in later years. A descriptive example of this increase in engaging audiences with nano and society content appears in Vignette #6 in the "Using Public Engagement Practices" section. Further information about these data and responses for the other content areas can be found in the Technical Appendix.

Figure 30. Over Years 8-10, both Tier 2 and ISE professionals increased time spent covering a nano and society concept.*



* Wilcoxon Signed Ranks Test. See Instrument Appendix #33h for item format and Technical Appendix for analysis notes.
Note. Tier and organization types are not mutually exclusive. Tiers 1, 2, and 3 consist of professionals from both ISE institutions and Universities.

Interview Vignettes

Vignette #5: Using NISE Net products

Abby's usage of NISE Net products over multiple years provides an example of how professionals found a variety of ways to integrate these resources into their work. Even with changing job responsibilities, Abby continued to draw on kit materials to incorporate ideas and concepts from the Network into a wide range of visitor experiences at her science center.

> *I would say, every week, every person in this department uses a direct activity from the NISE Net, either in the lab, or on the floor, or sometimes even in the science theater . . . I think [the usage of materials is] frequent because we have all of the resources from the NISE Net that really allows us to be able to make these connections across scientific disciplines.*
>
> *-Tier 2 ISE professional, Year 9 interview*

In the first year of interviews in Year 8, Abby was an educator in charge of programming and involved in teaching classes at her science center. In this role, she was actively using nano activities on the museum floor and in relation to outreach. She explained that

> *Every weekend we open our lab spaces and we bring the public in of all ages to do hands-on experiments and activities and demonstrations, and I use a lot of the nano activities because they're really well organized and there's a lot of background information that help me to explain some of those broader concepts. [Y8, #6]*

In particular, she listed the Lego activity, the stain resistant nano pants kit, and the giant balloon nanotube as popular with visitors. She also recalled referencing materials from NISE Net that were meant to help University professionals gain skills for speaking to the public. These were of interest because she ran her museum's Pub Science program.

By the second year of interviews, Abby had instituted a more "mandatory" training related to NanoDays where staff in the education department were expected to prepare by doing every activity, reading all of the materials and figuring out how they could use the kits. Abby was also active in creating and designing a new program, funded through a mini-grant from the Network, that would integrate nano into their traveling outreach designed to reach rural communities. For this work, she "focused on getting that nanotechnology into those classrooms in a way that was very hands-on . . . and presenting it in a way that was actually meaningful for them" [Y9, #6].

Besides expanding upon the ways she used NISE Net materials, by Year 9, Abby had moved into a leadership position within her department. This transition meant that "having a different title this year, with a little more leadership to it, I feel like I'm in a position where I can definitely push for a lot of these concepts to really be integrated and carried out well" [Y9, #6].

Further job changes by the third year of interviews meant that Abby oversaw the education department along with exhibits and grant projects. In her new role, Abby was excited to push for nano-related activities that would complement the awaited NISE Net *Nano* exhibition. Overall, she felt that the resources from NISE Net would continue to be used because "[t]he topic itself is not going away. The technology is changing the way we live our lives . . . and the resources that have already been provided are just going to help facilitate what we're already doing" [Y10, #6].

4. Using Public Engagement Practices

The NISE Network supported professionals' public engagement efforts not only by providing open-source exhibits and programs, but also by offering professional development about methods and practices for engaging diverse public audiences. While the NISE Net's tools and guides focused on the content area of nano, many of these practices could be applied to a broader range of topics. For the purposes of the *NISE Net Professional Impacts Summative Evaluation*, the following public engagement practices were identified in collaboration with NISE Net Leadership, and used for all data collection methods.

- Engaging young children
- Engaging adult audiences
- Engaging Spanish-speaking audiences
- Applying principles of universal design
- Engaging audiences with nano and society content
- Using team-based inquiry to incorporate evaluation into my work; and
- Communicating to a public audience findings from the field of nano research.[10]

Some of these practices were emphasized throughout the 10 years of the project such as engaging young children, engaging adults, applying principles of universal design, and communicating nano research findings to a public audience. Others, such as engaging Spanish-speaking audiences, engaging audiences with nano and society, and using team-based inquiry, were introduced to the broader Network in the last several years of the project.

The "Using Public Engagement Practices" section will focus on professionals who reported engaging the public in nano and provide findings about their confidence in and use of NISE Net public engagement practices. Table 10 provides the relevant goals and lists the findings that will be described in this section.

[10] There is one additional practice that has been incorporated into other areas of this report. See the "Community and Collaboration" findings for information about "initiating a partnership with an informal learning or research organization."

Table 10. NISE Net professional goals and findings related to Using Public Engagement Practices.

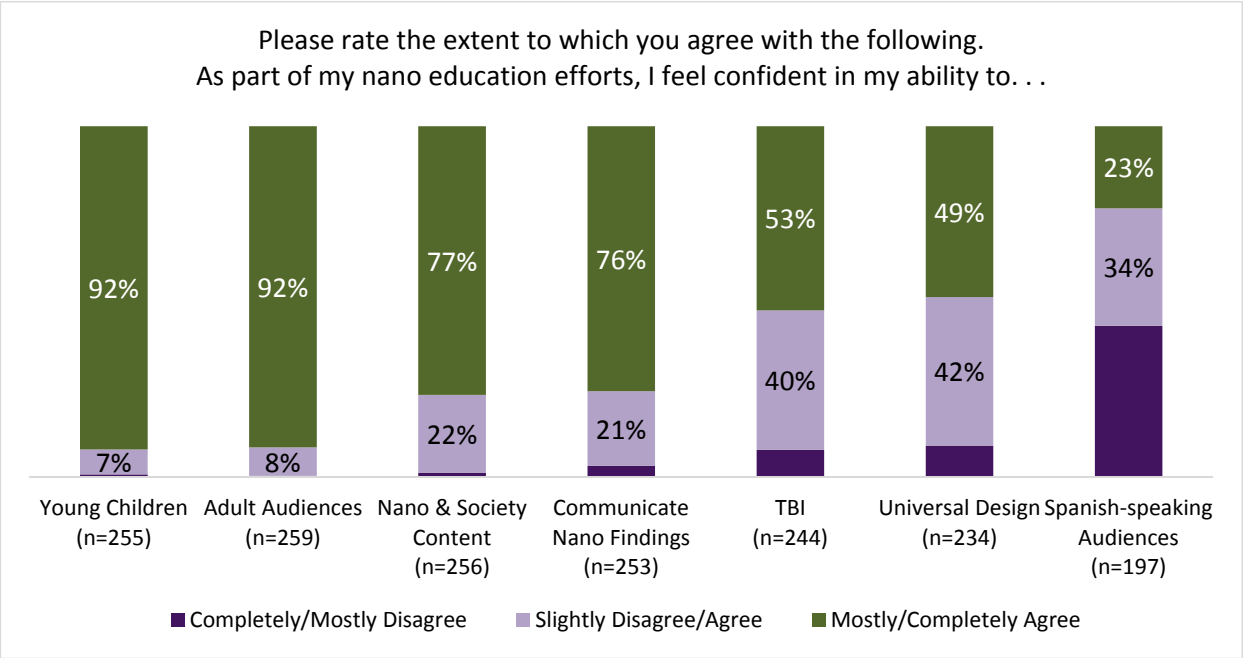
NISE Network Goals for Professionals	Using Public Engagement Practices Findings
Goal 4 Understand theories, methods, and practices for effectively engaging diverse public audiences in nano **Goal 5** Utilize professional resources and educational products for engaging diverse public audiences in nano	4.1 As of Year 10, Tier 1-3 professionals were confident in their ability to engage the public, especially the practices of engaging young children, engaging adults, engaging audiences with nano and society content, and communicating nano research findings to the public. 4.2 As of Year 10, Tier 1-3 professionals were using NISE Net resources to implement many public engagement practices, especially engaging young children, engaging adults, conveying nano and society content, and communicating nano research findings to the public. 4.3 As of Year 10, although some practices were not being used as broadly by Tier 1-3 professionals (including using team-based inquiry, applying universal design, and engaging Spanish-speaking audiences), Tier 2 professionals were still more aware of the NISE Net resources related to these practices than their Tier 3 counterparts. 4.4 Over Years 8-10, Tier 2 professionals and ISE professionals became more confident in engaging adult audiences and engaging Spanish-speaking audiences. 4.5 Over Years 8-10, Tier 2 professionals and ISE professionals increased their audience engagement around nano and society content.

Overall Findings

4.1 As of Year 10, Tier 1-3 professionals were confident in their ability to engage the public, especially the practices of engaging young children, engaging adults, engaging audiences with nano and society content, and communicating nano research findings to the public.

On the Year 10 survey, Tier 1-3 professionals were asked about their confidence in implementing public engagement practices supported by NISE Net. As shown in Figure 31, Tier 1-3 professionals reported higher confidence implementing some practices more than others. However, the majority of professionals responded in the top four of six response categories for all of the practices. The practice of engaging Spanish-speaking audiences had the least number of individuals responding that they mostly or completely agreed they were confident (23%).

Figure 31. Tier 1-3 professionals reported high levels of confidence in all of the public engagement practices, especially engaging young children, engaging adult audiences, engaging audiences with nano and society content, and communicating to a public audience findings from the field of nano research.[11]



Note. See Instrument Appendix #25a-g for item format and Technical Appendix for analysis notes.

When comparing survey respondents by tier and by organization type, two statistically significant differences were found. ISE respondents were more likely than University respondents to agree that they were confident in applying principles of universal design, whereas University respondents were more likely to agree that they were confident in communicating to a public audience findings from the field of nano research. All tiers are similarly confident in their ability to implement these public engagement practices.

[11] Respondents were able to select a "Not Applicable to my job" option; all N/A responses were removed from analysis (by public engagement practice).

Figure 32. University respondents were more likely than ISE respondents to completely or mostly disagree that they were confident in their ability to apply principles of Universal Design.* (n=226)

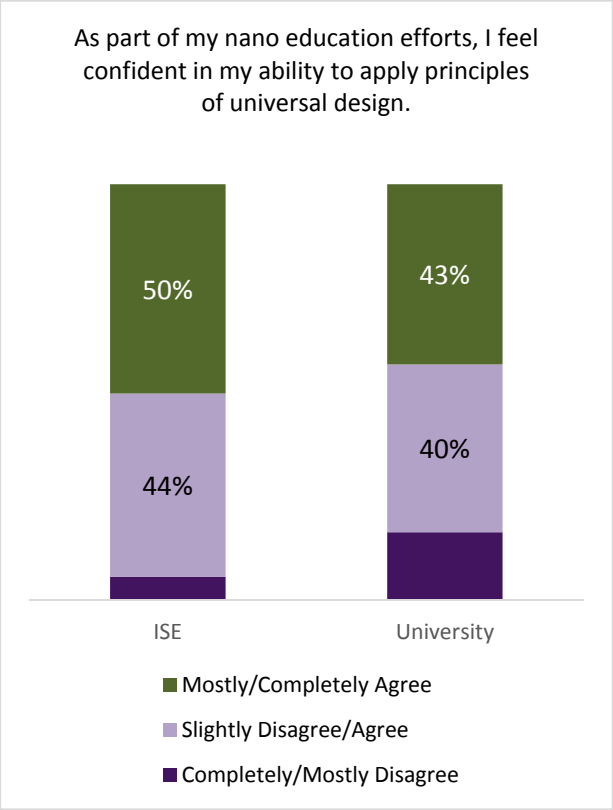
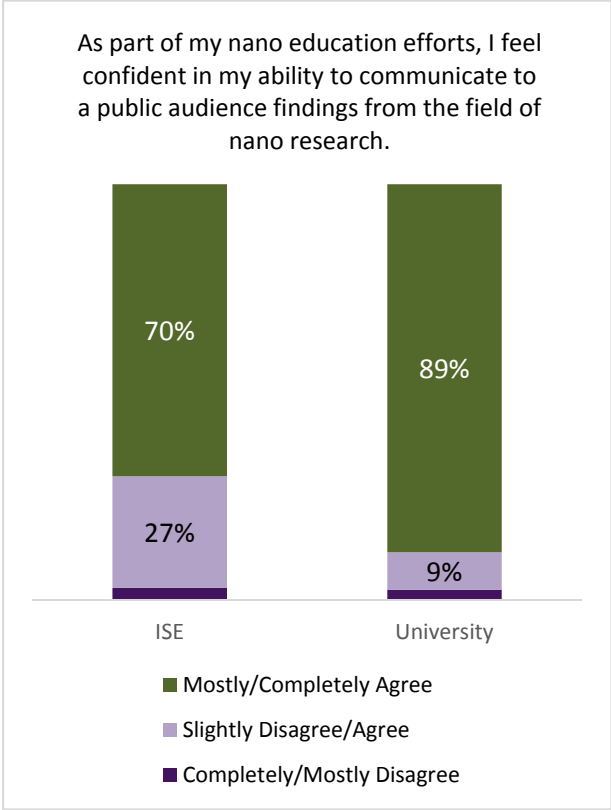


Figure 33. University respondents were more likely than ISE to agree that they were confident in their ability to communicate to a public audience findings from the field of nano research.* (n=242)



* Chi-Square Tests. See Instrument Appendix #25d and g for item format and Technical Appendix for analysis notes.

Data from the interviews support the two instances where University and ISE survey respondents differed in terms of their confidence around practices. In particular, interview data highlights how University scientists were more likely than ISE professionals to feel confident in communicating research findings. Although the scientists often talked about having a strong understanding of the nanoscience before becoming involved with NISE Net, for some individuals it was clear that NISE Net taught them ways to better communicate basic nano themes. For example, when one scientist was asked to name the most important thing she gained from participation in the NISE Network, she replied, "The [most] important thing? Oh, I would say it's a way to communicate nano in a way everyone understands" [Y10, #16].

Another scientist, in explaining what she had gained from NISE Net participation, described how she had increased confidence in explaining her research to a variety of audiences, including young children. This scientist said, "I think . . . the understanding that [sharing this information] doesn't have to be hard. In terms of either developing [an] activity or communicating nanotechnology concepts...I used to believe that communicating nanotechnology concepts to little kids was totally unrealistic" [Y10, #21].

Moreover, scientists talked about having a better understanding of what non-academic audiences might want to learn about in terms of nano research. For instance, when talking about how his communication with the public had changed due to NISE Net, a different scientist said,

> *It's the realization at what level we need to engage with the audiences to make concepts clearer. And I think maybe dealing with questions, we know a little bit more about what questions people will ask so we're maybe a little bit more prepared to give better answers. [Y9, #20]*

Together these quotes help illustrate how NISE Net played a role in these scientists' overall confidence in communicating nano research findings to the public.

In terms of the practice of universal design, interview data also support the survey results and the fact that ISE professionals were more confident than scientists in applying these principles. While most of the ISE participants seemed to know about universal design even in the first year of interviews, participating in NISE Net allowed several to learn more about this practice and gain further confidence in applying this work. One ISE individual commented on how,

> *I think we've gotten better at it. Just more practice with it . . . when we're thinking about signage or something big or small, we have focused on that . . . I think [in] the 2012 kit there was a nice guide to universal design [and] we've used that. [Y10, #8]*

A different ISE professional explained that, for "The principles of universal design, we're driven by the fact that that's how you guys provide stuff. We're aware of it and we always try to be as accessible as possible" [Y9, #9]. These quotes indicate how some ISE professionals felt they gained confidence and resources that could support their work in this area. However, finding 4.2 below will show that even though ISE professionals are confident in applying principles of UD, there can still be barriers that hinder implementation.

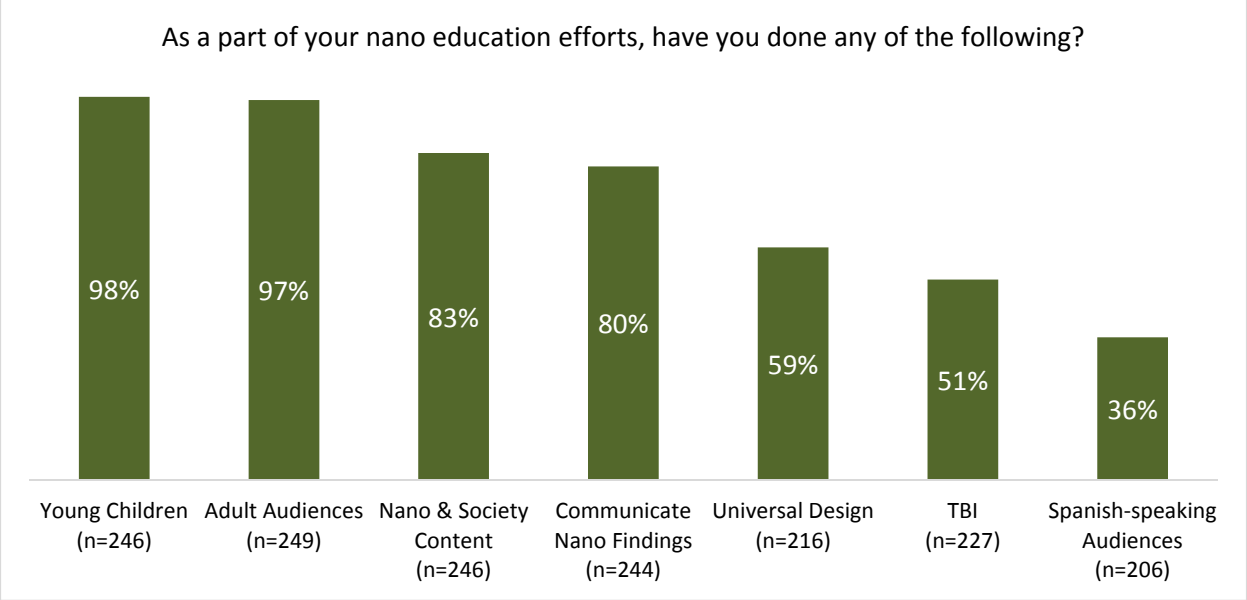
Unlike many of the ISE professionals, most of the interviewed University partners were less clear on what universal design was. During interviews, some of the scientists thought this was an education or museum-specific concept that did not apply to their work or setting. As one individual said, "So applying principles of Universal Design, I mean I'm not a museum person" [Y8, #14]. Another echoed this comment and stated, "I'm not even sure what universal design is. Is that scaling law?" [Y10, #20].

As can be seen, interview responses support the survey results that showed scientists to be less familiar with universal design than ISE professionals.

4.2 As of Year 10, Tier 1-3 professionals were using NISE Net resources to implement many public engagement practices, especially engaging young children, engaging adults, conveying nano and society content, and communicating nano research findings to the public.

On the Year 10 survey, Tier 1-3 professionals who engage the public were asked if they had done any of the public engagement practices. As shown in Figure 34, the majority of professionals report engaging in all of the practices except "engaging Spanish-speaking audiences" where about a third (36%) of professionals responded that they had done that practice.

Figure 34. Tier 1-3 professionals reported implementing all of the public engagement practices, especially engaging young children, engaging adult audiences, engaging audiences with nano and society content, and communicating to a public audience findings from the field of nano research.[12]



Note. See Instrument Appendix #26a-g for item format and Technical Appendix for analysis notes.

Data collected through interviews support these survey findings given that, in general, the practices of engaging Spanish-speaking audiences, applying principles of universal design, and using team-based inquiry were not areas where many interview participants were doing extensive work. For each of these practices, participants mentioned several barriers that kept them from applying these in their own settings. Common barriers included a lack of time and resources as well as a lack of knowledge or misconceptions. Moreover, professionals sometimes felt that the practice did not align with their professional role or with their organization's goals. These barriers are described in more detail in the following paragraphs along with a few that were specific to particular practices.

