NISE network
NANOSCALE INFORMAL SCIENCE EDUCATION

NISE NETWORK

Program Development

A Guide to Creating Effective Learning Experiences for Public Audiences

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www.nisenet.org

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Acknowledgements

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Introduction

The NISE Network

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"). The goals of NISE Net are to create a national community of partners to engage the public in nano, to develop and distribute educational experiences that raise public awareness and understanding of nano, and to generate knowledge about public and professional learning through evaluation and research.

NISE Net includes around 600 museums, universities, and other organizations. The Network is organized into regions, each with a regional hub leader that serves as the primary point of contact and provides advice, encouragement, and support to partners. Network partners work together to engage the public in new topics related to science, engineering, and technology. Collectively, our efforts give the Network broad reach to diverse public audiences across the United States.

Engaging the public

NISE Net's educational materials are designed to engage a wide range of audiences in learning about complex scientific content in ways that are fun and easy to understand. Our website, www.nisenet.org, offers hundreds of open-source educational resources that suit different educational contexts, engage diverse target audiences, and convey a range of content.

NISE Net educational experiences include programs for families, school groups, and other audiences that participate in learning experiences at museums, through university outreach, and in other informal settings. Our programs include educator-facilitated learning opportunities such as presentations, demonstrations, hands-on activities, and theater. Some incorporate media elements such as films, videos, graphics, and multimedia experiences. Others are designed to enrich or extend the learning opportunities offered through NISE Net exhibits.

Educators sharing a new program at a Network meeting

The Network develops our educational products collaboratively, taking advantage of the talents of educators and experts from science museums and research institutions across the country. Our development process includes peer review by educators, prototyping and testing with the target audience, and review by scientists and other experts. The resulting programs are used by museums, universities, and other organizations across the country.

About this guide

This guide offers a comprehensive overview of NISE Network programming, including development by a multi-organization team, implementation by hundreds of partners nationwide, and impact on public audiences. It offers a practical introduction to the approaches, methods, and tools the Network uses to ensure our programs provide effective learning opportunities.

Planning

NISE Net program development is part of a large, complex public engagement effort that includes multiple workgroups creating products for use by hundreds of partners. This guide shares some of the tools, ideas, and processes we have found useful, and which are transferable to different kinds of program development projects.

Development

The Network has adopted and established best practices in program development, including peer review, expert review, visitor testing, universal design, and inclusive approaches to multiple and diverse audiences. These practices are described in general terms and illustrated through specific case studies.

Implementation

NISE Net programs and professional resources are developed as open-source resources, and from the beginning are planned to work for a broad range of audiences and educational settings. The guide includes a number of "partner stories" to share the important and creative ways our partners have used and adapted our programs and resources.

Impact

The impact of the Network's programming efforts is documented through ongoing research and evaluation efforts. Here, we share some highlights of that work.

Tools and resources

The guide contains a variety of tools the NISE Net program development team has used through the years. We also provide a comprehensive list of the programming and professional resources the Network offers.

"When we got involved in NISE Net, we were just figuring out how to do science here at Marbles and how to collaborate with scientists and researchers out in the community. The structure of the activities and their resources has really been a model for us and for how we do science here at the museum."

- Hardin Engelhardt, Marbles Kids Museum

Planning

NISE Network programs are planned, developed, and disseminated by a team that includes members from museums and universities across the country. The ability to draw on educators and evaluators from many different organizations has given NISE Net great flexibility and depth of expertise in developing products. In addition, the integration of many different perspectives into the development teams provides insight into what kinds of programs, resources, and documentation are useful for our diverse partner organizations.

NISE Net's program development team regularly meets to plan out program work, brainstorm new ideas, and present in-progress programs to the group for constructive criticism and feedback. We generally use in-person team meetings (once or twice a year) to set direction and make major decisions. These meetings often include advisors from across the Network, or beyond, who give us new ideas and input on our work. Monthly phone and videoconference calls provide opportunities to check in and keep projects on track.