When describing factors that restrained them from engaging Spanish-speaking audiences, interviewed professionals frequently mentioned their inability to speak Spanish. Moreover, they often talked about how others at their organization lack these language skills as well. Other common barriers were not having time for translation work and/or not having the resources to accomplish these efforts. Professionals also talked broadly about their organizations not focusing on this area. As one interviewee explained,

> *We talk about it at times and for certain exhibits that has been the case, but we have not made it an organizational effort to do that. Some exhibits now obviously come with both [languages] on their exhibit signs. We internally have not made that a priority with our exhibits yet. [Y8, #4]*

[12] Respondents were able to select a "Not Applicable to my job" option; all N/A responses were removed from analysis (by public engagement practice).

Professionals raised other obstacles such as difficulties getting the word out to local bilingual communities, concerns about whether or not the scientific concepts would be understandable when translated, or the possibility that other languages in their area were more prevalent. In general, interview participants were fairly split as to whether or not they had high populations of Spanish-speaking individuals in their region. For those who felt they were in an area with few Spanish speakers, they described the limited number of potential visitors as a barrier to this work. As one professional said, "our particular geographic region, we just don't get a lot of Spanish speakers in our doors" [Y8, #13].

Tier 1-3 professionals had some of the same barriers when it came to implementing universal design, though a common theme for this practice was a general lack of understanding of what these principles are. Besides the barrier of not necessarily knowing what it is, interview data also highlighted how professionals felt they did not always have time or the opportunity to implement universal design. When talking about why their institution was not in a place to incorporate universal design, one ISE professional said,

> *Again, both because we are a new institution and we have limited staff, it's not something that we have dedicated time or staff to be looking at, but because you have done it for us obviously that makes it easy to do and it has also provided a model for thinking about applying those principals into other topics. [Y8, #3]*

A different ISE individual said, "I am familiar with the idea of universal design and I guess my feeling was I'm not sure how much I could carry out in my position" [Y8, #1]. As these responses showcase, professionals didn't feel it was the highest priority area or one where they could apply it due to their specific role.

Furthermore, both ISE and University partners sometimes had misconceptions about what universal design meant and how it could be used. For example, when describing the work of one of their grants, one of the scientists felt that universal design was "something that I really am leaving more to, you know, the education people" [Y8, #21]. While one of the ISE professionals said, "The universal design, I don't think that's applicable to us really. We can't really change out anything here in the exhibits" [Y8, #2]. Another ISE professional expressed how even though she was,

> *Familiar with UD . . . because I'm not in the education department, I wouldn't be the person to really apply this . . . so I put it as non-applicable. It's not related to our programming or what we do here. We set up tables and stations or I teach in the classroom when go do outreach. I have not had the opportunity to apply UD. [Y8, #11]*

These barriers kept many of the interviewees from actually implementing the practice of universal design.

Across interviews, there were only a few instances of when professionals had integrated or planned to incorporate TBI into their work. Instead, barriers to this work were often mentioned in the interviews, thus, providing insight into why others may have been less likely to use this as well. Often these barriers included lack of time or team members. As two ISE professionals described,

> *We really haven't [done TBI], in fact the booklet [is] sitting here on my desk and it's on my list of notes. I've taken notes on it. I really want to get our staff engaged in it, and again, priorities just keep getting pushed aside because of too many other fires that have to get dealt with. [Y9, #4]*

I really wanted to start using team-based inquiry . . . part of it is having the right team in place that would be open to it as well. We've had several people [leave] over the last year. I actually think the team in place right now will be very excited to incorporate this type of work into what we're already doing. [Y10, #6]

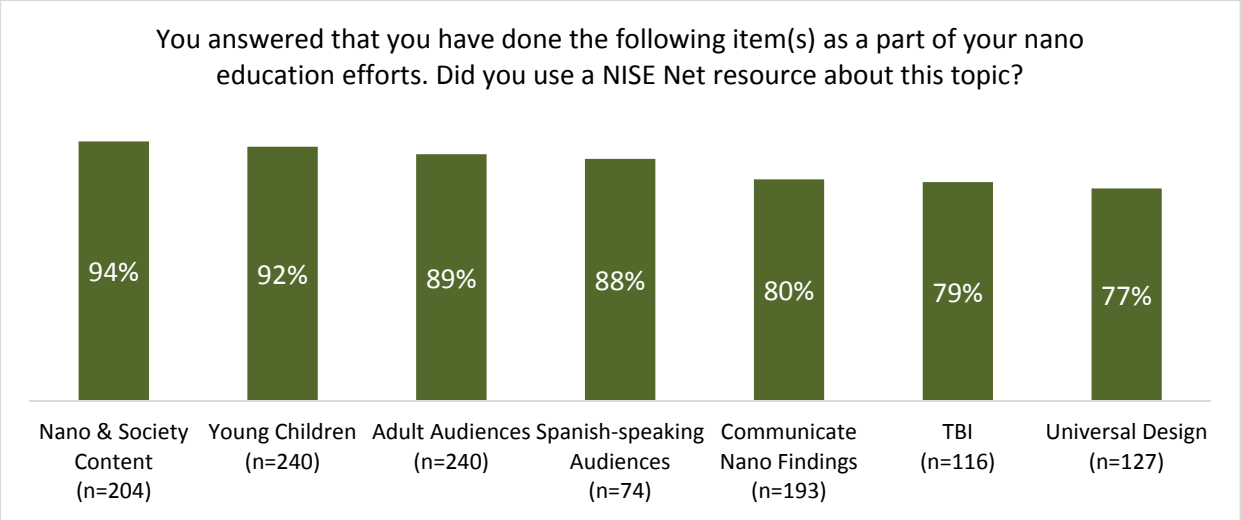
Without these two key affordances, it was difficult for professionals to implement TBI.

Besides not necessarily having the time or staff capacity for this process, some interviewees talked about not being sure of what it was. For example, one ISE professional mentioned how she didn't have a solid understanding of TBI and was therefore unable to implement this practice, saying "I haven't learned enough about it to feel empowered to do it" [Y9, #9]. Professionals also sometimes raised misconceptions that clearly prevented them from understanding how TBI could enhance their work. Among interviewees, a common misunderstanding of this practice was considering it to be related to inquiry-based learning instead of evaluative thinking. When asked about whether or not they use this practice, one individual explained, "team-based inquiry is one of our strategies in the classroom" [Y9, #12].

These misconceptions of interviewees led the study team to include an open-ended survey question on the Year 9 survey asking professionals where they first heard about team-based inquiry. On the Year 9 survey, around 10% (17 of 175) responded by mentioning resources outside of NISE Net team-based inquiry saying comments such as "business/education readings in 1990" or "I learned and have used this while I was teaching elementary and high school." Nonetheless, there was evidence that NISE Net's messages regarding TBI were spreading as 35% (61 of 175) reported first hearing about TBI through NISE Net activities or meetings. As a whole, professionals ran into challenges when trying to incorporate TBI into their work which might have related to time, staff capacity, or understanding the concept of TBI.

On the Year 10 survey, if Tier 1-3 professionals responded that they had implemented any of the public engagement practices, they were asked if they used a NISE Net resource about the topic. As shown in Figure 35, for each of the practices included in this study, the majority of professionals who report implementing the practice were using a NISE Net resource about the topic. Further analyses illuminate that this was fairly similar across tiers and organization types.

Figure 35. Of the respondents who are implementing the public engagement practices, over 75% of professionals are using a NISE Net resource for each of the below practices.



Note. See Instrument Appendix #27a-g for item format and Technical Appendix for analysis notes.

Although there were only a few interviewees who were actively thinking about incorporating TBI into their work or had already attempted to do so, interview data suggested that NISE Net provided them with the resources they needed, including examples and the TBI Guide. As one Tier 2 ISE professional said,

> *Just in December, I went to one of the sessions on team-based inquiry, so hopefully that's something to start incorporating. Um, especially now that I'm a little more comfortable with my position, and what I'm doing, and, you know, what could change. I think that would be easier to incorporate now, kind of, now that I have those resources too from, from the conference on kind of how to organize that and what types of questions to ask with the other team. I think that would be good.* [Y8, #6]

Another Tier 2 ISE professional explained that,

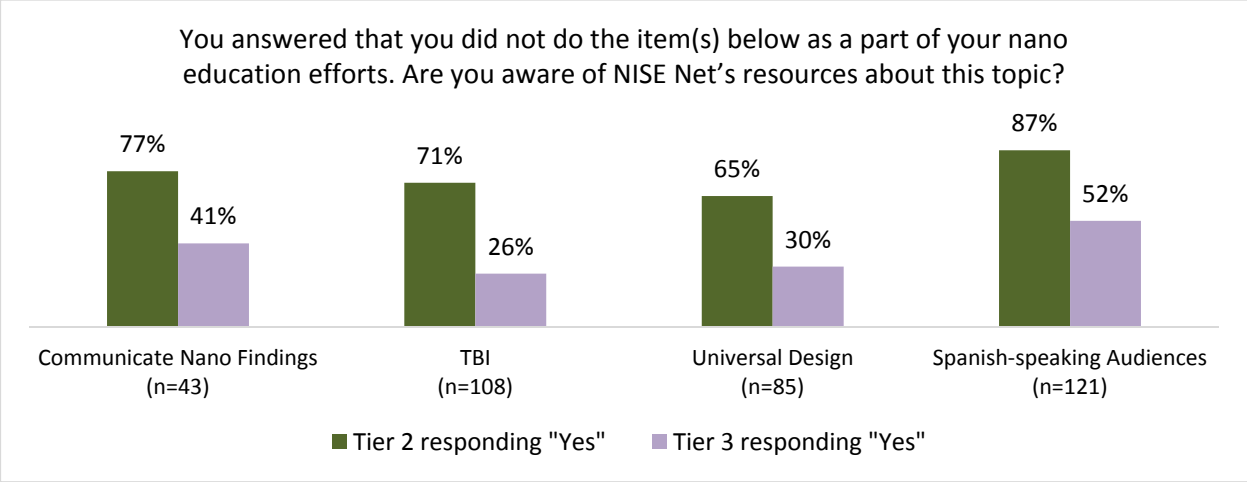
> *NISE Net gave us tools to use team-based inquiry . . . We've been trying to incorporate [it] in terms of staffing and also in terms of teaching outreach programming. But [it's] still very new and will evolve . . . With staff, [we've been] using written feedback and discussing [it] as a group. [Y10, #11]*

4.3 As of Year 10, although some practices were not being used as broadly by Tier 1-3 professionals (including using team-based inquiry, applying universal design, and engaging Spanish-speaking audiences), Tier 2 professionals were still more aware of the NISE Net resources related to these practices than their Tier 3 counterparts.

In addition to asking Tier 1-3 professionals about implementing the public engagement practices and whether they were using NISE Net resources, the Year 10 survey asked about professionals' awareness of NISE Net resources. Only professionals who responded that they have not done a practice as a part of their nano education efforts were asked if they were aware of NISE Net

resources about that topic. Therefore, for the practices being used quite broadly (i.e. engaging young children, engaging adults, and conveying nano and society content), there were too few people offered this survey question to be able to make any tier or institution type comparisons. For the remaining four practices, of those individuals who are not implementing the practice, Tier 2 professionals are more aware of NISE Net resources than Tier 3 professionals (see Figure 36). When comparing organization types, the only statistical difference was related to engaging Spanish-speaking audiences. Of those who are not engaging Spanish-speaking audiences, ISE respondents are more aware of NISE Net resources about the topic than University respondents.[13]

Figure 36. Of those Tier 1-3 professionals who are not implementing the practice, Tier 2 respondents are more aware of NISE Net resources about these topics than Tier 3 respondents.*



* Chi-Square Tests. See Instrument Appendix #28a-g for item format and Technical Appendix for analysis notes.

Change Over Years 8 Through 10

This study included methods for tracking NISE Net's impact on individuals over the final three years of grant funding, allowing the study to reflect the way that professionals' involvement with NISE Net builds over time. Findings in this section help to understand how an individual's use of NISE Net public engagement practices might have changed as a result of more NISE Net exposure, which relates to Network goals four and five. While the overall findings present data from all professionals combined or illustrate differences *between* groups, the findings exploring change over Years 8-10 provide findings *within* individuals in a group (e.g. examining the individuals within ISE or examining the individuals who are Tier 2 professionals).

There were two Network-wide survey questions related to practice use that were a part of this phase of analysis. These questions asked professionals about their confidence in implementing the public engagement practices and whether they had done so. These were explored across all respondents as well as by tier and organization type. As is true throughout the entire report, all findings described below refer to the statistically significant difference detected by the statistical test with a *p*-value below .05. Non-significant findings are not described, as it was impractical to

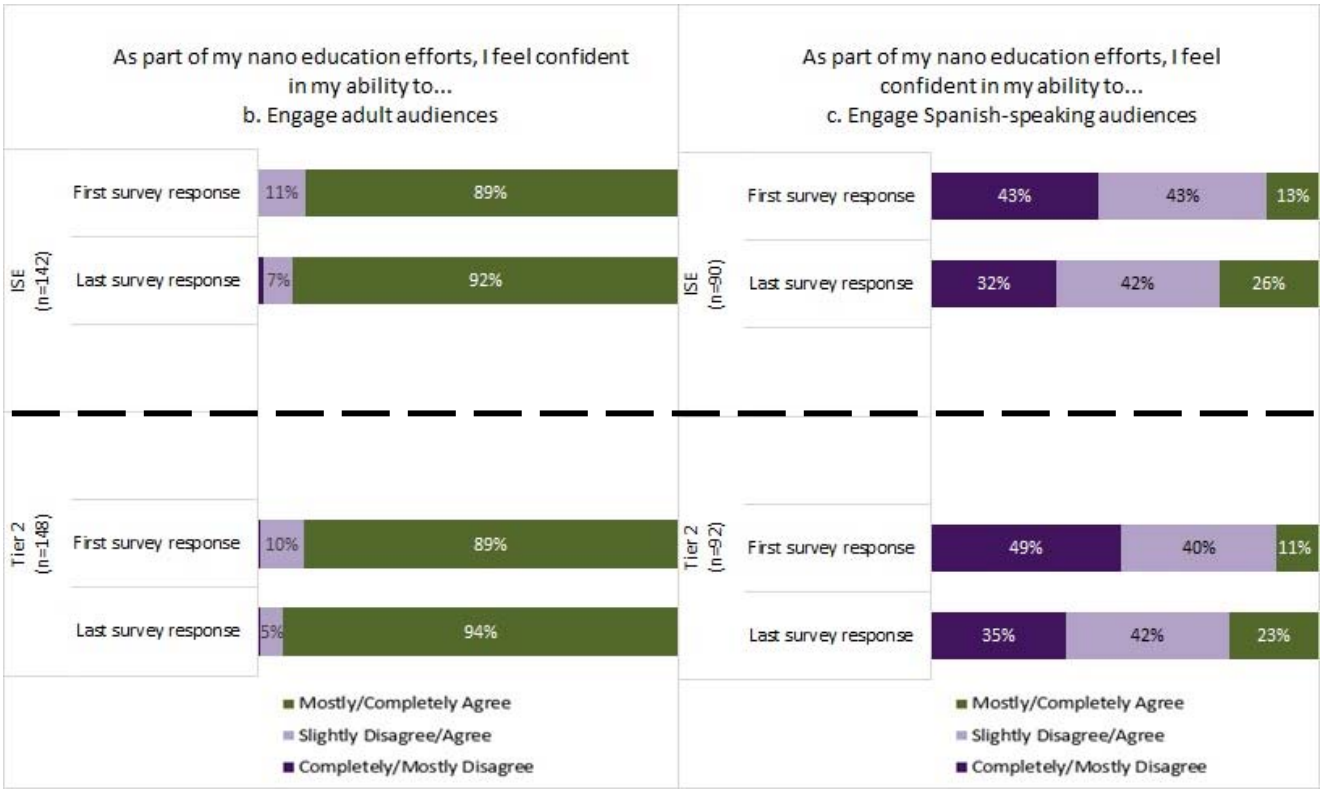
[13] Chi-Square Test. See Technical Appendix.

include all of this information in this report. The Technical Report provides additional clarification around these analyses.

4.4 Over Years 8-10, Tier 2 professionals and ISE professionals became more confident in engaging adult audiences and engaging Spanish-speaking audiences.

When analyzing individual survey respondents over Years 8-10, there were two practices where professionals in Tier 2 and those working in ISEs reported significantly increased levels of confidence. As shown in the figures below, these professionals had higher levels of confidence in engaging adult audiences as well as engaging Spanish-speaking audiences by the end of Network funding.

Figure 37. Over Years 8-10, Tier 2 professionals' and ISE professionals' mean confidence in engaging adult audiences and engaging Spanish-speaking audiences increased.*



* Wilcoxon Signed Ranks Tests. See Instrument Appendix #25b and c for item format and Technical Appendix for analysis notes.
Note. Tier and organization types are not mutually exclusive. Tiers 1, 2, and 3 consist of professionals from both ISE institutions and Universities.

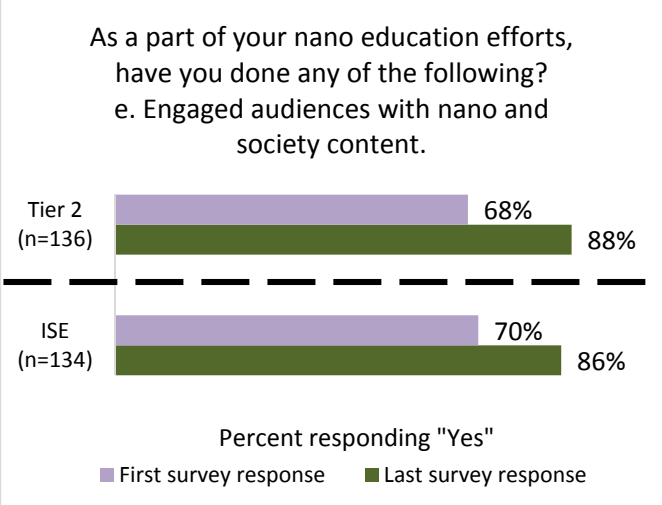
While this finding focuses on the practices of engaging adult audiences and Spanish-speaking audiences, where differences were found for both ISE and Tier 2 professionals, there were also practices where one group's confidence increased. Tier 2 professionals' mean confidence increased over Years 8-10 for the practice "communicating to a public audience findings from

the field of nano research" from 4.9 to 5.1. ISE professionals' mean confidence increased over Years 8-10 for the practice "applying principles of universal design" from 4.91 to 5.14.[14]

4.5 Over Years 8-10, Tier 2 professionals and ISE professionals increased their audience engagement around nano and society content.

In addition to asking about their confidence, professionals were also asked to report whether they had engaged in the various practices encouraged by the Network. When analyzing individual survey responses over Years 8-10, significant increases were seen for whether or not professionals in Tier 2 and professionals in ISE were engaging audiences in nano and society content.

Figure 38. Over Years 8-10, there was an increase in the percentage of Tier 2 professionals and ISE professionals engaging audiences with nano and society content.*



* McNemar Tests. See Instrument Appendix #26e for item format and Technical Appendix for analysis notes.
Note. Tier and organization types are not mutually exclusive. Tiers 1, 2, and 3 consist of professionals from both ISE institutions and Universities.

[14] Wilcoxon Signed Ranks Tests, see Technical Appendix.

Interview Vignettes

Vignette #6: Engaging audiences with nano and society content

Beth's experiences with nano and society content illustrate how many people in the Network were exposed to nano and society for the first time through NISE Net. Her story also provides an example of how professionals used materials from NISE Net to start incorporating nano and society into their practice.