The Network also consults with educators from museums across the country to find out what they need, what they use, and how they modify our programs. This input helps us improve existing programs and prioritize new development work. In addition to the programs developed by NISE Net teams, many partners and other projects develop their own educational products. Some of these are also disseminated through the NISE Net website, either as NISE Net adaptations or in their original form.

As we plan our program development work, the NISE Net program team considers three different aspects: content, audience, and format.

"NISE Net has brought together institutions from all across the country to become one big group think tank. It has allowed us to collaborate with a very broad range of people, all of whom had different ideas, backgrounds, and understanding. It has children's museums, science centers, researchers, all of these partners working together towards a common goal."

- Keith Ostfeld, Children's Museum of Houston

Content

NISE Net programs engage the public in learning about nanoscale science, engineering, and technology (or "nano" for short). To guide the development of all our educational products, NISE Net created a content map that identifies important concepts for engaging the public in nano, and a learning framework that describes the kinds of learning opportunities that we value (Bequette et al., 2012; Ellenbogen et al., 2012; Sciencenter, 2011). Each program has defined *learning objectives* that relate to these tools.

Key concepts

NISE Net has identified four key concepts for engaging the public in nano:

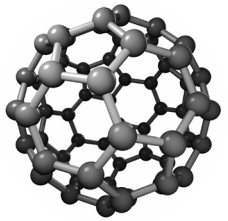
1. **Nano is small and different:** Nanometer-sized things are very small, and often behave differently than larger things do.

2. **Nano is studying and making tiny things:** Scientists and engineers have formed the interdisciplinary field of nanotechnology by investigating properties and manipulating matter at the nanoscale.

3. **Nano is new technologies:** Nanoscience, nanotechnology, and nanoengineering lead to new knowledge and innovations that weren't possible before.

4. **Nano is part of our society and our future:** Nanotechnologies—and their costs, utility, risks, and benefits—are closely interconnected with society and with our values.

Learning Principles



The Network focuses on engaging the public in three learning principles, described in terms of the kinds of activities visitors do when they participate in our exhibits, programs, and media:

1. Imagining the nano world

- Explore the relative size of macroscale, microscale, and nanoscale objects
- Use tools (or models of tools) that allow us to investigate the nanoscale world
- Examine magnified images and models of the nanoscale world
- Talk about how we can apply our knowledge of the nanoscale world to create new technologies

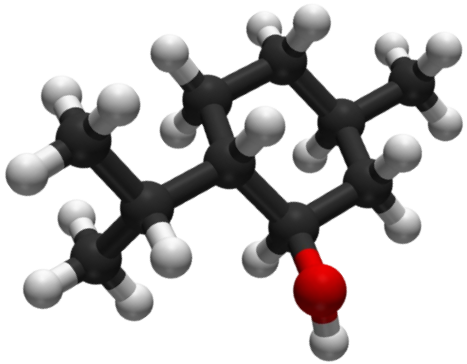
2. Exploring scale and properties

- Observe phenomena demonstrating the relationship of scale, properties, and forces
- Manipulate materials and explore the resulting changes
- Reflect on the nanoscale world and how it works differently from the human scale world
- Consider how knowledge about the nanoscale allows us to create new materials and technologies

3. Connecting nano and society

- Recognize that nanotechnologies may help us solve problems that traditional technologies cannot

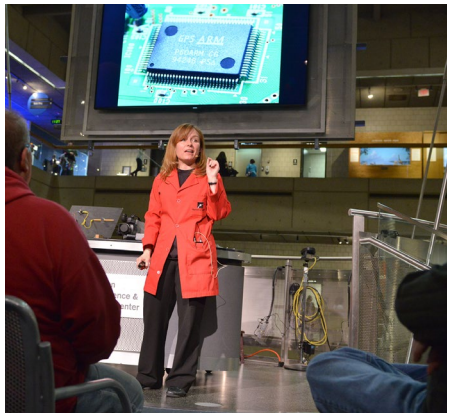
- Envision a future in which nanotechnologies are an important part of our everyday lives
- Evaluate the responsible development of nanotechnologies by considering values, risks, and benefits
- Discuss the role of individuals and groups in shaping the development of emerging technologies



Audience

NISE Net programs are designed in a variety of formats suitable for different educational settings and audiences. The Network has also developed products and practices that increase the capacity of our partners to reach out to and engage underserved audiences.