> *"It's just my go-to place for knowledge . . . if I want to talk about nano and society, science and society, [NISE Net is] the first place I'm going to go."*
>
> *- Tier 2 ISE professional, Year 10 interview*

In the first interview in Year 8 with Beth, a senior level educator, it was clear that nano and society was a new area of work that they were just starting to contemplate. In describing this recent area of interest, Beth acknowledged that her organization was not covering much of this content in their programming. As she said,

> *The science and society has recently become something that I am interested . . . in getting discussions with the public. We have not necessarily taken that to the next level on how we're going to do that. I think we can do it in some of our camps and classes . . . we've considered it, but I don't know that we're doing that very effectively yet. [Y8, #4]*

As her organization was in its early phases of figuring out how to integrate this content into their offerings, Beth credited NISE Net for encouraging this type of work. To her, the resources from the website were especially crucial because "they talk about those implications to society," whereas other websites she uses, she felt like "you kind of get the nuts and bolts of the scientific content and not necessarily what the implications might be" [Y8, #4].

By the second interview, Beth explained how others at her organization had recently attended a NISE Net Nano and Society Workshop and how together they had started implementing it in some offerings. One specific example of how they were integrating nano and society into their work was through a camp for middle school students. Here, Beth detailed how she used the Flying Cars activity and "[s]pent a significant amount of time talking about . . . how does that affect driver's licenses and . . . traffic lights and . . . the people that work in those businesses? . . . That's directly from nano and society topics on the NISE Net website" [Y9, #4].

In reflecting on this experience, Beth commented on how "[b]efore [being exposed to this by NISE Net], I don't know that I would've done that. We would've made the cars [and] talked about the science . . . but I don't know that I would've gone to the lengths that I did" [Y9, #4].

During the final interview, Beth described yet another area where she had started integrating nano and society content and how she saw herself as a leader at the organization pushing this work forward. In particular, she mentioned planning to cover this content in a talk for young professionals. In order to prepare for this presentation, she went back to the NISE Net website and also contacted her regional hub leader for suggestions on how to talk "to [an] audience on science and society." In general, at her organization, Beth described herself as "leading that charge and trying to be the role model" for covering this type of information [Y10, #4].

Beth cited NISE Net as helping her transfer this topic to other areas of work when saying, "I think I've taken that to a lot of different topics outside of nano, but that's where I first learned kind of the idea of that" [Y10, #4].

Vignette #7: Engaging Spanish-speaking audiences

An in-depth look at Kacy's use of NISE Net bilingual materials over the years shows an example of how a few partners integrated these resources into their practice. While this vignette raises some common barriers that other partners ran into when doing this work, it also shows how this Tier 2 ISE professional and her organization ultimately were able to do more engagement with Spanish-speaking audiences using NISE Net resources.

> *When we go out [and do programs in] schools, we are using activities from the NanoDays kits or from the NISE Net . . . especially the activities that we're using from the kits. Then we make available the Spanish translation.*
>
> - Tier 2 ISE professional, Year 10 interview

During the first year of interviews, Kacy, an exhibit and programs developer, mentioned how she was familiar with the practice of engaging Spanish-speaking audiences but had not done it yet "due to time and staffing constraints." Although she had attended a session at a recent Network-Wide Meeting about diverse audiences and mentioned how they have a growing Spanish-speaking population in the area, this was described as something her organization was only "begin[ing] to take a better look at." Moreover, the challenges of being a new organization and having a limited budget seemed to be slowing down their progress related to this practice. As she indicated,

> *Like I said, we are new. We have tended to be a fast paced and very nimble and working with limited budgets. We have kind of done some of these things on the fly and not in the formal way and now we have turned five and are a little more grounded that these are some things we want to start doing in a more formal and intentional way. [Y8, #3]*

When talking with Kacy a year later, it was apparent that there had been growth in terms of how her organization used bilingual materials and that NISE Net had supported this. As she described, a colleague went to the NISE Net Bilingual Audiences Workshop and then came back and used some of the NISE Net bilingual signage at an outreach event. She explained, "Well, actually I wanted to say that a new audience is the State Fair audience. . . . Because that's very, very much the general public. . . . And so, we did . . . advocate there, we did provide some bilingual signage at that event" [Y9, #3]. However, even though they were using these materials for outreach in this way, Kacy explained that this was the only place in regard to their nano education efforts where they had used the bilingual resources.

Yet by the third year of interviews, Kacy felt they were doing more with Spanish speaking audiences. This was demonstrated through their outreach to specific schools with Spanish speaking populations. When describing this work, Kacy explained "we are also reaching more of a Spanish-speaking audience because the schools [where] we have chosen to go out into their STEM nights are schools that have a larger Spanish-speaking population" [Y10, #3]. In general, they rely on the NISE Net activities and Spanish translations to help run these events.

Besides increasing the amount of Spanish offerings they do at their organization, Kacy also talked about how she had shared her bilingual work with people in the museum field. For a recent conference presentation, pulled together by a NISE Net hub leader, Kacy talked about how they showcased information related to "engaging bilingual audiences" [Y10, #3]. Clearly, in the span of a few years, Kacy's work had evolved to include a focus on engaging Spanish audiences, and she was now seen as someone who could contribute to the knowledge of others in this area.

5. Expanding Beyond Nano Content

The NISE Network employed a range of strategies to encourage and support professionals in their nano-related work. These strategies developed over the course of the ten years of funding and often grew in response to partners' requests and needs. For example, as partners suggested higher use of a particular product type or lower knowledge base around engaging a particular audience (often found through formative evaluation or during face-to-face meetings), NISE Net developed resources around those areas. One strategy that NISE Net employed was encouraging professionals to integrate nano content into their existing public engagement efforts. Initially, this was helpful, as the majority of professionals did not have previous experience with nano education. Over time, it became evident to NISE Net leadership that partners were not only integrating the content of nano, but also the broader lessons learned from their NISE Net experience.

While the main focus of the *NISE Net Professional Impacts Summative Evaluation* was the individual professional's achievement of the NISE Network short- to medium-term goals which focus on the content of nano, this study also included a smaller number of survey and interview questions related to how NISE Net impacted Tier 1-3 professionals' work related to topics other than nano. This examination was intended to systematically collect information about how, if at all, NISE Net materials or experiences were leading to longer-term impacts. Specifically, Tier 1-3 professionals were asked about the overall value of NISE Net, the extent to which NISE Net impacted partnerships on topics other than nano, and if they had drawn on NISE Net information to implement any of the public engagement practices with content other than nano.[15] As a whole, professionals reported many ways in which NISE Net impacted their work, nano or otherwise. Table 11 provides the findings described in this section.

Table 11. Findings related to Expanding beyond Nano Content.

Expanding beyond Nano Content Findings
5.1 Tier 1-3 professionals reported that NISE Net has been valuable to their organizations and to themselves because the materials are models they can emulate.
5.2 Tier 1-3 professionals reported that, as of Year 10, NISE Net has increased their organization's amount of partnerships on any topic, nano or otherwise.
5.3 Professionals, especially those in Tier 2 ISE, reported that NISE Net helped them communicate other STEM topics to the public.
5.4 While Tier 1-3 professionals reported drawing on NISE Net information to implement any of the public engagement practices with content other than nano, ISE professionals were more likely than University professionals to do so for four practices: engaging young children, engaging adults, applying principles of universal design, or using team-based inquiry.

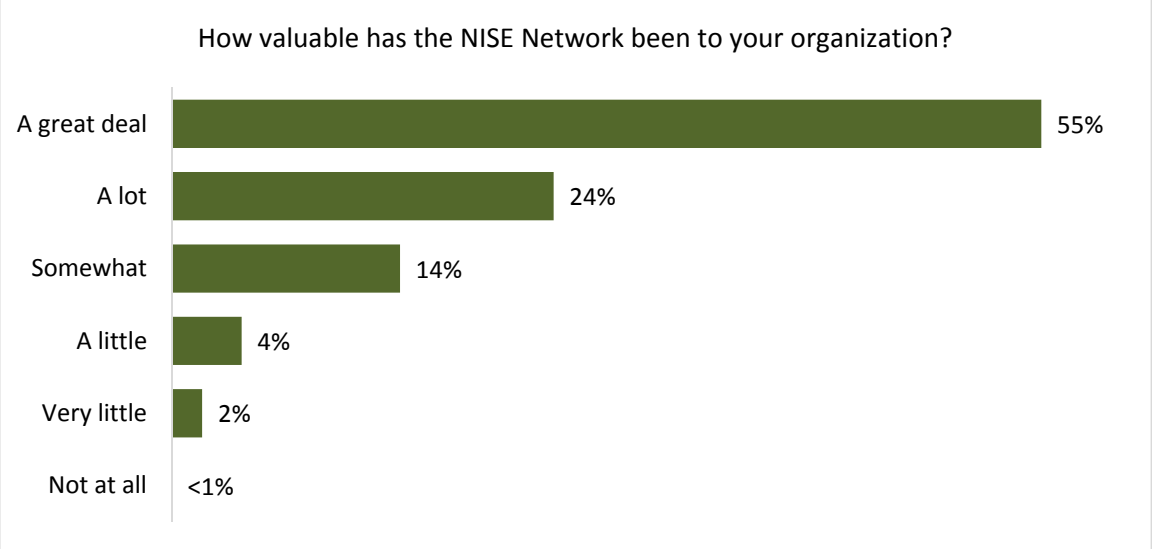
[15] It is important to note that while some of these questions ask the professional about their perspective on their organizational efforts, these data are limited to the viewpoint of one individual.

Overall Findings

5.1 Tier 1-3 professionals reported that NISE Net has been valuable to their organizations and to themselves because the materials are models they can emulate.

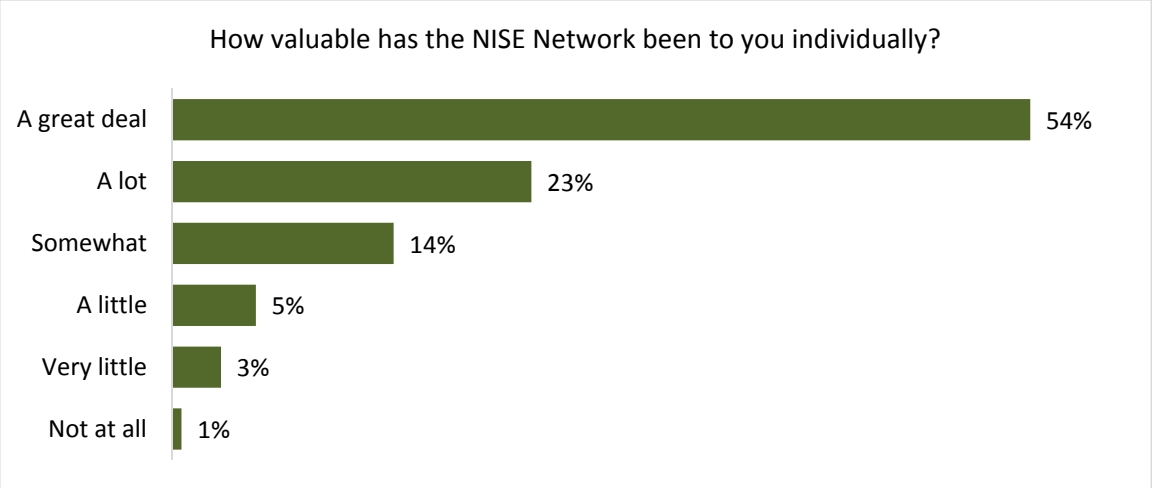
At the close of the Year 10 survey, Tier 1-3 professionals were asked to think about their experience with NISE Net overall and, using a six-point scale, respond to two questions asking how valuable the NISE Network has been to their organization and how valuable the NISE Network has been to them as individuals. While the majority of Tier 1-3 professionals responded highly to both questions (see Figures 39 and 40), there were statistically significant differences by tier and organization groups for the question asking about NISE Net's value to their organizations. Tier 1 and 2 professionals were more likely to respond more positively than Tier 3, and ISE professionals were more likely to respond more positively than University professionals (see Figure 41).

Figure 39. As of Year 10, the majority of all Tier 1-3 professionals reported that NISE Net has been valuable to their organization. (n=319)



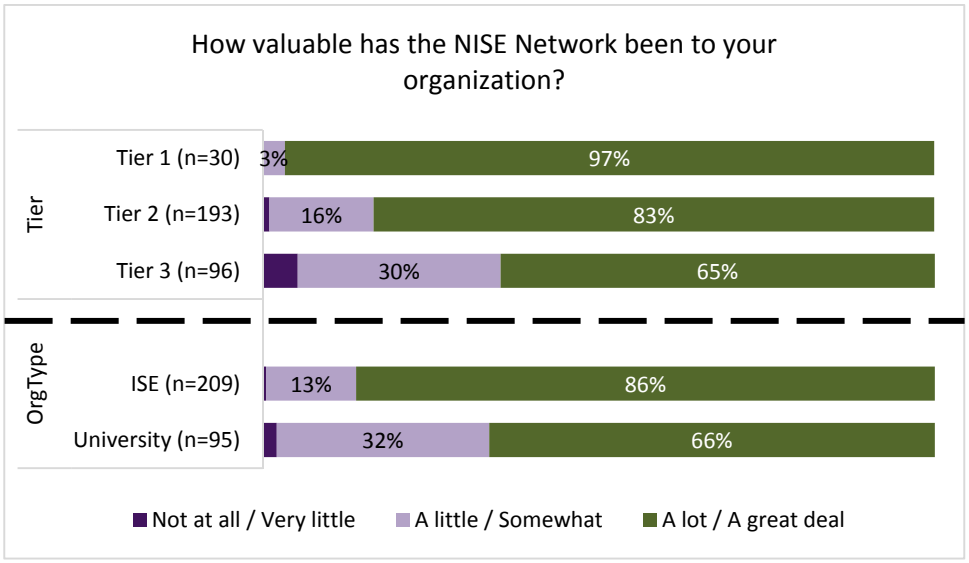
Note. See Instrument Appendix #41 for item format and Technical Appendix for analysis notes.

Figure 40. As of Year 10, the majority of all Tier 1-3 professionals reported that NISE Net has been valuable to themselves. (n=321)



Note. See Instrument Appendix #42 for item format and Technical Appendix for analysis notes.

Figure 41. In Year 10, when asked to rate how valuable NISE Net has been to their organization, Tier 1 and 2 professionals were more likely to respond more positively than Tier 3 professionals. ISE professionals were more likely to respond higher than University professionals.*



* Chi-Square Tests. See Instrument Appendix #41 for item format and Technical Appendix for analysis notes.
Note. Tier and organization types are not mutually exclusive. Tiers 1, 2, and 3 consist of professionals from both ISE institutions and Universities.

During the interviews, professionals were asked to reflect on their answers to these survey questions and describe what, in particular, about the NISE Network has been valuable to their organizations and themselves. One theme that came up strongly in these responses was the fact that professionals felt they could use NISE Net materials as a "model" for how to put other activities together and how to teach staff facilitation techniques.

Specifically, when talking about NISE Net materials as a "model" for other activities, both ISE and University participants felt the materials were useful examples for how to convey content. As one Tier 2 ISE professional described,

> *[NISE Net materials have] guided the amount and kind of information that we give to the public because I think NISE Net resources are very good at giving the facilitators an appropriate amount of background information and then boiling that down to the appropriate amount of information to share with the public. . . . We've used the style and approach of the NISE Net resources for all of our science content. [Y10, #3]*

Besides modeling the amount of content to convey, NISE Net materials also offered strong examples of visuals or quick fact-sheets that were appropriate for a variety of environments. A different Tier 2 partner reflected on how the format of NISE Net materials was useful for other areas of work because, "We've been able to use that model as we both develop our own science programming, and the more we're working with other professors or researchers kind of to show them that this is a style that works in our setting" [Y9, #3]. Another individual explained that due to the fast-paced nature of their programming demands, "[we use] the way the activities are put together as a model . . . since we do a new program every week" [Y10, #1].

Simply stated, one Tier 2 ISE partner said,

> *I think that the NISE Net activities are so well put together. I just think in general, we have probably begun to emulate some of the way the activities are put together. But I'm not sure it's an actual thing I can articulate or measure in any way, but I think it has influenced us. [Y10, #4]*

University partners also mentioned that the NISE Net materials offered valuable examples of how to convey content. As one individual said, "it enabled us to do the demonstrations for the museum, but it also, as I said, I think, gave us somewhat of a template for making our own kits, for our own demonstrations" [Y10, #20].

Another University partner described how NISE Net materials helped showcase "how to engage visitors" and that he had used the kits in a class exercise related to a different topic. For example, "the students each got one of the nano kits that they spent some time with and demonstrated to the class. Then they had to do something similar for astrobiology. The kit [was used] as a model for teaching a concept" [Y2, #19].

As can be seen in these responses, professionals found the format of the NISE Net activities to be an especially valuable and applicable model for other types of work.

When describing why participation in NISE Net had been valuable, several staff also mentioned gaining information related to staff training. For some, participation in NISE Net influenced not only how they trained staff on nano content but more generally as well. As one ISE professional indicated,

> *Some of [our staff] are not people who have museum backgrounds, so this was kind of their introduction to museum education. So having those tips is helpful in terms of teaching them how to talk about a topic with the public, not just nanotechnology, but any topic, for that matter. [Y10, #2]*

Moreover, she described how the,

> *Videos and PowerPoints were extremely helpful because I was able to put them on a designated computer that the staff [was] able to use . . . [They could] review it at their own convenience. Also the tips for engaging visitors and those kinds of things were really great and they were helpful overall for our staff dealing with the public in general. [Y10, #2]*

Another Tier 2 ISE member described how they used specific NISE Net materials saying,

> *We use the NISE Net materials in our training for our staff. We use the good demo/bad demo, and the speeducate, and the best top presenter – whatever that one's called – America's next top presenter tips for engaging visitors. We incorporate that into all of our training. We certainly still have exhibit-specific training that we do, but we certainly use a lot of NISE Net material in our training. [Y10, #4]*

These quotes illustrate how information from NISE Net related to engaging visitors, especially in terms of facilitation techniques, was a model ISE professionals could turn to when performing trainings. Data from the interviews also suggests that a few University partners found this material to be useful for the types of training they perform. For instance, one of the University partners who worked a lot with other scientists and outreach events explained,

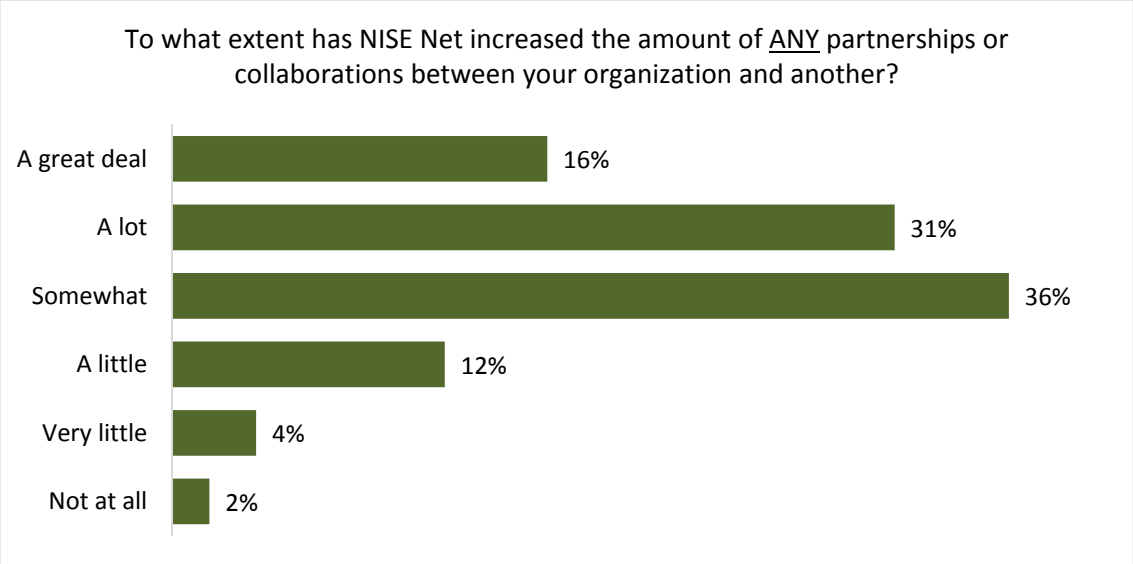
> *I hand out the cards about . . . good presenting techniques . . . [For] the programs at the library and the various day activities, where people are visiting campus, those principles apply . . . [I show the scientists] videos, Speeducate is one I've just used recently, and a few of the other "what to do, what not to do" [videos] and [we] have discussions . . . Scientists, they have the knowledge of how science works . . . [but] the knowledge of how to interact with the public is something that a lot of them still don't have. [Y10, #14]*

Together these examples provide further insight into why professionals found information from NISE Net to be a valuable model for their work.

5.2 Tier 1-3 professionals reported that, as of Year 10, NISE Net has increased their organization's amount of partnerships on any topic, nano or otherwise.

As a part of the Year 10 survey, Tier 1-3 professionals were asked the extent to which NISE Net had increased their organization's partnerships or collaborations on any topic. As shown in Figure 42, over 80% of respondents reported in the top three response categories saying that these partnerships had increased "somewhat," "a lot," or "a great deal." This was consistently high across tiers and organization types, and no statistically significant differences were found between groups even when collapsing response categories.

Figure 42. The majority of Tier 1-3 professionals report that NISE Net has increased their organization's amount of partnerships and collaborations on any topic. (n=248)



Note. See Instrument Appendix #19 for item format and Technical Appendix for analysis notes.

The interview data support the fact that NISE Net helped increase Tier 1-3 professionals' partnerships on a variety of topics. Both ISE professionals and University partners talked about how NISE Net provided useful information, valuable connections, and an impetus for reaching out to others. As one ISE professional described

> *I would say that we're a relatively new museum . . . we have more of a science focus now than we did 7 years ago and because the NISE Net resources are so strong . . . it has definitely strengthened our partnerships and expanded our partnerships and has kind of helped us structure our partnerships in a way that is successful. [Y10, #3]*

To partners, there was a sense that NISE Net helped them reach out to both local partners and people across the nation. When mentioning how NISE Net supported local connections, one ISE professional described how,

> *We wrote a grant recently and [I] needed to find an evaluator and I know we reached out to [our hub leader] and asked her for a recommendation. [For] other completely different activities that we're doing, we've reached out to partners who had skills that we probably wouldn't have otherwise known [about] because of the NISE Net. We met our friend in [the local area] through NISE Net. [Y10, #13]*

A different ISE individual, in talking about partnerships, highlighted how NISE Net also made professionals feel more connected with other museums across the US, saying,

> *[NISE Net] helped us connect with other organizations. It kind of gives us a reason to collaborate. So that's been really good and it's opened a door for us in terms of just connecting with what other science museums in the country are doing. [Y10, #8]*

Besides providing resources and connections to others, some ISE professionals talked broadly about how NISE Net raised their confidence to go after new partnerships. As one professional exclaimed,

> *NISE Net helped embolden me. All of the experiences . . . [including] entry into labs, going to science cafes, hearing these speakers who then hang around, drink a beer, and answer your questions. Going to the conferences* **. . .** *I think it just really emboldened me to ask questions and approach people, cold-call people [for our science café series] and say, "Hey, you know . . . would you come talk about this? [Y10, #9]*

Scientists, too, discussed a variety of ways the NISE Net helped them increase their work with other organizations. Particular products produced by NISE Net, such as the *Nano* exhibition, and opportunities like NanoDays were considered key reasons why they were able to increase their number of partnerships while participating in the Network. As one scientist described, "I don't know if I'd be working with the library [if it wasn't] for the mini-exhibit and NanoDays. [These opportunities have] probably opened the door [for us] and that's [going to] be a fruitful partnership I see for years to come" [Y10, #14].

Another scientist described how

> *[NISE Net] certainly fueled our collaboration with [a local museum] . . . I think that it brought us gains as an organization, but also individually . . . [it] got a lot of students engaged in that type of activity, and I would say it actually changed the perceptions of students who are doing outreach. Initially, when we had said we all have to do outreach, some students were a little bit, you know, "we don't really want to do that" or "we feel awkward talking in front of little kids or grownups." I think that has changed largely. Generally, students are quite enthusiastic doing it. [Y10, #20]*

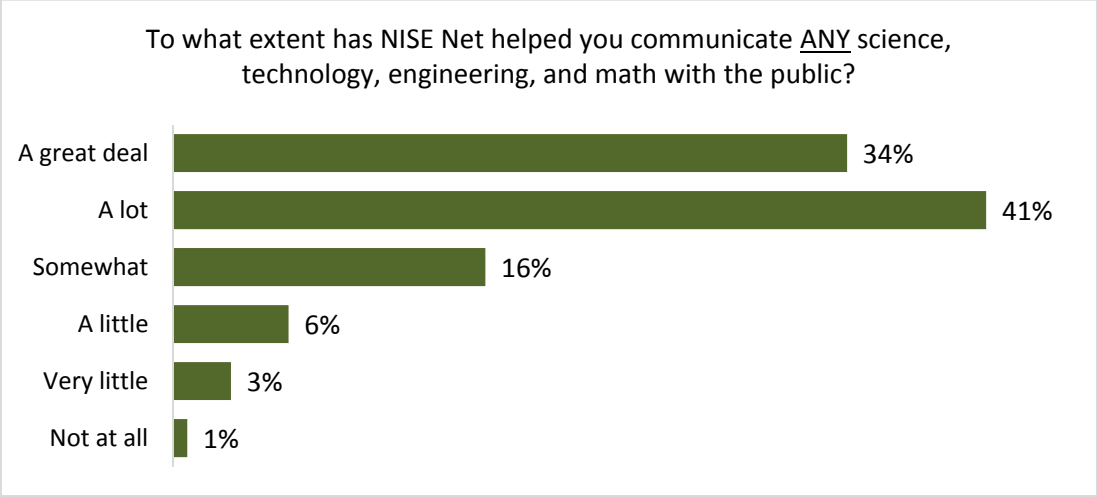
Moreover, interview data also provided examples of how participating in NISE Net changed the way some scientists worked with colleagues at their own institutions. For instance, one professional discussed how, "I have made some connections [with people in the Network] and that's super valuable, but [NISE Net has kind of] been the catalyst for connections within the university and those are probably just as valuable, if not more so" [Y10, #19].

Through these interview responses, it is evident that NISE Net efforts affected professionals' work related to partnerships on many levels.

5.3 Professionals, especially those in Tier 2 ISE, reported that NISE Net helped them communicate other STEM topics to the public.

As a part of the Year 10 survey, Tier 1-3 professionals were asked the extent to which NISE Net has helped them communicate any science, technology, engineering, and math (STEM) with the public. As shown in Figure 43, over 90% of respondents reported they were in the top three response categories saying that NISE Net had helped them communicate STEM "somewhat," "a lot," or "a great deal."

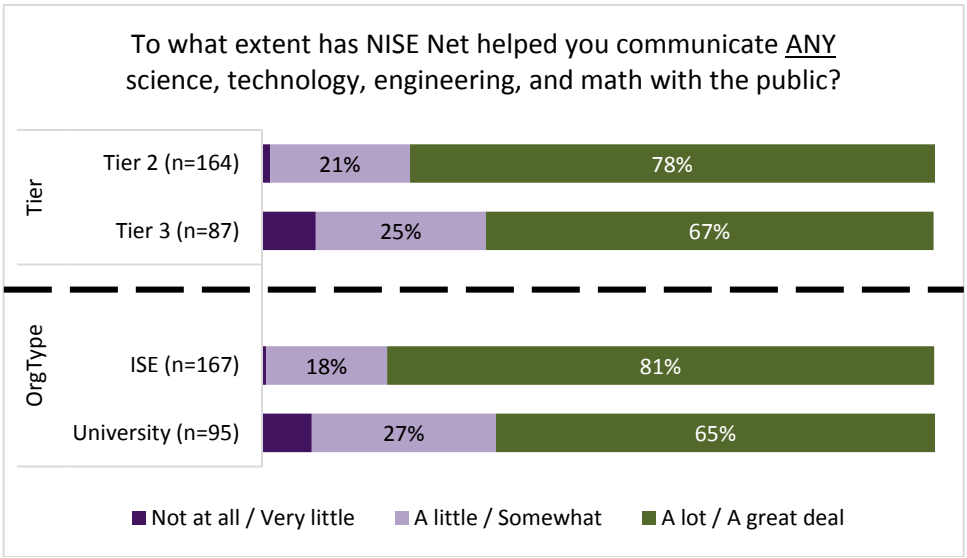
Figure 43. On the Year 10 survey, the majority of Tier 1-3 professionals reported that NISE Net has helped them communicate other STEM topics. (n=274)



Note. See Instrument Appendix #30 for item format and Technical Appendix for analysis notes.

While responses were high for all individuals, differences by tier and organization type were found. Specifically, Tier 2 professionals were more likely than Tier 3 professionals to respond highly and ISE professionals were more likely than University professionals to respond highly.

Figure 44. When asked to rate the extent to which NISE Net helped them communicate STEM, in Year 10, some groups responded the extent to which NISE Net helped them was higher than other groups. Tier 2 responded higher than Tier 3 and ISE professionals responded higher than University professionals.*



* Chi-Square Tests. See Instrument Appendix #30 for item format and Technical Appendix for analysis notes.
Note. Tier and organization types are not mutually exclusive. Tiers 1, 2, and 3 consist of professionals from both ISE institutions and Universities.

Besides coming across clearly in the survey data, interview participants also talked at length about how NISE Net affected their ability to communicate STEM topics. Professionals mentioned how NISE Net improved their communication in a range of ways. Not only did NISE Net provide them with more scientific understanding, but it also provided strategies for how to share information. As one ISE professional said,

> *[I am now] more comfortable talking about science to the public, particularly [about] a field of science that I wouldn't have previously felt comfortable talking about. I'm okay with the natural sciences, but [the nano] aspect of chemistry and material sciences [was] not something I really felt like I could wrap my head around. [Y10, #2]*

Another commented on how,

> *I feel a big part of my job is science education and before getting involved in NISE Net, we were still doing . . . biology and ecology, stuff like that, but in the winter, we also [did] more technology-related programming. So there [were] certain aspects [of NISE Net] that help[ed] with how we communicate STEM and teach STEM topics and all that stuff . . . we've kinda set up other STEM programs [that] definitely [have] been influenced [by] our involvement with NISE Net, they're just a little bit better organized in terms of . . . how different activities interact with each other and what concepts are reinforced. [Y10, #8]*

Although ISE professionals were statistically more likely to respond highly on the survey than their University counterparts, both groups reported that NISE Net helped their STEM communication. Interviews illustrated this and provided examples of how NISE Net affected scientists' ability to convey STEM to the public. For instance, one University partner explained,

> *As an individual, for me, I teach undergraduate classes . . . I'm an active researcher in the field, so I'm always involved in nano at the highest research level . . . It's not just enough for me to lock up myself in a lab and keep doing research, I know my role as a professor is also to get the word out, explain what I'm doing to the general public so that the students and the community will be motivated to be a researcher . . . So we want to motivate the next generation of scientists to do science just like we are doing. So NISE Network has been very valuable to me in providing that information. [Y10, #17]*

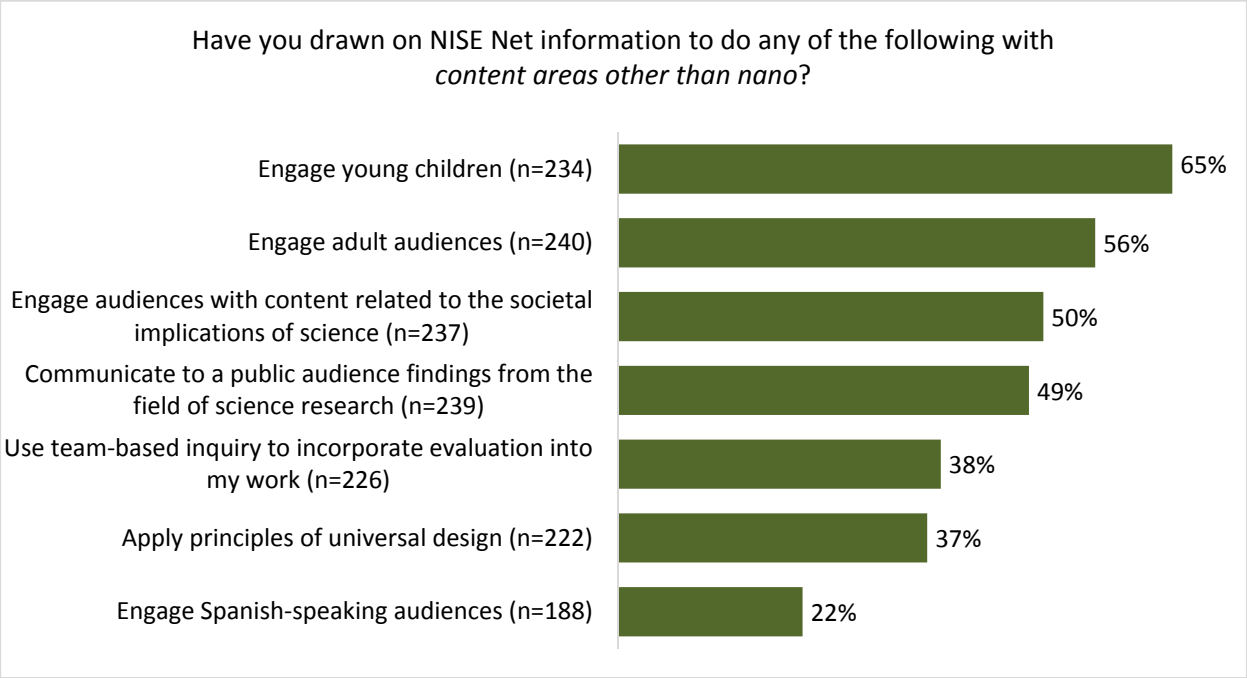
Another scientist similarly felt that NISE Net, her work with a museum partner, and the kits had allowed her and her students to learn how to deliver "just generally science content, maybe engineering content, to a lay audience . . . through outreach activity, to see [students] learning how to convey information about my own work, but also about other concepts in science and engineering, particularly on the nanoscale" [Y10, #20].

5.4 While Tier 1-3 professionals reported drawing on NISE Net information to implement public engagement practices with content other than nano, ISE professionals were more likely than University professionals to do so for four practices: engaging young children, engaging adults, applying principles of universal design, or using team-based inquiry.

On the Year 10 survey, Tier 1-3 professionals were asked whether they had drawn on NISE Net information to implement any of the public engagement practices included in this study. As shown in Figure 45, the majority of Tier 1-3 professionals reported drawing on NISE Net information to help with presenting around content other than nano when engaging young children (65%), engaging adult audiences (56%), or engaging audiences with content related to

the societal implications of science (50%). The practice with the smallest proportion was engaging Spanish-speaking audiences, where 22% of professionals reported drawing on NISE Net information to engage Spanish-speaking audiences with content areas other than nano.

Figure 45. As of Year 10, Tier 1-3 professionals reported drawing on NISE Net information to implement the public engagement practices with content other than nano.

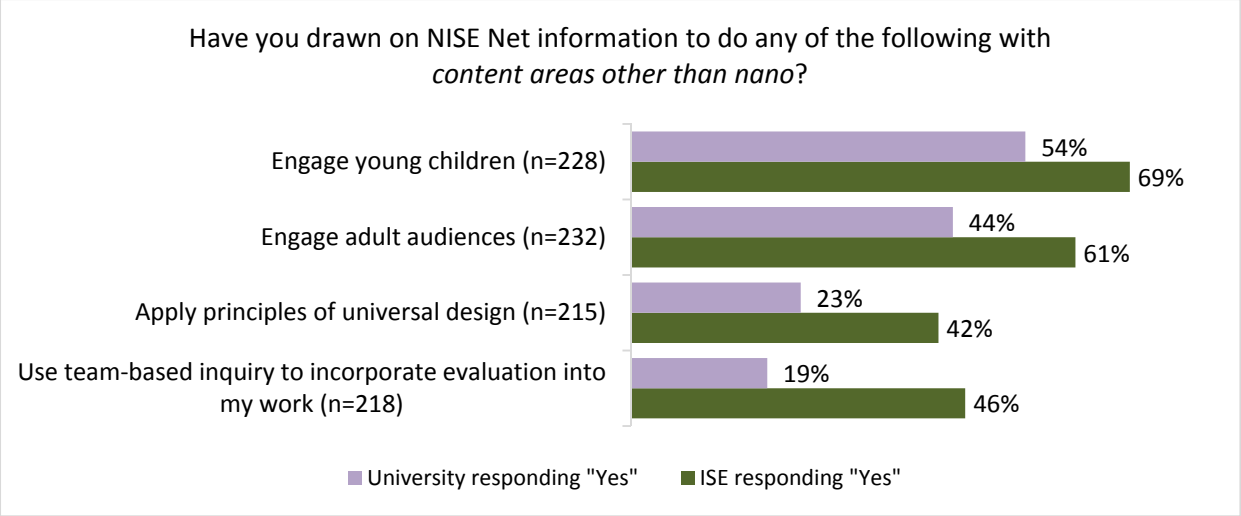


Note. See Instrument Appendix #29 for item format and Technical Appendix for analysis notes.

As shown in Figure 46, which provides the percentage of Year 10 ISE and University respondents reporting "yes" to this question, there are four practices for which ISE professionals were more likely than University respondents to draw on NISE Net for content areas other than nano. The practices where ISE and University respondents differed include engaging young children, engaging adults, applying principles of universal design, and using team-based inquiry. The percentage of ISE and University respondents drawing on NISE Net information for engaging audiences in other content was similar for the remaining three practices.

The analysis of this survey question also compared individuals by tier involvement and found that, in general, professionals drew on NISE Net to implement most of the practices to a similar extent, despite tier involvement. The only differences that were found between tiers were that Tier 1 professionals were more likely than Tier 3 professionals to apply universal design or use team-based inquiry with non-nano content areas.

Figure 46. ISE professionals are more likely than University professionals to draw on NISE Net information when engaging young children, engaging adults, applying principles of universal design, or using team-based inquiry with content areas other than nano.*



* Chi-Square Tests. See Instrument Appendix #29 for item format and Technical Appendix for analysis notes.

Summary of Findings and Discussion

This section synthesizes and interprets the results of the *NISE Network Professional Impacts Summative Evaluation*. Organized around four discussion points, each sub-section includes a chart providing an at-a-glance listing of the relevant findings, an expanded summary of the data supporting the larger theme, and a discussion delving into potential explanations and implications for the field.

Overall, this longitudinal study explored how involvement with NISE Net impacted Tier 1-3 individuals' achievement of the NISE Net goals for professionals—in particular, their sense of community, understanding of nano concepts, and use of nano educational products and practices. Tier 1 -3 professionals were the main individuals involved in the Network and are, at times, referred to as NISE Net professional partners within this section.