Each program has a defined *target audience,* and many include tips for implementing the program with various audiences or adapting it for different audiences. To help make our programs accessible for and inclusive of diverse individuals and groups, NISE Net has created a variety of resources, including a universal design guide for public programs in museum settings (Johnson et al., 2011b; Museum of Science, 2010).



Public audiences served by the Network include:

- **Family groups:** One or more adults and one or more children participating in free-choice learning
- **Adult-only groups:** One or more adults without children participating in free-choice learning
- **Younger children:** Children ages 8 and younger
- **Out-of-school time program participants:** School-aged children participating in group programs outside the classroom (such as afterschool programs and camps)
- **School groups:** Groups of school-aged children participating in a program led by an informal education institution (such as a class field trip to a museum or university, or an outreach visit to the classroom by an informal educator)

NISE Net provides tools and support for engaging many underrepresented audiences in STEM learning:

- **Spanish-speaking audiences:** Spanish is the second most commonly spoken language in the United States
- **People with disabilities:** Currently, one in five Americans has a disability, including users of wheelchairs, individuals with low dexterity, individuals who are blind, visually impaired, deaf, or hearing impaired, individuals with learning disabilities, and individuals with developmental disabilities

- **Girls:** Despite many gains in closing the gender gap in STEM achievement in K-12 education, girls and women continue to be underrepresented in key areas of STEM studies and careers
- **Ethnic minorities underrepresented in STEM:** African Americans, Native Americans, and Latinos are underrepresented in STEM areas

Format

NISE Net programs are designed for different settings and groups. To ensure that our programs are useful and usable by our many partner organizations, we asked partner museums and universities across the country about the kinds of programming they most often implement. Each program is categorized according to common program types, which often help determine its length, the size of the group it is designed for, and the space where it is offered.

The NISE Net Program team works to create a balanced portfolio of programs. To encourage widespread and sustained use, NISE Net products are designed to work well for different kinds of organizations and to be integrated into partners' ongoing activities. We have focused our efforts on the most essential content for exploring nano, including foundational knowledge; the core audiences that our partners serve, particularly families and school groups; and the formats that our partner organizations most commonly implement, such as brief hands-on activities. We have rounded out the portfolio with more challenging content, additional target audiences, and innovative formats. In addition to balancing content, audiences, and formats within our program portfolio, the team also considers how our programs complement the Network's other educational products, such as exhibits and media.

PROGRAM FORMATS

NISE Net programs are designed in a variety of formats, which are suitable for different organizations and audiences

Hands-on activities

Stage programs

Classroom programs

Museum theater

Forums and science cafés

Open-ended conversations

Tips for program planning

Think big picture

Always consider content, audience, and format together. What kind of experience will best accomplish your learning goals for given audiences? Of course, you also have to take into account the constraints of your resources. It can be helpful to clarify which aspects of a program are most important or "non-negotiable," and which aspects are flexible. Often, format and audience are closely connected.

Weigh the trade-offs

NISE Net has developed hundreds of programs in a variety of formats, and each one suits its purpose. The feedback we've received from partners on how they use various programs indicates:

- If you're looking for maximum use and flexibility, consider developing a collection of brief activities and demos. Short programs encourage strong visitor learning, and are great building blocks for longer programs.
- When program formats fit into the ongoing structure and schedule of the public programs or education team, they can be very effective in reaching diverse and large audiences.
- More unusual or innovative formats can stretch your team's skills and repertoire, but they may be harder to implement regularly and therefore may have less of an impact on the public.