The following four discussion points summarize the main findings of this study:

1. NISE Net professional partners reported that their sense of community increased after they became involved with the Network and that NISE Net affected their understanding of nano.
2. NISE Net professional partners reported engaging the public with all types of Network products and practices, though some were used less than others.
3. While the majority of NISE Net professional partners reported gains related to the Network's goals, Tier 2 and ISE professionals specifically reported positive change over time from their NISE Net involvement, especially concerning nano and society content.
4. Evidence indicates that a range of NISE Net professional partners integrated aspects of NISE Net into their work that is unrelated to nano.

1. NISE Net professional partners reported that their sense of community increased after they became involved with the Network and that NISE Net affected their understanding of nano.

As highlighted throughout the findings and in the following discussion, the *NISE Net Professional Impacts Summative Evaluation* provides evidence that NISE Net impacted Tier 1-3 professionals' sense of community and understanding of nano concepts. These areas relate to three NISE Net goals for professionals:

1. Identify with a broader community including scientists and museums
2. Value local research-ISE collaborations
3. Understand and appreciate key concepts in nanoscale science, engineering, and technology and its relationship with our lives, society, and environment

Findings Supporting Discussion Point 1
Community and Collaboration • Tier 1-3 professionals reported an increased sense of community after getting involved with the NISE Net. • As of Year 10, Tier 1-3 professionals participated in the NISE Network in a variety of ways and valued the opportunities provided. • As of Year 10, Tier 1-3 professionals felt confident initiating a partnership with an informal learning or research organization and often used NISE Net resources to do so.
Learning about Nano Concepts • As of Year 10, the majority of Tier 1-3 professionals rated highly both their confidence in their ability to explain nano to another adult and the amount that NISE Net has affected this confidence. • Tier 1-3 professionals reported that NISE Net resources such as NanoDays kits, face-to-face meetings, and the website were particularly useful for their learning, though they also reported learning about nano through methods outside of NISE Net.

Summary of findings

NISE Net's goals for **community and collaboration** centered on the relationship between museum and University professionals, and how these connections have the potential to bring emerging research directly to the public. This study's findings provide evidence that, as of Year 10, connections were made and the study sheds light on the role that NISE Net played in bringing individuals together.

On the Year 10 survey, Tier 1-3 professionals reported an increased sense of community since becoming involved with NISE Net. When answering a retrospective pre/post question, 38% of individuals felt that before getting involved with NISE Net they identified either "a lot" or "a great deal" with a community that included both scientists and museum professionals as compared with 77% who identified in this way after they were involved with the Network (see Figure 3).

Data also indicate that the majority of NISE Net Tier 1-3 professionals not only participated extensively in the opportunities provided by NISE Net such as receiving educational materials, meeting with and learning from other professionals, and fostering local partnerships, but they valued these kinds of opportunities for involvement. As of Year 10, the majority of Tier 1-3 survey respondents had visited the website, read the monthly e-newsletter, or connected with their Regional Hub Leader (see Figure 6). Additionally, individuals who participated in the interviews described the NISE Net community as "supportive," "thorough," and "welcoming." One particular aspect of NISE Net that reinforced a sense of community for interview participants was the face-to-face meetings. All of the interview participants who had gone to a NISE Net meeting (14 of 21) mentioned at least one benefit from attending, and several interview participants who had never attended a NISE Net meeting noted how an opportunity such as this might be useful. In speaking about how attending a NISE Net meeting was helpful to her work, one ISE professional commented,

> *I don't get a lot of opportunities to have discussions with other science centers educationally. I loved going to the meeting in Boston because of the fact that I got to talk with people in my own little cohort even though we're spread out all over the place. That was really helpful and I was able to gain some new insights and some ideas. [Y8, #12]*

Findings from the survey and interviews also indicate that NISE Net played a role in increasing the sense of community by connecting individuals through partnerships. As of Year 10, 75% of Tier 1-3 professionals who responded to the survey felt confident in their ability to initiate a partnership with an informal learning or research organization (Figure 9). Moreover, 78% of respondents reported their organization had partnered with another institution around nano, and professionals identified NISE Net resources as useful when starting or continuing an existing collaboration. Interviewed professionals mentioned that NISE Net impacted their sense of community by expanding the types of organizations with which they partnered and by helping them focus collaborations through a nano-themed event. The fact that professionals more strongly identified with a community of scientists and museum professionals as of Year 10, and that many recognized NISE Net-related reasons for this increased sense of community, suggests that NISE Net's goals for community and collaboration have been met.

In the same way that professionals on the Year 10 survey reported that NISE Net had affected their sense of community, the vast majority of professionals reported being influenced by the Network in terms of **learning about nano**. Because part of the Network's professional development goals related to learning about nano, NISE Net focused on impacting individuals' understanding and appreciation of four key nano concepts defined in a content map available on the website. This nano content drove all of NISE Net's public engagement development efforts (Bequette, et al., 2012). This evaluation study sought to determine professionals' confidence in concepts from all four of the outlined areas.

Findings indicate that the majority of Tier 1-3 professionals responding to the Year 10 survey reported high levels of confidence in their understanding of nano concepts and high ratings for the extent to which NISE Net affected their confidence in nano. Even for the concepts related to nano and society, about which respondents were the least confident, almost 75% reported high levels of agreement in being able to explain these areas to another adult. As of Year 10, over 65% of survey participants also credited NISE Net with affecting their confidence "a lot" or "a great deal" in terms of being able to explain all of the key nano concepts identified in this study (see Figures in 2.1).

When describing how NISE Net affected their understanding, professionals on the survey and in interviews reported that NISE Net resources such as NanoDays kits, face-to-face meetings, and the website were particularly useful for their learning, though they also reported gaining knowledge about nano through methods outside of NISE Net. For instance, 50% of respondents mentioned using only a NISE Net resource to learn about the nano concepts they felt most confident about, while 24% described using both a NISE Net and an outside resource (see Figure 18). Some University professionals cited additional materials connected with their own research. ISE professionals, at times, mentioned their own extra research efforts or that they had generally become more aware of nano since becoming involved with NISE Net. As one ISE professional commented, "It's just that I notice it now. I think about things in different ways because of nano. Water quality. Fabrics. Cosmetic industry. Windshields. I think it has changed the way that I look at the world pretty significantly" [Y9, #9]. These findings illustrate that, as of Year 10, Tier 1-3 professionals self-reported high levels of confidence in their understanding of nano, and that the majority of these professionals credited aspects of NISE Net for impacting this sense of confidence. This suggests that NISE Net has achieved its goal for impacting professionals' understanding of nano.

Discussion

These data provide evidence that NISE Net impacted professionals' sense of community and understanding of nano concepts. In both of these areas, it seems that NISE Net was able to impact professionals through a variety of resources and experiences. While one limitation of this study is not being able to attribute these increases in learning and sense of community to *particular* aspects of NISE Net, data from this summative evaluation do seem to be in alignment with the findings from the *Network Communication Study* (Morgan Alexander et al., 2012). Specifically, both of these studies show that the NanoDays kits, NISE Net meetings, and various opportunities to connect with others were useful and appropriate for creating a sense of community and helping professionals learn about nano content.

While it is certainly true that some partners were exposed to more opportunities than others, as a whole, it seems that NISE Net's efforts to be open and welcoming help explain why professionals increased their sense of community and collaboration. Examples of how NISE Net worked to encourage professionals across tiers to feel connected with the larger group included the Regional Hub structure with leaders who were available to help specific regions of the country, an all-encompassing website which included a range of resources, and the Network's strong presence at non-affiliated events such as ASTC. Moreover, because NISE Net provided materials related to partnering and promoted an annual public event (NanoDays) that brought individuals from different settings in contact with one another, it is perhaps not surprising that professionals felt the Network had an impact on their identification with a broader community. These findings echo not only what was heard in the *Network Communication Study* but also results summarized in the *Review of NISE Net Evaluation Findings: Years 1*-5 that describe how the Network positively affected professionals' relationships and networking (Nelson, Morgan, Reich, & Goss, 2011).

In terms of learning about nano content, there is strong evidence from this evaluation that professionals credited the Network with affecting their confidence in these areas. While one reason these ratings were so high for professionals across the board might be that this study started in Year 8 of a 10-year Network, it appears that NISE Net resources were particularly instrumental in conveying nano content and relevant real world applications. Most professionals reported using products created by the Network to become more confident about nano. Additionally, some professionals indicated that they referenced both NISE Net materials and other resources to learn more. NISE Net may have spurred many of these professionals to search for further details about nano because they were now doing more nano-related programming with the public.

While these data provide evidence about the impact of NISE Net in shaping professionals' connection to a broader community or understanding of nano, it is also possible there are additional factors beyond NISE Net impacting professionals in these areas. For instance, many current projects in the ISE field and other grants funded by NSF stress the importance of partnering and working with colleagues from different settings, particularly museums and universities. Thus, it is possible that some of these ISE/University partnerships would have occurred without NISE Net resources. Moreover, for any of these findings, it may be that the professionals most interested in maintaining involvement with NISE Net were predisposed to connect with the Network or to learn about nano, and that the evaluation did not capture the feelings of those professionals who dropped out of NISE Net or for whom the Network was not as successful.

Nonetheless, there is evidence that the NISE Net played a part in professionals' sense of community and knowledge about nano. Future projects may want to consider using some of the

same strategies that NISE Net implemented to create a national community and to develop products that supported professionals' learning about nano.

2. NISE Net professional partners reported engaging the public with all types of Network products and practices, though some were used less than others.

As highlighted throughout the findings and in the following discussion, the *NISE Net Professional Impacts Summative Evaluation* provides evidence that NISE Net impacted professionals' public engagement with nano. These areas relate to the following two NISE Net goals for professionals:

4. Understand theories, methods, and practices for effectively engaging diverse public audiences in nano
5. Utilize professional resources and educational products for engaging diverse public audiences in nano

Findings Supporting Discussion Point 2
Using Public Engagement Products • On a retrospective pre/post question, Tier 1-3 professionals reported they were significantly more likely to engage the public in nano as of Year 10 than they were prior to Network involvement. • As of Year 10, the majority of Tier 1-3 professionals engaged the public in nano throughout the year and used NISE Net cart demonstrations and hands-on activities, media, and classroom activities more than other types of products. • As of Year 10, although Tier 1-3 professionals were not using some product types as often (including museum theater and forums), Tier 1 and 2 professionals were still more aware of these products than their Tier 3 counterparts. • Since joining NISE Net, in order to integrate nano into their existing educational offerings, the majority of Tier 1-3 professionals reported adapting a NISE Net product and many reported developing a new nano educational product.
Using Public Engagement Practices • As of Year 10, Tier 1-3 professionals were confident in their ability to engage the public, especially the practices of engaging young children, engaging adults, engaging audiences with nano and society content, and communicating nano research findings to the public. • As of Year 10, Tier 1-3 professionals were using NISE Net resources to implement many public engagement practices, especially engaging young children, engaging adults, conveying nano and society content, and communicating nano research findings to the public. • As of Year 10, although some practices were not being used as broadly by Tier 1-3 professionals (including using team-based inquiry, applying universal design, and engaging Spanish-speaking audiences), Tier 2 professionals were still more aware of the NISE Net resources related to these practices than their Tier 3 counterparts.

Summary of findings

NISE Net laid out two specific goals related to professionals **engaging the public with nano**. NISE Net aimed to encourage both *understanding* and *use* of practices, resources, and educational products for those engaging diverse audiences in nano content. This study helps illuminate which NISE Net products and practices had a large impact on professionals' work as well as reasons why others may have been used less extensively.

When summarizing these data, it is important to note that, overall, Tier 1-3 professionals reported they were significantly more likely to engage the public in nano as of Year 10 than they were prior to Network involvement. According to retrospective pre/post survey responses, before getting involved with NISE Net, 31% of Year 10 respondents personally engaged the public in this content, whereas in the final year of the Network, 82% of respondents were doing so (see Figure 21).

As of Year 10, data related to professionals' use of specific **public engagement products** indicate that all product types were being used, with some being used by more professionals than others. For Tier 1-3 professionals who engaged the public in nano, the most popular product type (cart demonstrations/hands-on activities) was used by 84% of professionals while the product type with the least frequent usage (forums) was used by 14% of partners (see Figure 23).

Besides cart demonstrations and hands-on activities, other product types that were used by at least 60% of professionals included media and classroom activities. During the survey and interviews, professionals emphasized how they often integrated these popular NISE Net products into existing programs and found them to be useful both during and outside of NanoDays. In fact, of the Year 10 survey respondents who described using hands-on activities, media, or classroom activities, at least 70% employed these products not only during NanoDays, but throughout the year (see Figure 24). As one ISE professional explained, "The demos I would say we do once a month and we do them on Saturdays. . . . And then [we do them on] the NanoDays which we've done generally [for] one day" [Y8, #2].

Professionals also reported feeling confident in making modifications to NISE Net products. As seen on the survey, the majority of Tier 1-3 professionals were confident in adapting programs and had changed NISE Net products in some way to fit with their work (see Figures 27 and 28). Comments made during interviews illustrated how participants even felt encouraged to do so by the Network. For example, one ISE professional said,

> *Most of [the people in NISE Net developing the materials] are museum professionals. They understand that with different audiences you have to be able to modify to make things as accessible as possible. I've never felt discouraged to modify based on the needs of our visitors. [Y8, #6]*

During interviews and on the survey, professionals reported various adaptions they had made. The most frequent modification that professionals reported in Year 10 was incorporating a NISE Net product into an existing program (73% of respondents).

Yet, data suggest that other product types created by NISE Net were not being used as often by Tier 1-3 professionals. Survey responses indicate that stage presentations, science cafes, museum theater, and forums were not being used as frequently by Tier 1-3 professionals. These product types were all being used by less than 40% of professionals in Year 10 (see Figure 23). Findings from Years 8-10 show that this level of use remained consistent over the years and, overall, it was evident that these types of public engagement products were being used to a limited degree.

For the less frequently used NISE Net product types, data from this study highlight certain barriers that professionals ran into when trying to implement them with the public. In particular, barriers mentioned by professionals centered on individual or institutional obstacles rather than Network-related factors. For example, when talking about reasons why they weren't using products such as stage presentations, science cafes, museum theater, or forums, Tier 1-3

professionals often mentioned weighing the age and audience appropriateness for their setting, delivery format and space considerations, or current level of staff capacity. As one professional explained, several institutional obstacles arose when they considered implementing certain types of materials that came in the NanoDays kit:

> *The current kit I know has some topics on [nano and society] this year, but again I have a feeling it's going to be harder for me to implement those than some of the others 'cause they're like games or something and, you know, we don't really do games. We don't have a stage or any kind of a theater . . . so we don't really do demonstrations so much. But, maybe as we reach out to the libraries they have different formats it might be more possible to use them. [Y8, #13]*

Table 12. NISE Net public engagement product types, rates of use, and how professionals made decisions about which products to use.

Used by 60% or more of Tier 1-3 partners	Used by less than 40% of Tier 1-3 partners	When choosing products, professionals considered…
• Cart demonstrations and hands-on activities • Media (print, posters) • Media (videos, multimedia, images) • Classroom activities	• Stage presentations • Science cafes • Museum theater • Forums	• Connections to existing content • Age/audience appropriateness • Delivery format • Ease of use • Quality of materials • Space availability • Staff capacity • Visitor enjoyment • Staff preferences

Note. Frequency of use comes from Year 10 survey responses whereas professionals' considerations are based on interview responses.

In terms of **public engagement practices** encouraged by NISE Net, professionals again reported implementing all of the practices included in this study and using NISE Net resources related to these topics. As with the findings concerning the use of products, professionals were employing some of the practices more frequently than others. In particular, over 60% of professionals who engaged the public reported feeling especially confident in and actually implementing the practices of engaging young children, engaging adults, engaging audiences with nano and society content, and communicating nano research findings to the public. However, professionals were less likely to be using team-based inquiry (TBI), applying universal design, or engaging Spanish-speaking audiences, with less than 60% having done any of these individual practices as part of their nano education efforts (see Figure 34 for more details). Nonetheless, there is evidence to show that NISE Net supported professionals' use of all practices, as over 75% of respondents implementing any individual practice reported they used a NISE Net resource to help them (see Figure 35).

When describing why they were less likely to implement team-based inquiry, apply principles of universal design, or engage Spanish-speaking audiences, professionals regularly remarked that for all three, a lack of time kept them from applying these ideas. Moreover, for both TBI and universal design, professionals indicated how their lack of knowledge or misconceptions prevented them from integrating these practices into their work. Other barriers were unique to each practice, but again emphasized the individual or organizational nature of these challenges. For instance, when talking about why they could not implement TBI, professionals cited having roles or positions where they worked alone; in regard to engaging Spanish-speaking audiences,

professionals pointed out their inability to speak the language or acquire the resources to do translations.

Table 13. NISE Net public engagement practices and rates of use.

Used by 60% or more	Used by less than 60%	Professionals reported barriers to implementing practices such as…
• Engaging young children • Engaging adult audiences • Engaging audiences with nano and society content • Communicating to a public audience findings from the field of nano research	• Applying principles of universal design • Using team-based inquiry to incorporate evaluation into their work • Engaging Spanish-speaking audiences	• Lack of time/resources • Lack of knowledge or misconception • Not within their professional role • Not aligned with organizational goals

Note. In addition to these overarching barriers, there were also factors related to specific practices such as the inability to speak Spanish (for the practice of engaging Spanish-speaking audiences) or the lack of team members (for the practice of using team-based inquiry). Frequency of use comes from Year 10 survey responses whereas barriers are based on interview responses.

Discussion

Survey and interview data indicate that professionals used all of the types of products and practices that NISE Net provided in order to support and encourage implementation of nano. Indeed, it was clear that more Tier 1-3 professionals were engaging the public in nano after getting involved in the Network than before. Yet data also show that some of these products and practices were used more frequently than others, with usage of the hands-on activities and some of the more general practices, like engaging young children or engaging adults, being especially high.

One explanation for these results is that the Network placed positive value on partners' expertise in their own organization and educational setting and did not mandate that partners use certain types of products or practices. Findings reflect that the Network did not anticipate that professionals would incorporate every single product or practice into their work. Rather, the Network developed a variety of educational products for a wide range of settings expecting that organizations and individuals would pick and choose among the different formats, topics, and practices. The Network knew that partners would decide to use the ones that worked best for their own particular context, and in fact, changed some of the products and practices that they created to better fit the needs of Tier 1-3 professionals. Regardless, they also felt it was important to encourage all of these various areas of work as examples to the ISE field.

Even though the Network may not have anticipated that all partners would start using every product type or practice, it is important to point out that NISE Net tried to respond to the lower levels of adoption of some products and practices in several ways over the years. In some cases, the NISE Net changed course to develop more materials that partners reported they were implementing and desired (e.g. activities for younger children) and fewer of those that partners reported being unable to put in place (e.g. forums). Concerning the nano and society content, which was at first hard for professionals to understand and integrate into their programming, the Network devoted serious efforts to learning about partners' barriers and needs and then enacted various efforts to encourage implementation and use. For instance, the Network developed new products, professional development materials, in-person opportunities, and extended training resources and videos to respond to partners' obstacles and requests.