Remember the context

Keep in mind the ways that programs and activities enrich, complement, and incorporate other learning experiences, such as exhibits and media, and other programs. Programs may be completely self-contained, or they may refer to other experiences such as nearby exhibits. Think through these connections as you develop your programs, so that you can reinforce and deepen learning opportunities and avoid redundancies and gaps.

Get bang for your buck

Consider ways to create flexible assets that can be used across different modes of engagement, maximizing your resources and creating connections for visitors. For example, if you invest in creating a core set of graphics, you can use them in exhibits, programs, books, posters, and videos.

Development

To develop our educational materials, the Network consistently uses a rigorous process that includes *peer review, expert review, visitor testing,* and *partner feedback*.

Peer review

Members of the NISE Net program team provide advice and suggestions at all critical stages of program development. This includes offering input into content, format, and audience at a preliminary planning stage and providing feedback on a prototype (draft) program before it is finalized. Some programs, such as NanoDays activities, are also tested with visitors by additional staff and volunteers at a different organization to get a fresh perspective on nearly final program materials before they are distributed. Periodic development workshops, regular virtual meetings, and a variety of content-sharing mechanisms help the program group keep in touch and review work in progress.

Program critique questions

During NISE Net program critiques, a group of educators reviews in-progress programs. This supportive process considers the following questions:

1. Does the program meet its objectives?
2. Is the program well designed?
3. Is the program relevant and engaging?
4. If you were going to revise this program, what would you do?

Expert review

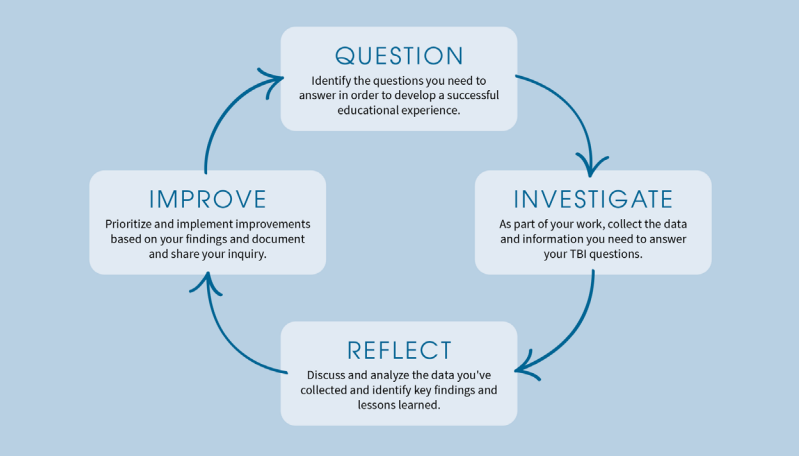
NISE Net programs are reviewed by an appropriate expert, such as a scientist, to ensure the content is accurate. Additional experts might also provide feedback on pedagogy, universal design, cultural relevancy, or other aspects of the program. The experts review all the program materials: the lesson plan, guide, or talking points, as well as any graphics, props or other materials used during program delivery. Sometimes experts are involved throughout the development process, helping with all aspects of a program from learning objectives to materials and supplies; other times they review a program when it is underway.

Visitor testing

NISE Net programs are tested with visitors to evaluate them against learning and engagement objectives and to work out pedagogical, practical, and logistical aspects of the program's structure and materials. The results of visitor testing are used to improve the next iteration of the program. NISE Net has used more than one formative evaluation approach: a visitor testing process led by program evaluators, and team-based inquiry where small groups of educators facilitate visitor testing with the support of evaluation mentors.

Partner feedback

NISE Net programs are planned and improved based on input from our extended group of partners across the country. Partners share information through many channels: from discussions at NISE Net meetings, through reports and evaluation, through site visits and conversations with regional hub leaders, and through personal relationships. We seek advice on our overall scope of work, as well as specific initiatives and programs. We also encourage all partners to adapt NISE Net programs to fit the needs of their organization and audiences, and to share the results with others in the Network.