When further examining the barriers that professionals mentioned in regard to some of NISE Net's products and practices, it seems that these issues often had to do with individual circumstances and organizational factors, rather than the quality of the materials. Products and practices were deemed less applicable and/or more prone to implementation barriers if they were misaligned with professionals' organizational goals or audiences. At times, job responsibilities and staff- or space-related constraints also impeded professionals from implementing some of the more specific products and practices encouraged by the Network. Moreover, professionals may have felt that they were already using some of these practices to the extent needed for their organization. When it came to implementing TBI, for example, people may have felt that they had a previous evaluation system in place that suited their requirements and didn't need to turn to NISE Net materials in order to make adjustments.

Although data suggest that some practices and products were better aligned with the work of professionals than others, it was clear that NISE Net resources were helpful to the professionals who did use them. Not only do findings show that professionals often used NISE Net resources throughout the year and when implementing many of the Network's most commonly used practices, but it was evident that professionals found ways to modify or adapt them to their needs. Judging from the high number of professionals who felt confident and had changed NISE Net's products to fit their setting, it seems that the Network was able to offer useful and flexible resources for engaging the public in nano. Data from this study show that even though partners were not using all of the NISE Net products and practices, the Network was successful in providing resources to support professionals, as most individuals who had used information or materials from NISE Net indicated that they were beneficial.

NISE Net's decision to create easily adaptable resources was probably a main reason why so many professionals were doing more nano than before joining NISE Net; however, additional reasons may also play into this overall shift. For example, professionals' own context may have changed, thus, allowing them to bring in more nano content to their work. This may have been the case if organizations underwent change in terms of their mission and goals to become more STEM-focused or more aligned with addressing emerging science. Another contextual reason why professionals might have engaged the public in nano more by Year 10 could have been the fact that their job responsibilities shifted during their involvement with NISE Net facilitating this opportunity. Nonetheless, there is strong evidence that NISE Net's wide variety of educational products and resources related to practices facilitated engaging the public in nano.

Together these findings suggest that future projects might want to consider how to minimize barriers related to any products and practices being introduced to participants. For example, future projects might decide to focus their resources and efforts on the types of products that saw the highest use among professionals since these appear to have the lowest institutional barriers to adoption. Or perhaps, if aiming to convey some of the less commonly adapted practices, future projects might consider embedding concepts or methods into popular product types such as hands-on activities, media, and classroom activities. This evaluation also highlights the importance of investing resources such as additional professional development offerings to help professionals adapt less popular products or practices. Moreover, these findings indicate how necessary it is for future projects to be able to respond to participant feedback mid-project. Some of the high levels of professionals' use and understanding were no doubt tied to NISE Net's efforts to respond to areas where there were initially lower levels of adoption. Data from this study also underscore how vital it can be to create products that can be easily adapted by professionals in their own settings, as that surely contributed to the increased levels of public engagement with nano.

3. While the majority of NISE Net professional partners reported gains related to the Network's goals, Tier 2 and ISE professionals specifically reported positive change over time from their NISE Net involvement, especially concerning nano and society content.

As highlighted throughout the findings and in the following discussion, the *NISE Net Professional Impacts Summative Evaluation* provides evidence that Tier 2 and ISE professionals reported significant gains around aspects of the Network goals. In particular, although all participants indicated that NISE Net had a large impact, Tier 2 professionals and ISE professionals reported changes in terms of their nano and society work thanks to the Network.

Findings Supporting Discussion Point 3
Community and Collaboration • Over Years 8-10, ISE professionals' confidence in initiating a partnership increased, possibly because of NanoDays.
Learning about Nano Concepts • Over Years 8-10, Tier 2 professionals and ISE professionals became more confident in nano and society concepts and increased the extent to which they attributed NISE Net with that confidence.
Using Public Engagement Products • Over Years 8-10, the types of public engagement products used by all individual professionals was fairly consistent, but the content being covered shifted for Tier 2 and ISE professionals.
Using Public Engagement Practices • Over Years 8-10, Tier 2 professionals and ISE professionals became more confident in engaging adult audiences and engaging Spanish-speaking audiences. • Over Years 8-10, Tier 2 professionals and ISE professionals increased their audience engagement around nano and society content.

Summary of findings

When analyzing data, differences were seen in individuals' longitudinal results on several survey questions. These analyses, which explored results by tier or organization type, examined changes in how the same individual responded over Years 8-10. Overall, it was evident that professionals who were in Tier 2 or worked in ISEs had significant gains from the NISE Net over time, especially in regard to the nano and society practice encouraged by NISE Net.

Changes seen around **nano and society** indicate that professionals in Tier 2 became more confident in this content area over Years 8-10 and also showed increases in the extent to which they attributed this confidence to NISE Net. Similar results were seen over Years 8-10 among ISE professionals who, likewise, became more confident in concepts related to the societal implications of nano and increased how much they attributed this change to NISE Net (see Figures 19 and 20).

Not only did confidence around nano and society increase, but over Years 8-10, the percentage of Tier 2 professionals and ISE professionals who reported using this practice for engaging the public in nano also increased (See Figure 38). Furthermore, data from Years 8-10 regarding the extent to which professionals covered various nano content areas confirmed this finding. Both Tier 2 professionals and ISE professionals who engaged the public indicated that as part of their nano education efforts they had increased the proportion of time spent implementing nano and

society (see Figure 30). Thus, although product use was consistent during the final three years of the Network, these longitudinal findings further suggest that Tier 2 and ISE professionals saw positive changes around understandings, use, and implementation of nano and society content.

Interview data across Years 8-10 also indicate how some professionals overcame barriers related to learning and use of nano and society concepts in order to more frequently incorporate this content into their programming. As one professional said in her second interview, "While developing the outreach program, I learn[ed] more about future and potential innovations that scientists are currently working on. . . . Haven't been able to emphasize that before, but now with older children we are able to discuss and focus on it" [Y9, #11] (see 2.4 for further details and interview Vignette #6).

Besides nano and society, there were other areas related to practices and community in which Tier 2 and ISE professionals showed increases over time while individuals in other groups did not. For instance, over Years 8-10, Tier 2 professionals who engaged the public became more confident in engaging adult audiences and Spanish-speaking audiences, whereas these changes were not seen for professionals in other tiers (see Figure 37). ISE professionals who engaged the public also increased their confidence in these areas over time, although University professionals did not (see Figure 37 and Vignette #7). In regard to community and collaboration over Years 8-10, data indicate that ISE professionals' confidence also increased in initiating a partnership with an informal learning or research organization. All together, these data point to significant changes that Tier 2 and ISE individuals experienced.

Discussion

Because they were embedded in the structure of the Network, tier and organization types were the two main groupings used to explore potential differences among professional outcomes in the *NISE Net Professional Impacts Summative Evaluation*. Looking across the findings, it is clear that Tier 2 professionals and ISE professionals reported especially positive gains from their involvement with NISE Net. This is evident in all areas studied in this evaluation including community and collaboration, learning about nano concepts, and engaging the public using NISE Net products and practices, but especially in responses related to the practice of nano and society.

The fact that individuals in these groups reported higher gains from their NISE Net experience aligns with the way that the Network, especially over Years 6-10, provided resources and opportunities to professionals. While all professionals were encouraged to become involved with NISE Net to the extent that supported their own professional and organizational goals, NISE Net especially targeted Tier 2 organizations in an effort to support the infusion of nano education. The definition of the tiers clearly states that Tier 2 institutions are the primary recipients of Network resources and professional development efforts, including regional workshops, online workshops, and network-wide meetings.[16] The type of organization (ISE or University) also influenced how NISE Net provided resources. In general, NISE Net materials and products were focused on ISE professionals and intended for use with visitors to these institutions. There were professional development opportunities available for University professionals, but NISE Net focused less on this group because it was felt that ISE professionals would be the ones who would primarily be implementing public products.

[16] For further discussion of NISE Net's impacts on Tier 2, see Appendix A which highlights additional analyses related to this group.

The reasoning behind the Network's resource distribution helps explain why there may have been more longitudinal gains around nano and society concepts for individuals in Tier 2 and ISE. As was seen in the *Review of NISE Net Evaluation Findings: Years 1-5*, mid-way through the Network there was little evidence of use of this content by any group of partners (Kollmann, 2011). Yet starting in Year 8, this area became a major push for the Network. NISE Net added several nano and society-specific materials to their resource offerings and began covering this topic in-depth during in-person gatherings. And, although all professionals in Tiers 1-3 had access to the nano and society content that was posted on the website, Tier 2 professionals and ISE individuals may have been especially prone to pick up this information due to the factors described below.

To start, Tier 2 individuals may have been more likely to be exposed to nano and society concepts than individuals in other tiers because they received the bulk of the physical materials from NISE Net. Most NanoDays kits, for instance, were distributed to individuals in Tier 2. Thus, in later years, when the kits contained specific activities geared toward this content and a guide for practitioners devoted to nano and society, individuals in Tier 2 would have had more access to the physical materials. Tier 2 individuals were also typically the partners who were invited to the in-person gatherings and regional meetings where nano and society content was frequently highlighted. Moreover, a portion of Tier 2 professionals received extended professional development around this content when they were invited to one of several multi-day workshops on this topic. Taken together, these additional opportunities may have been reasons why Tier 2 professionals were especially affected by NISE Net in this area.

When considering explanations for why this content might have resonated more with ISE professionals than with University professionals, it could be that ISE professionals felt that the nano and society activities were an especially strong fit for their informal learning environments. NISE Net geared their activities toward these settings as compared to more formal academic environments, and ISE professionals may have recognized this focus and the utility of the resources. There is also the possibility that those in the field of informal science education felt less familiar with this information in general and benefited from the additional professional development and materials geared towards them. University partners, on the other hand, may have felt that they already knew about this topic and so they were not as likely to increase their implementation of this content over time. It is also possible that University partners, unlike informal science educators, when interacting with the public could have been more focused on sharing findings from their own research rather than touching on the examples of societal implications of nano provided by NISE Net.

Remembering the specific professional context of Tier 2 and ISE professionals can also help explain why there were other areas, in addition to nano and society, where these individuals saw significant gains. As explained above, NISE Net's overarching strategy of providing additional resources and opportunities geared towards Tier 2 and ISE professionals, as opposed to Tiers 1 and 3 and University professionals, certainly allowed individuals in these groups to have more frequent contact with the Network and obtain materials that were especially suited to their work. The ability of Tier 2 professionals to regularly interact with the Network to learn about best practices might help explain why individuals in this group saw increased confidence around engaging adult audiences and Spanish-speaking audiences. Another explanation could be that ISE professionals experienced gains in these areas because they felt the NISE Net resources could transfer to other areas of their work. Furthermore, because partnerships and collaborations are being heralded as important and vital in the ISE field, it makes sense that the NISE Net resources might have helped ISE individuals experience increased confidence in this

area. It is likely that ISE professionals felt they could apply information they had learned from NISE Net to other partnerships.

As these findings point out, NISE Net impacted the confidence of professionals in Tier 2 and ISE in a number of ways. However, it should be noted that data do not indicate significant changes over time in terms of Tier 2 or ISE professionals actually engaging adults or Spanish-speaking audiences or creating new partnerships. Barriers mentioned in interviews such as an inability to speak Spanish or a lack of time and resources kept individuals from doing more bilingual work or starting new collaborations. Moreover, the lack of change regarding adult engagement serves as a reminder that many NISE Net partners may have already been doing this work even before joining the Network, and change would have been unlikely in this area.

These findings suggest that future projects should consider how certain audiences may be impacted more than others simply due to the nature of the project design and set-up of offerings. They also point to how large-scale, targeted efforts, like NISE Net's work around nano and society, can sometimes have an extensive impact on participants who are able to take part in project opportunities and among professionals whose work is closely aligned. Findings specifically underscore how the NISE Net was able to have an impact on Tier 2 professionals' and ISE professionals' confidence regarding some of the practices. Other projects might want to consider the fact that changes in confidence did not necessarily translate to changes in practice for these individuals. When making decisions about potential outcomes and how to prioritize work, future projects can look to the lessons these data provide in regard to ways different audiences may or may not be impacted.

4. Evidence indicates that a range of NISE Net professional partners integrated aspects of NISE Net into their work that is unrelated to nano.

As highlighted throughout the findings and in the following discussion, the *NISE Net Professional Impacts Summative Evaluation* provides evidence that NISE Net impacted Tier 1-3 professionals' work in areas beyond nano.

Findings Supporting Discussion Point 4

Expanding Beyond Nano Content

- Tier 1-3 professionals reported that NISE Net has been valuable to their organizations and to themselves because the materials are models they can emulate.
- Tier 1-3 professionals reported that, as of Year 10, NISE Net has increased their organization's amount of partnerships on any topic, nano or otherwise.
- While Tier 1-3 professionals reported drawing on NISE Net information to implement any of the public engagement practices with content other than nano, ISE professionals were more likely than University professionals to do so for four practices: engaging young children, engaging adults, applying principles of universal design, or using team-based inquiry.

Summary of findings

Although the main emphasis of this study was on the achievement of NISE Net's short- to medium-term professional development goals focused on nano content, this evaluation also included questions about the Network's impact on professionals in other areas. Findings indicate that NISE Net resources and broader best practices were **transferable to a wide variety of work.**

Survey data show that not only did 77% of professionals value NISE Net for themselves "a great deal" or "a lot," but 79% felt similarly about the value of NISE Net to their organization as a whole (see Figures 39 and 40). During interviews, professionals commented that NISE Net materials, in particular, were valuable because they could be used as a model for how to put together other activities and how to teach staff facilitation techniques. As one individual explained, NISE Net materials

> *guided the amount and kind of information that we give to the public because I think NISE Net resources are very good at giving the facilitators an appropriate amount of background information and then boiling that down to the appropriate amount of information to share with the public. [Y10, #3]*

Besides providing insight into how to convey content, NISE Net materials also offered examples of useful formats and training techniques that could be appropriate for a variety of environments and topics.

Moreover, over 80% of respondents reported NISE Net had increased their partnerships or collaborations on various topics at least "somewhat" (see Figure 42). When discussing partnerships in the interviews, both ISE and University professionals talked about how NISE Net had provided useful information, valuable connections, and a reason for reaching out to others through events such as NanoDays.

Additional areas beyond nano where NISE Net had a major impact on professionals were in their communication of other STEM topics and in their use of public engagement practices with non-nano content. Over 90% of professionals felt that NISE Net had helped them communicate other STEM topics at least "somewhat" (see Figure 43). One scientist explained that her experiences connected with the Network helped her and her students learn how to "generally [deliver] science content, maybe engineering content, to a lay audience . . . [as well as] learning . . . how to convey information about my own work" [Y10, #20].

As seen in Figure 45, when describing their use of practices that were encouraged by the Network with non-nano content, the majority of professionals reported drawing on NISE Net information when engaging young children (65%), engaging adult audiences (56%), or engaging audiences with content related to the societal implications of science (50%). Even though other practices included in this study were integrated with less frequency into different areas of work, during interviews professionals sometimes talked about how they also used information about those practices. For instance, one professional said,

> *I think we've done a bit more of the team-based inquiry and evaluation. . . . I have the book that came out. I don't know how [or] where I got it, [perhaps] it was part of a kit, or something, and I know. I shared it with the staff. I developed some survey materials that I think probably must have referenced that at some point during the work of designing the materials. I remember. . . looking at the book and trying to see if it would provide me with some guidelines for how to design my study. [Y10, #13]*

All together, these data show that NISE Net impacted professionals in many ways outside of nano.

Discussion

While it was beyond the scope of this study to document the long-term impacts of the Network, questions were added to explore NISE Net's effect on professionals in areas unrelated to nano.

Ultimately, data supported the fact that NISE Net impacted professionals' work beyond nano in a variety of ways.

One reason why information from NISE Net may have transferred so well to other topics and been so highly valued is that NISE Net implemented techniques that could be expanded to any type of content. For instance, NISE Net products offered strong examples of how to present STEM concepts and societal and ethical considerations in a clear, understandable manner. Additionally, NISE Net products included formats that were applicable to many settings and audiences. The Network also created resources related to various public engagement practices, such as applying principles of universal design and engaging Spanish-speaking audiences, which could be called upon when presenting content other than nano. These strategies developed over the course of the Network and often grew in response to partners' requests and needs for more resources in different areas. Furthermore, NISE Net's NanoDays event may have been an especially successful initiative for helping individuals make professional connections that could be easily expanded. After working together for this public engagement experience, it is reasonable that individuals would find ways to partner around other areas of mutual interest.

Another explanation for why the NISE Net may have been able to influence professionals' work more broadly was that the Network encouraged partners to integrate nano into activities they were already doing. NISE Net used a Creative Commons license and advocated for partners to modify and adapt materials. The Network also readily made connections with other topics to help professionals incorporate NISE Net-created activities with other areas of work. At first, this strategy helped professionals who were new to nano education find ways to convey this content, but, in the end, it may have been especially appropriate for expanding the impact of NISE Net. The fact that the majority of Tier 1-3 professionals reported modifying a NISE Net product by incorporating it into an existing program, and over one-third of Year 10 respondents reported developing a new nano education product provides further evidence of the kinds of far-reaching impacts that are possible when professionals are able to use materials and build on them as they see fit.

These findings suggest that other projects should think carefully about the strategies and techniques they are applying when creating products and professional development opportunities. By implementing methods or encouraging connections that can expand beyond the content or material at hand, the project actually may be able to have a greater impact on professionals' work.

Conclusion

Findings from this summative evaluation study show that NISE Net was able to impact its Tier 1-3 professional partners in a number of ways. Not only did professionals experience increase in their sense of community and learning, but they also used products and practices from NISE Net to enhance their nano and non-nano work. In terms of community, main findings indicate that after being involved in the Network, the majority of professionals in Tiers 1-3 reported an increased sense of identity with a broader group of museum professionals and scientists. They valued the opportunities NISE Net offered for involvement and found the Network to be welcoming and supportive. Professionals also felt confident in initiating partnerships; the majority partnered with others and used NISE Net resources during these efforts.

Responses similarly show that NISE Net had a major impact on Tier 1-3 professionals' learning about nano. As of the final year of the Network, the majority of Tier 1-3 professionals reported high levels of confidence in their understanding of these concepts and high ratings for the extent to which NISE Net affected their confidence. While professionals described using both NISE Net and outside resources to learn more about this content, they mentioned in particular the NanoDays kits, face-to-face meetings, and the NISE Net website.

When it came to engaging the public in nano, professionals indicated they were more likely to do so at the end of the Network than prior to their involvement. While data indicate that some Network products were used more frequently than others, the majority of Tier 1-3 professionals engaged the public through cart demonstrations and hands-on activities provided by NISE Net. It was common for professionals to use these throughout the year or to adapt a NISE Net product to fit their setting. Professionals were also confident about and implemented many of the public engagement practices encouraged by the Network, although some practices were used more than others. In particular, Tier 1-3 professionals were using NISE Net resources to engage young children, engage adults, convey nano and society content, and communicate nano research findings to the public.

Overall, the majority of all survey responses were positive regardless of tier or organization type. Still, data from Years 8-10 point out that Tier 2 professionals and those working in ISEs experienced significant gains. Professionals in Tier 2 and working in ISEs became more confident in nano and society concepts and increased the extent to which they attributed this confidence to NISE Net. Moreover, the percentage of Tier 2 professionals and ISE professionals who reported using the nano and society practice for engaging the public became higher. Individuals in these groups also reported increasing the amount of time they focused on societal and ethical implications of nano with their audiences.

Furthermore, findings highlight how professionals in all tiers and organization types experienced unanticipated impacts that related to their work beyond nano. Not only did partners report how valuable they found the Network for themselves and for their organizations, they also described how NISE Net's resources and materials were especially useful models when creating other activities. Likewise, professionals stressed that NISE Net had affected how they do additional types of work, such as forming general partnerships or enhancing their communication of other STEM topics. Professionals indicated that for these areas of work, the Network provided valuable connections and useful resources that were aiding them beyond their Network participation.

Together, data from this evaluation underscore the large impacts NISE Net had on professionals in terms of their nano and non-nano areas of work. These findings help emphasize the potential of networks to achieve a variety of professional impacts. Specifically, this information may be useful to other networks hoping to impact their partners' feelings of community, learning, and use of products and practices. More broadly, this report suggests that further study concerning professionals' nano and society work or use of products and practices after the NISE Net ends would enrich the ISE field.

References

2012 Annual Partner Survey. (2012). *Context document & summary results from close-ended questions*. Portland, OR: NISE Network.

2013 Annual Partner Survey. (2013). *Context document and summary results from close-ended questions*. Portland, OR: NISE Network.

2014 Annual Partner Survey. (2014). *Context document and summary results from close-ended questions*. Portland, OR: NISE Network.

Bequette, M., Ostman, R., Ellenbogen, K., Petersen, G. Z., Porcello, D., Livingston, T., et al. (2012). *Nanoscale science informal learning experiences: NISE Network content map*. Boston, MA: NISE Network.

Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International journal of qualitative methods*, *5*(1), 80-92.

Kollmann, E. K. (2011). Engaging the public with societal and ethical implications content through NISE Network products *Review of NISE Network Evaluation Findings: Years 1-5* (pp. 78-113). Boston: NISE Network.

Morgan Alexander et al. (2012). *A study of communication in the Nanoscale Informal Science Education Network*. Boston, MA: NISE Network.

Nelson, A. G., Morgan, J., Reich, C., & Goss, J. (2011). Connecting ISE professionals with nano informal science education *Review of NISE Network Evaluation Findings: Years 1-5* (pp. 18-43). Boston: NISE Network.

NISE Network. (2011a). *About the NISE Network*. Retrieved from http://www.nisenet.org/about

NISE Network. (2011b). *NISE Network website homepage*. Retrieved from http://www.nisenet.org/

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

Rennie, L. J., & Johnston, D. J. (2007). Visitors' perceptions of changes in their thinking about science and technology following a visit to science center. *Visitor Studies*, *10*(2), 168-177.

Svarovsky, G., Goss, J., Ostgaard, G., Reyes, N., Cahill, C., Auster, R., et al. (2013). *Summative study of the Nano mini-exhibition*. St. Paul, MN: NISE Network.

Appendix A: Findings from the Tier 2 Focused Analyses

In addition to studying the impacts on all professionals involved in the Network, the *NISE Net Professional Impacts Summative Evaluation* included a series of focused analyses on professionals from Tier 2 organizations. Tier 2 was selected, as these organizations are the primary recipients of Network resources and professional development efforts.[17] In collaboration with NISE Net leadership, it was determined that data collected about these individuals through this study would be examined based on three types of NISE Net involvement: NanoDays, mini-grants, and face-to-face meetings.[18]

Analyses

This study assumes that the individual who completed the NanoDays report or the mini-grant report is the person most impacted by these efforts. The NISE Net database tracks NanoDays and mini-grants at the organizational level. This is reasonable, as NanoDays is an organization's public event and mini-grants support an organization's initiatives to engage audiences in a new way. While these often include more than one professional per organization, there is frequently a main contact who plans these initiatives and serves as a primary contact between NISE Net and the organization. In order to identify the individual who had been most impacted by these offerings, this evaluation used the Record ID of the individual who completed the NanoDays report or the mini-grant report. These reports are required after hosting a NanoDays event or after completing a mini-grant, and "typically the person who filled out the NanoDays report also organized the NanoDays event" and "typically the person who led the [mini-grant] project filled out the [mini-grant] report" (personal communication with Network leadership, September 3, 2014).

The evaluation study team defined which face-to-face meetings should be included in these analyses in collaboration with NISE Net leadership. Meetings were included if they were intended to impact attendees' achievement of the NISE Net Professional Development Goals, if they were intensive experiences occurring in person, and if they occurred prior to the final Annual Partner Survey (i.e. before November 2014). A full list of the 43 meetings used for this study is at the end of this appendix section.

For the Tier 2 focused analyses, this study investigated the following comparisons:

- NanoDays: Individuals who completed one or more NanoDays reports vs. Individuals who never completed a NanoDays report
- Mini-grants: Individuals who completed one or more mini-grant reports vs. Individuals who never completed a mini-grant report
- Face-to-face meetings: Individuals who attended one or more meetings vs. Individuals who never attended a meeting

[17] For a full description of the NISE Net tiers, please see the Introduction section of this report.
[18] Between Years 6-10, the NISE Network provided a total of 193 mini-grants. Over the course of eight NanoDays (Year 3-Year 10), the Network distributed 1,650 kits to 468 unique organizations. A full list of the 43 meetings used for this study can be found in Table A6.

Survey Respondents

Table A1. Tier 2 professionals' organization type.

Org Type	# of Respondents	%
ISE	140	72%
University	55	28%

Table A2. Number of NanoDays events hosted by Tier 2 professionals.

# of NanoDays	# of Respondents	%
0	90	46%
1 or more	105	54%

Table A3. Number of mini-grants by Tier 2 professionals' organization type.

# of Mini-grants	# of Respondents	%
0	142	73%
1 or more	53	27%

Table A4. Number of meetings attended by Tier 2 professionals' organization type.

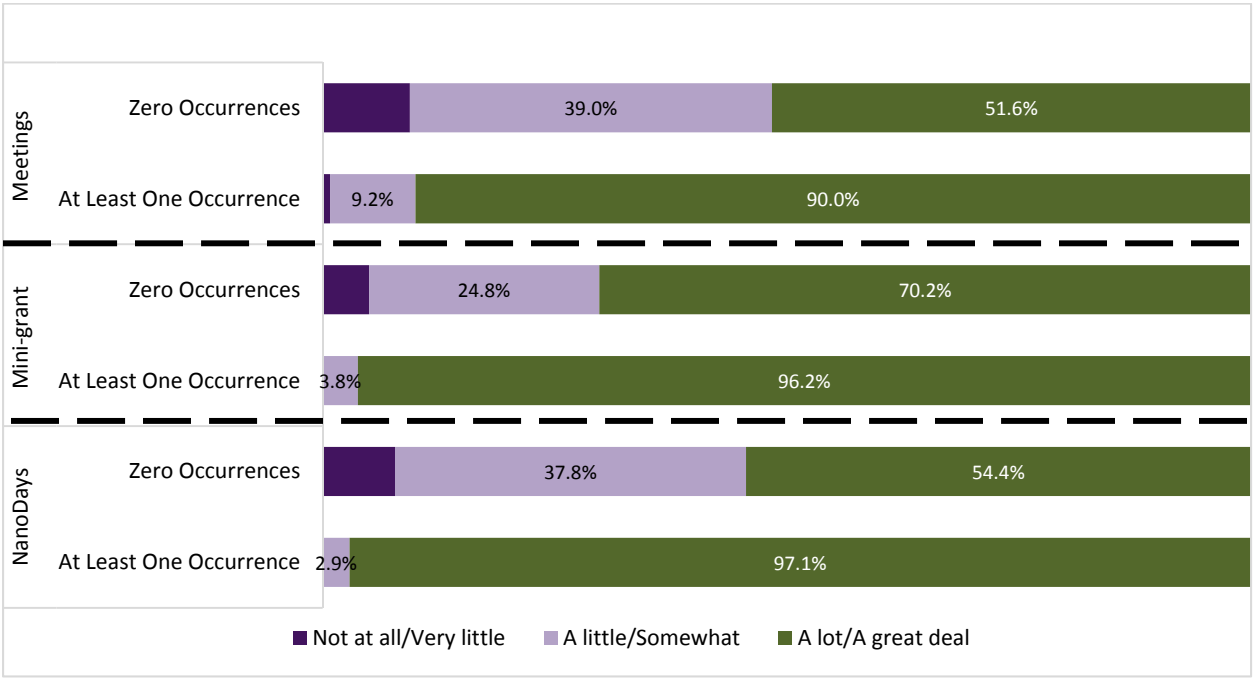
# of Meetings	# of Respondents	%
0	65	33%
1 or more	130	67%

Findings from the Tier 2 Focused Analyses

Involvement with NanoDays, mini-grants, and face-to-face meetings corresponded with higher ratings of NISE Net's value.

The survey asked professionals how valuable the NISE Net has been to them individually. When responding about NISE Net's value to themselves, Tier 2 individuals who reported on one or more NanoDays, one or more mini-grants, or attended one or more face-to-face meetings, were more likely to respond in the higher categories. This suggests that these aspects of NISE Net involvement have a relationship with the sense of overall value that Tier 2 professionals feel about NISE Net.

Figure A1. How valuable has the NISE Network been to you individually? (n=194)*

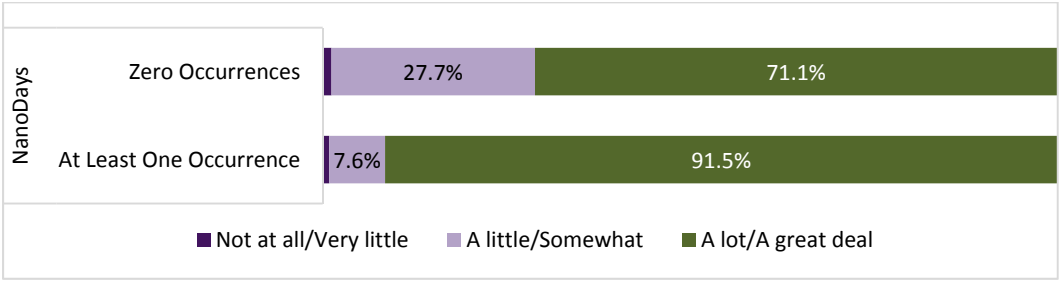


* Chi-square Tests. See Instrument Appendix #42 for item format and Technical Appendix for analysis notes.

Involvement with NanoDays corresponded with a stronger identification with the NISE Net community.

The survey asked professionals the extent to which they identify with a broader community that includes both scientists and museum professionals. Tier 2 individuals who reported on one or more NanoDays were more likely to respond in the higher categories. This suggests that this aspect of NISE Net involvement has a relationship with the sense of community that Tier 2 professionals feel about NISE Net.

Figure A2. Now that you are involved with NISE Net, to what extent do you identify with a broader community that includes both scientists and museum professionals? (n=195)*



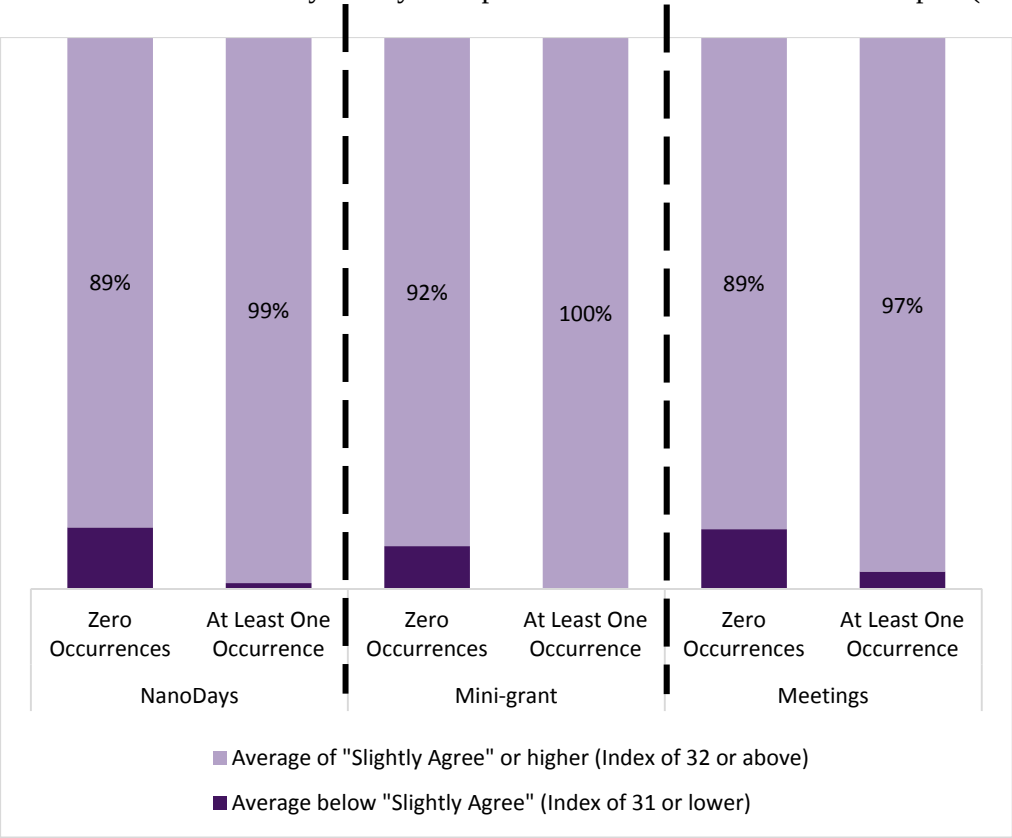
* Chi-square Tests. See Instrument Appendix #12 for item format and Technical Appendix for analysis notes.

Individuals involved with NanoDays, mini-grants, and face-to-face meetings were more likely to feel confident in their understanding of nano concepts and attribute that confidence to NISE Net.

The survey asked professionals about their confidence in their ability to explain eight different nano concepts to another adult, as well as how much NISE Net has affected that confidence. An

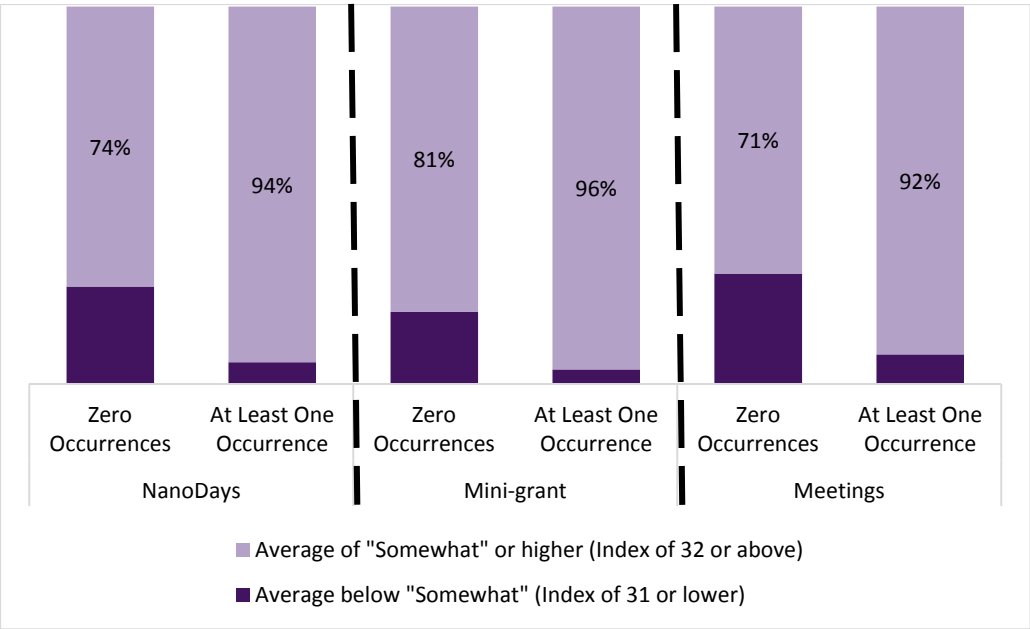
index of these responses was created by aggregating responses across the eight concepts. All three types of involvement being analyzed correspond with both higher average confidence ratings and higher average ratings of NISE Net attribution.

Figure A3. I feel confident in my ability to explain to another adult nano concepts. (n=195)*



* Mann-Whitney *U*-Tests. See Instrument Appendix #20 for item format and Technical Appendix for analysis notes.

Figure A4. How much has NISE Net affected your confidence in explaining to another adult nano concepts? (n=194)*



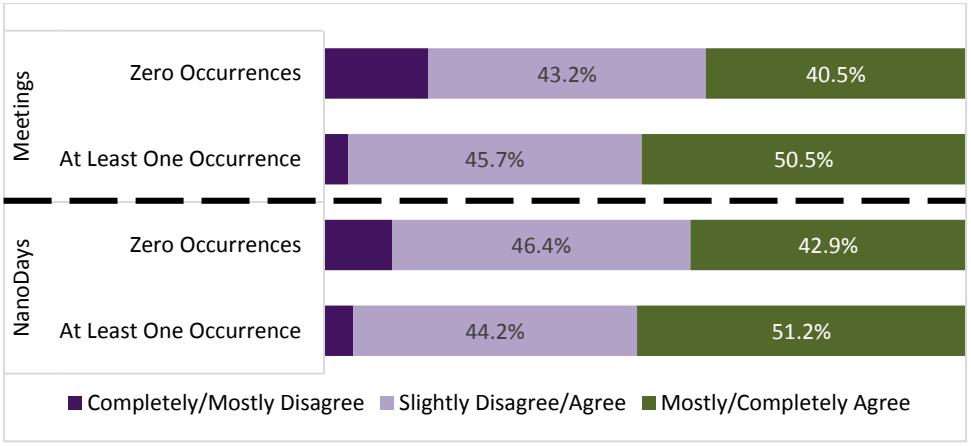
* Mann-Whitney *U*-Tests. See Instrument Appendix #21 for item format and Technical Appendix for analysis notes.

Involvement with NanoDays or face-to-face meetings corresponded with higher confidence ratings about applying principles of universal design, while involvement with NanoDays also corresponded with higher confidence in one's ability to initiate a partnership.

The survey asked professionals several questions related to practices that NISE Net promoted and disseminated. Some of these related to nano education specifically, such as "engaging audiences with nano and society content" or "communicating to a public audience findings from the field of nano research." Many practices that were included on the survey could extend beyond nano education, such as "engaging young children," "engaging adult audiences," or "using team-based inquiry to incorporate evaluation into my work."

When exploring differences based on involvement with NanoDays, mini-grants, or face-to-face meetings, it was found that there was a difference in Tier 2 professionals' responses about their confidence in their ability to apply principles of universal design. This occurs with NanoDays involvement and meeting attendance. Individuals who had never reported on a NanoDays event were more likely to completely disagree with their confidence than those who had reported on one or more NanoDays events. Additionally, individuals who had never attended a meeting were more likely to completely disagree with their confidence in applying universal design than those who had attended one or more meetings.

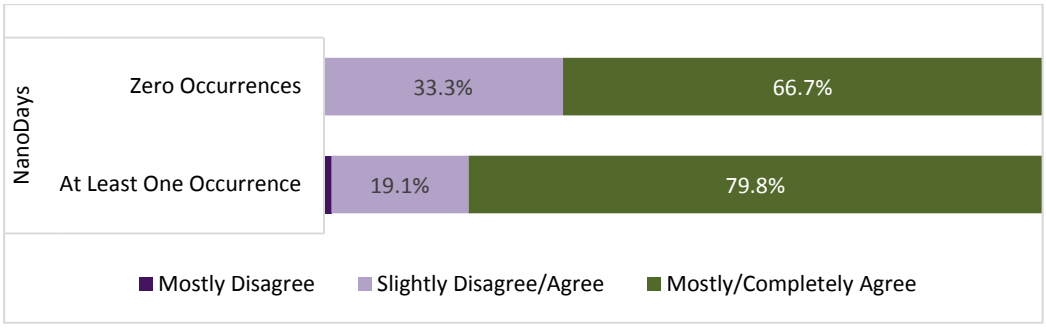
Figure A5. As part of my nano education efforts, I feel confident in my ability to. . .
d) Apply principles of universal design. (n=142)*



* Chi-square Tests. See Instrument Appendix #25d for item format and Technical Appendix for analysis notes.