Source: Team-based inquiry: A practical guide for using evaluation to improve informal education experiences (Pattison, Cohn & Kollmann, 2013).

Best practices

The NISE Network has modeled and disseminated effective practices for the development, delivery, and evaluation of educational programs in informal settings. This work has included creating and sharing inclusive approaches for engaging diverse audiences.

Team-based inquiry approach (TBI)

Team-based inquiry is a practical approach to empowering education professionals to get the data they need, when they need it, to improve their products and practices. Ultimately, TBI helps educators to engage public and professional audiences more effectively. The TBI process involves an ongoing cycle of inquiry.

Universal design guidelines

NISE Net's universal design guidelines offer three guiding principles to make programs inclusive of a wide spectrum of learners:

1. Repeat and reinforce the main concepts

2. Create multiple entry points and multiple ways of engagement

3. Provide physical and sensory access to all aspects of the program

(Museum of Science, 2010).

Bilingual design

The Network is committed to creating educational experiences that are inclusive of broad public audiences, including Spanish-speaking

audiences in the United States. Many of our educational products are available in both English and Spanish, including NanoDays activities, exhibits, and our public website. There are many considerations related to creating a bilingual experience. Based on our experience, NISE Net offers the following suggestions:

- **Inclusive approach:** As far as possible, make the language, images, and interactive elements of learning experiences relevant and accessible to broad public audiences
- **Equitable approach:** Treat both languages with the same quality, integrity, and perceived importance
- **Development process:** Prototype and test with bilingual audiences, and seek input and feedback from bilingual expert advisors and reviewers (e.g., Spanish-speaking scientists)

(Jensen et al., 2011; Ostman et al., 2012).

"Two of our team members work part time at a community library, which serves a population that is 99.9% Hispanic. The team was very excited about having the materials in Spanish, all equally as complete and lovely as the English version. That says the community is equally important and is not getting hand-me-down stuff."

- Lynn Cole, Queens Library Children's Library Discovery Center

CASE STUDY:

INCORPORATING EDUCATOR FEEDBACK

"Nano Around the World" is a card game designed to get a group of participants to reflect on the potential uses of nanotechnology across the globe. Players each receive three cards: a character card, a current technology card, and a future technology card. They are asked to assume the role of their character to find nanotechnologies that might benefit them. After game play there is a facilitated discussion to help players reflect on the choices they made, the difficulty in finding appropriate technologies for many of the characters, and the possible nanotechnologies that could benefit a wider array of people than current nanotechnologies do.

NISE Net educators reviewed an early version of this program at an in-person program group meeting at the Oregon Museum of Science and Industry in January 2012. The game was conceived by a NISE Net university partner and was originally created as a teaching tool for professional audiences, providing an introduction to ideas related to nano and society. We included it in a program group critique both to improve it as a training tool and also to consider whether it would work for public audiences in a museum setting.

After playing the game, the group of educators felt the program structure was solid and supported the program objectives. We thought it was a great training tool and also felt it could be successful for certain public audiences and contexts (for example, summer camps). We focused our suggestions on improving the design of the game cards and considering how to ensure the game could be inclusive of a wide range of players and facilitators.

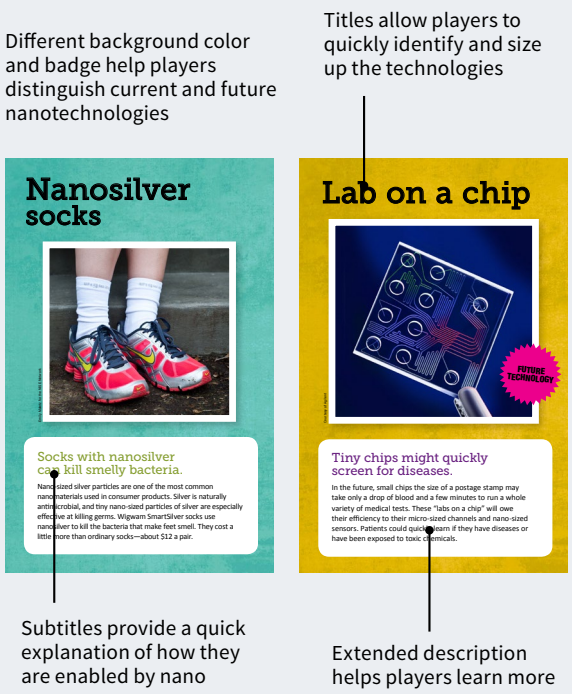
Many of the elements of the cards' final design were suggested at the critique:

Character and technology cards have different orientations, so they can be easily distinguished

Title allows players to quickly identify and discuss their characters

Vital stats are summarized in a call-out box

Maps and text help players understand the characters' lives



The group also considered how this game could be adapted to work in more museum settings, since the original version requires quite a bit of time and a large group of players with strong reading skills. One suggestion was to create a smaller selection of simplified cards, and to challenge players to discuss and decide which technologies they felt were most important, first as themselves and then as a character. This idea ultimately led to a second version of the game, which was included in the NanoDays kits as "Exploring Nano & Society—You Decide!"

CASE STUDY:

WORKING WITH EXPERTS

The program team calls on all sorts of experts to help us plan and develop our programs. In one memorable example, we worked with experts at two different companies—an artisan from a glassmaking company and a scientist at a nanofabrication lab—to co-develop an activity for the NanoDays kits. This work occurred over the summer of 2011.

"Exploring Materials—Nano Gold" is a hands-on activity in which visitors discover that nanoparticles of gold can appear red, orange, or even blue. They learn that a material can act differently when it's nanometer-sized. During the activity, they observe the difference in appearance of macroscale gold and nanoscale gold, explore how nanoscale gold in solution interacts with light, and examine squares of red and orange stained glass that get their color from nanoparticles of gold.

The NanoDays physical kit for this activity includes small squares of the orange and red stained glass and vials of actual nanoscale gold particles in solution. In addition to allowing visitors to handle real materials (stained glass and nano gold), the NanoDays kit offers a simple activity. When you look at the container of 80 nm gold under regular ambient light, you see the longer, orange wavelengths of light that are scattered by the tiny particles of nano gold. If you instead shine a bright light through the container and onto a piece of white paper, you see the shorter, purple wavelengths of light that are transmitted by the suspension of nano gold. This activity allows learners to observe that nanoscale gold interacts with light in

surprising ways, which is key not only to its use in stained glass but also in other applications, such as experimental cancer treatments.

This activity was suggested by a scientist at a commercial nano lab. He described the phenomenon to us, sent us photos to illustrate how it worked, and provided samples of gold in solution to allow us to test it with museum visitors. Early attempts required us to bring volunteers into a dark closet to see the phenomenon! But by testing different light sources and working with the scientist to "tune" the concentration of gold particles in solution we were able to get the activity to work in regular ambient light, making it practical for NanoDays. The scientist offered advice throughout the prototyping process, and ultimately the lab manufactured and packaged special small vials of 80 nm and 10 nm gold particles in solution for the kits.

Acknowledgements: Bullseye Glass (www.bullseyeglass.com) and nanoComposix (www.nanocomposix.com) provided expert consultation for the development of the Nano exhibition and the NanoDays activity.

CASE STUDY:

TESTING WITH VISITORS

"Exploring Structures—Butterfly" is a hands-on activity in which visitors investigate Blue Morpho butterfly wings. They learn that these butterfly wings get their color from nanoscale structures rather than pigment. During the activity, visitors shine a bright light through the wings of a Blue Morpho butterfly and observe what happens.

This program was improved through several rounds of testing with visitors at two different museums during the summer of 2011. There were two major phases of testing, one at each museum. Throughout both phases, the team implemented incremental improvements as the work progressed.