Involvement with NanoDays is also related to higher ratings of confidence in initiating a partnership with an informal learning or research organization. Individuals who had reported on one or more NanoDays events were more likely to completely agree with their confidence when compared with individuals who had never reported on a NanoDays event.

Figure A6. As part of my nano education efforts, I feel confident in my ability to. . .
h) Initiate a partnership with an informal learning or research organization. (n=154)*



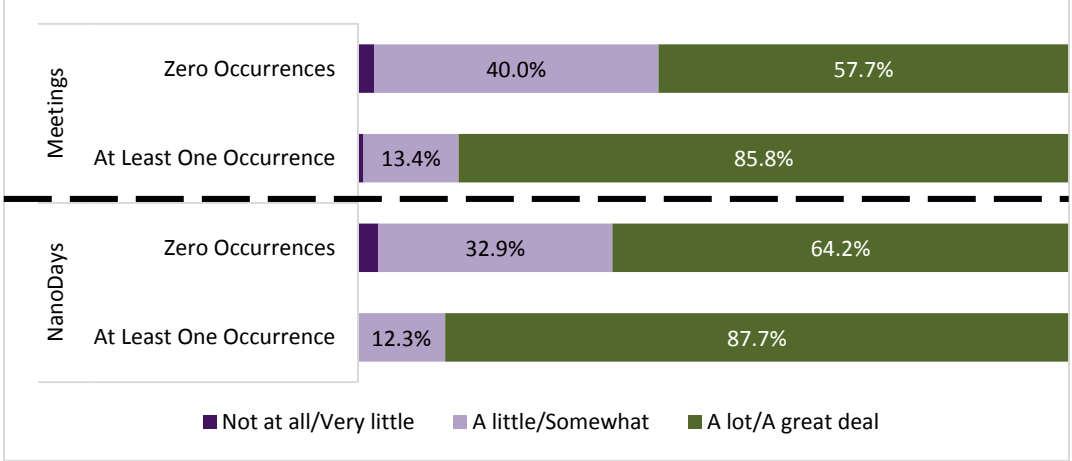
* Chi-square Tests. See Instrument Appendix #25h for item format and Technical Appendix for analysis notes.

In addition to exploring differences about professionals' confidence in implementing practices, this series of analyses also examined potential differences for the survey question asking whether professionals had implemented the practice. This question asked, "As a part of your nano education efforts, have you done any of the following: [list of 8 practices]" with options of yes, no, or not applicable. There were no differences found for any of the practices based on any of the three types of involvement.

Involvement with NanoDays and face-to-face meetings corresponded with a higher rating of how much NISE Net helped an individual communicate any science, technology, engineering, and math.

The survey asked professionals the extent to which NISE Net has helped them communicate any science, technology, engineering, and math (STEM) with the public. Tier 2 individuals who reported on one or more NanoDays events, one or more mini-grants, or attended one or more face-to-face meetings, were more likely to respond in the higher categories. This suggests that these aspects of NISE Net involvement have a relationship with the perception that NISE Net has helped with STEM communication skills.

Figure A7. To what extent has NISE Net helped you communicate any science, technology, engineering, and math with the public? (n=164)*



* Chi-square Tests. See Instrument Appendix #30 for item format and Technical Appendix for analysis notes.

Discussion of the Tier 2 Focused Analyses

The types of involvement included in these focused analyses (reporting on one or more NanoDays events, reporting on one or more mini-grant projects, and attending one or more face-to-face meetings) aligned with higher ratings about the overall value of the NISE Net, professionals' sense of community, and professionals' understanding of nano concepts and NISE Net attribution of that understanding. In addition, both NanoDays and face-to-face meeting attendance correspond to higher confidence in two to three of the practices being promoted by the Network. The following chart identifies instances where significant differences were found between groups.

Table A5. Instances where significant differences were found between individuals with zero occurrences and one or more occurrences of meeting attendance, mini-grant reporting, and NanoDays reporting.

	NanoDays	Mini-grants	Meetings
NISE Net value to the individual	✓	✓	✓
Sense of community	✓		
Confidence in explaining nano	✓	✓	✓
Attributing to NISE Net confidence in explaining nano	✓	✓	✓
Confidence in implementing practices	✓ • Universal Design • Initiating a partnership		✓ • Universal Design
Implementing practices			
NISE Net helped communicate any STEM	✓		✓

Taken together, this suggests that any of these three types of involvement have a relationship with higher achievements of the NISE Net professional development goals. In particular, NanoDays events and meetings were impactful across a number of professional impacts goals. However there were fewer statistically significant differences between mini-grant recipients and non-recipients. This may be because these projects are quite varied and might not have focused on the public engagement practices included in the survey questions.

Key Takeaway

Tier 2 professionals who are reporting on one or more NanoDays events, one or more mini-grant projects, or attending one or more NISE Net meetings often correspond with higher achievement of NISE Net professional development goals.

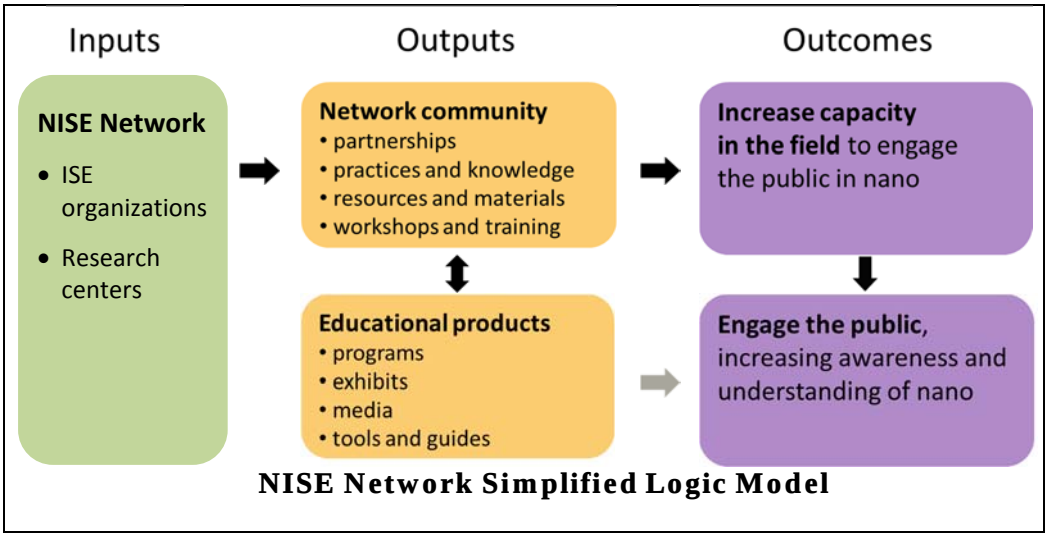
Table A6. List of Meetings included in Tier 2 analyses

Meeting Name	Date
Year 1 Annual Meeting	2005-11
Year 2 Annual Meeting	2006-11
Regional Workshop 2007 – Oregon Museum of Science and Industry	2007-07
Regional Workshop 2007 – Museum of Life and Science	2007-09
Year 3 Annual Meeting	2007-11
Regional Workshop 2008 – Science Museum of Minnesota	2008-08
Regional Workshop 2008 – Museum of Life and Science	2008-08
Regional Workshop 2008 – Oregon Museum of Science and Industry	2008-09
Regional Workshop 2008 – Sciencenter	2008-09
Forum Workshop – The Franklin Institute	2008-10
Regional Workshop 2009 – The Franklin Institute	2009-01
Regional Workshop 2009 – The Lawrence Hall of Science	2009-01
Regional Workshop 2009 – Fort Worth Museum Science and History	2009-02
Year 4 Annual Meeting	2009-09
ACM 2010 Preconference Workshop: Children's Museums	2010-05
Year 6 Network Wide Meeting	2010-10
National Program Workshop 2011	2011-02
ACM 2011 Pre-conference Workshop	2011-05
Year 7 Regional Meeting – Mid-Atlantic – The Franklin Institute	2011-09
Year 7 Regional Meeting – Midwest – Science Museum of Minnesota	2011-09
Year 7 Regional Meeting – Northeast – Sciencenter	2011-09
Year 7 Regional Meeting – South – Children's Museum of Houston	2011-09
Year 7 Regional Meeting – Southeast – Museum of Life and Science	2011-09
Year 7 Regional Meeting – Southwest – The Lawrence Hall of Science	2011-09
Year 7 Regional Meeting – West – Oregon Museum of Science and Industry	2011-09
Nano and Society Pilot Workshop 2012	2012-03
Implementing the REU Science Communication Workshop	2012-06
Peer to Peer Learning Group – Inclusive Audiences 2012*	2012-07
Nano and Society 2012 workshop	2012-09
ASTC 2012 Pre-conference Workshop Really Great Programming	2012-10
Network-Wide Meeting 2012	2012-12
Bilingual Audiences Workshop	2013-06
Universal Design of Educational Programs	2013-07
Year 9 Regional Meeting – Mid-Atlantic – The Franklin Institute	2013-09
Year 9 Regional Meeting – South – Children's Museum of Houston	2013-09
Year 9 Regional Meeting – Southeast – Museum of Life and Science	2013-09
Year 9 Regional Meeting – Southwest –The Lawrence Hall of Science	2013-09
Year 9 Regional Meeting – Northeast – Sciencenter	2013-9
Year 9 Regional Meeting – Midwest – Science Museum of Minnesota	2013-10

Year 9 Regional Meeting - West – Oregon Museum of Science and Industry	2013-10
ASTC 2013 Pre-conference Workshop Team-Based Inquiry	2013-10
Sharing Science Workshop 2014	2014
Team Based Inquiry (TBI) Cohort	2014

*Note: The 2012 Inclusive Audiences Peer to Peer Learning Group did not occur in-person, but was included in this analysis as it was a focused and on-going virtual experience with a small subset of partners.

Appendix B: NISE Net Logic Model (Simplified and Full Versions)

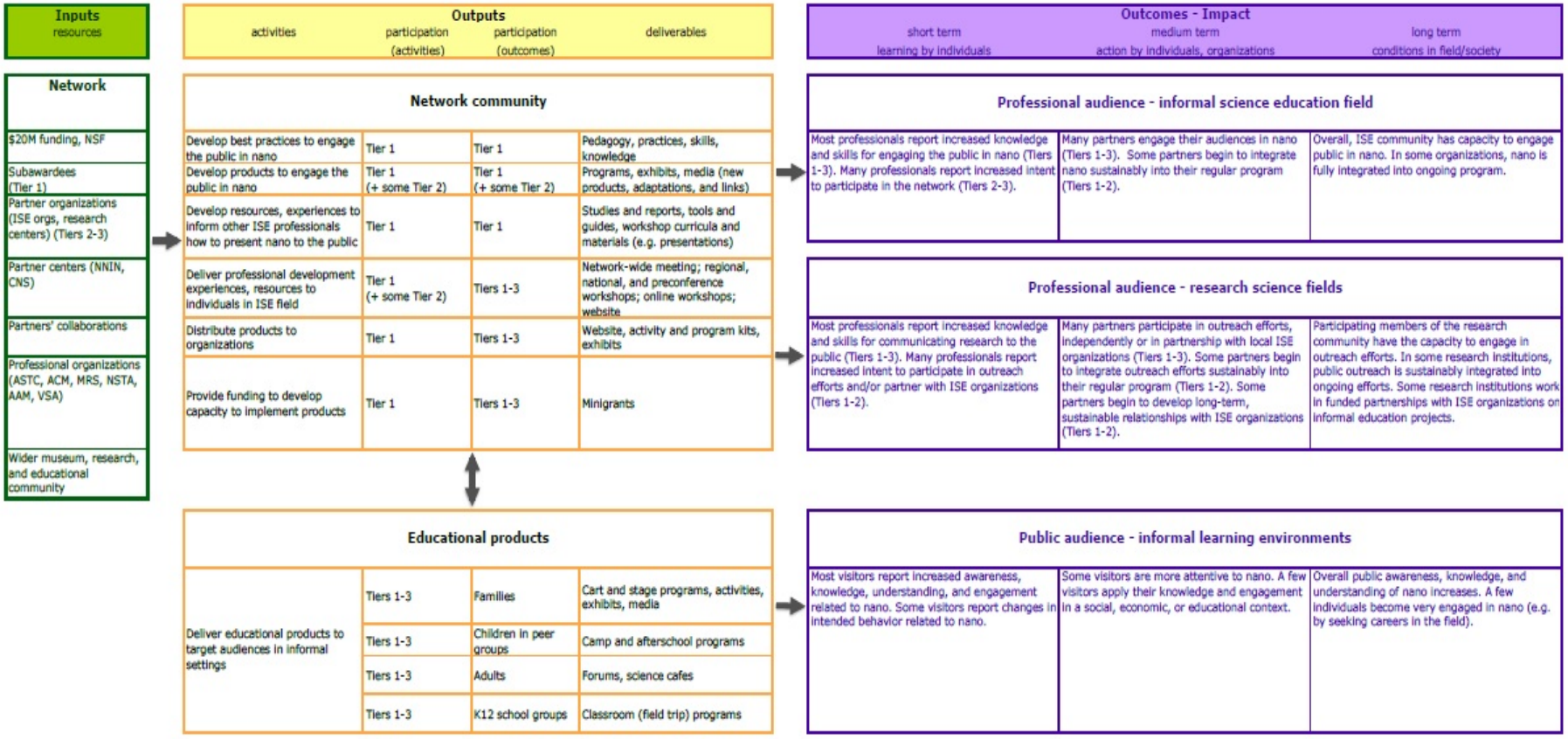


NISE Network Simplified Logic Model

NISE Net Logic Model Years 6-10

Overarching Network Goals

1. In partnership with the research community, develop the necessary capacities and resources to achieve a widespread, sustainable impact on the ISE field.
2. Engage the development and delivery power of the network community to raise the level of public awareness, engagement, and understanding of nanoscale science, engineering, and technology.



Inputs (resources)	Outputs: activities	Outputs: participation (activities)	Outputs: participation (outcomes)	Outputs: deliverables	Outcomes - Impact: short term (learning by individuals)	Outcomes - Impact: medium term (action by individuals, organizations)	Outcomes - Impact: long term (conditions in field/society)
Network	**Network community**				**Professional audience - informal science education field**		
$20M funding, NSF	Develop best practices to engage the public in nano	Tier 1	Tier 1	Pedagogy, practices, skills, knowledge	Most professionals report increased knowledge and skills for engaging the public in nano (Tiers 1-3). Many professionals report increased intent to participate in the network (Tiers 2-3).	Many partners engage their audiences in nano (Tiers 1-3). Some partners begin to integrate nano sustainably into their regular program (Tiers 1-2).	Overall, ISE community has capacity to engage public in nano. In some organizations, nano is fully integrated into ongoing program.
Subawardees (Tier 1)	Develop products to engage the public in nano	Tier 1 (+ some Tier 2)	Tier 1 (+ some Tier 2)	Programs, exhibits, media (new products, adaptations, and links)			
Partner organizations (ISE orgs, research centers) (Tiers 2-3)	Develop resources, experiences to inform other ISE professionals how to present nano to the public	Tier 1	Tier 1	Studies and reports, tools and guides, workshop curricula and materials (e.g. presentations)			
Partner centers (NNIN, CNS)	Deliver professional development experiences, resources to individuals in ISE field	Tier 1 (+ some Tier 2)	Tiers 1-3	Network-wide meeting; regional, national, and preconference workshops; online workshops; website	**Professional audience - research science fields**		
Partners' collaborations	Distribute products to organizations	Tier 1	Tiers 1-3	Website, activity and program kits, exhibits	Most professionals report increased knowledge and skills for communicating research to the public (Tiers 1-3). Many professionals report increased intent to participate in outreach efforts and/or partner with ISE organizations (Tiers 1-2).	Many partners participate in outreach efforts, independently or in partnership with local ISE organizations (Tiers 1-3). Some partners begin to integrate outreach efforts sustainably into their regular program (Tiers 1-2). Some partners begin to develop long-term, sustainable relationships with ISE organizations (Tiers 1-2).	Participating members of the research community have the capacity to engage in outreach efforts. In some research institutions, public outreach is sustainably integrated into ongoing efforts. Some research institutions work in funded partnerships with ISE organizations on informal education projects.
Professional organizations (ASTC, ACM, MRS, NSTA, AAM, VSA)	Provide funding to develop capacity to implement products	Tier 1	Tiers 1-3	Minigrants			
Wider museum, research, and educational community	**Educational products**				**Public audience - informal learning environments**		
	Deliver educational products to target audiences in informal settings	Tiers 1-3	Families	Cart and stage programs, activities, exhibits, media	Most visitors report increased awareness, knowledge, understanding, and engagement related to nano. Some visitors report changes in intended behavior related to nano.	Some visitors are more attentive to nano. A few visitors apply their knowledge and engagement in a social, economic, or educational context.	Overall public awareness, knowledge, and understanding of nano increases. A few individuals become very engaged in nano (e.g. by seeking careers in the field).
		Tiers 1-3	Children in peer groups	Camp and afterschool programs			
		Tiers 1-3	Adults	Forums, science cafes			
		Tiers 1-3	K12 school groups	Classroom (field trip) programs			

Appendix C: Goals for Professional Development

NISE Network Goals for Professional Development

May 4, 2011

The NISE Network is a community that aims to increase the capacity of the informal science education field to provide nanoscale science, engineering, and technology educational experiences to diverse public audiences. The fundamental purpose of the Network is to raise the level of public awareness and understanding of this emerging field of research. The Network provides different ways for partners to participate, appropriate to each organization's mission, capacity, and audience.

Overarching goal: Increase the **readiness of individual practitioners and the capacity of the field** of informal science education (ISE) to foster public awareness, understanding, and engagement with nanoscale science, engineering, and technology and its relationship with our lives, society, and environment ("nano").

As a result of participating in NISE Net professional development activities, professionals will:

1. Identify with a **broader community** that includes scientists and museums
   - Short-term: Professionals value networking opportunities offered by NISE Net.
   - Short- to medium-term: Professionals value participation in the Network and the opportunities for collaboration NISE Net offers.
   - Long-term: It is a norm in the ISE field to collaborate with other organizations.

2. Value local **research-ISE collaborations**
   - Short- to medium-term: Researchers and ISE professionals begin to collaborate on discrete nano-related projects.
   - Long-term: Research and ISE organizations create strong and lasting partnerships.

3. Understand and appreciate **key concepts** in nanoscale science, engineering, and technology and its relationship with our lives, society, and environment
   - Short-term: Professionals are aware of nano concepts.
   - Short- to medium-term: Professionals understand nano concepts.
   - Short- to medium-term: Professionals are enthusiastic about engaging their public audiences in nano.
   - Long-term: It is the norm in the ISE field to engage diverse public audiences in nano.

4. Understand **theories, methods, and practices** for effectively engaging diverse public audiences in nano
   - Short-term: Professionals are aware of theories of learning, educational methods, and effective practices for engaging the public in nano.
   - Medium- to long-term: Professionals apply theories of learning, educational methods, and effective practices when engaging the public in nano.

5. Utilize **professional resources and educational products** for engaging diverse public audiences in nano
   - Short-term: Professionals are aware of professional resources and public educational products for engaging the public in nano.
   - Short- to medium-term: Professionals have the tools, skills, and confidence to use, adapt, and create educational products for engaging the public in nano.
   - Long-term: Organizations integrate nano into ongoing ISE efforts.