The visitor testing was done through the Network's Team-Based Inquiry (Pattison, Cohn & Kollmann, 2014) process. Our TBI team included a small group of educators from the two museums and an evaluation mentor. We asked these questions about the prototype activity:

- Is the program engaging? Do visitors want to stay and try it?
- Are the instructions clear and easy to follow?
- Is an LED mini-light bright enough to demonstrate the color change when light is transmitted through the butterfly wing?
- Do visitors understand the activity's learning objective: "The way a material behaves on the macroscale is affected by its structure on the nanoscale"?

In the first round of testing, we tried the activity with around 10 visitor groups. An educator observed visitors as they read and followed the instructions for the activity. Following the program, the educator asked visitors what they had learned and whether or not they found the activity fun. Visitors were also asked if the instructions were clear and easy to follow.

The team found that the activity was very engaging. Families were impressed with the phenomenon and called over other members of

their party to join in the activity. Children in particular found the real butterfly specimen appealing. The LED mini-light was bright enough to allow visitors to observe the color change. Visitors did have difficulty following the instructions as written: they weren't sure how to turn on the light and they did not always shine the light through the butterfly from underneath. Once they were successful in using and positioning the light, visitors were able to describe the butterfly and explain that the blue color of its wing is not caused by pigment.

Based on this information, the team rewrote the activity instructions to explain more clearly that the light should shine through the butterfly wing from underneath. We also included a note to squeeze the light to turn it on.

In the second phase of testing at a second museum, we expanded the TBI group to include volunteer facilitators who had not been part of the initial activity development. These volunteers tried the activity with visitors and offered feedback on their experience. In this phase, the team tested the revised instructions. This round of testing resulted in the creation of additional information meant for educators facilitating the activity, included in the Notes to the Presenter and Extension sections of the guide, as well as the development of separate explanatory image sheets for educators to share with visitors.

CASE STUDY:

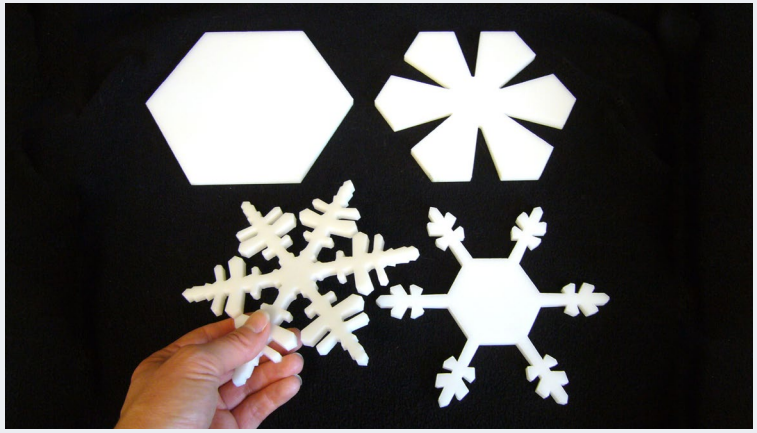
IMPROVING ACCESSIBILITY

"Snowflakes—Nano at its Coolest" is a public presentation that introduces broad public audiences to nano by considering how snowflakes form, why they have six sides, and if it's true that no two snowflakes are alike. During the course of the program, visitors look at images of snowflakes, handle models, and observe real ice crystals forming in a chilled chamber.

This program was improved as part of a universal design workshop held at the Museum of Science in Boston in 2007. During the workshop, experts from the field of universal design who have disabilities worked together with museum professionals to revise and refine four public programs to make them more inclusive of visitors with disabilities. Afterwards, museum visitors representing various disabilities viewed the programs and provided further feedback. In addition to helping the program team learn the principles of universal design and apply them to specific programs, the workshop also resulted in NISE Net's universal design guidelines for programs (Museum of Science, 2010).

Several original features of the program design helped to make it inclusive of all visitors. The program uses snowflakes—a familiar, interesting subject for many visitors—as an entry point to nanoscale science. The program is organized into discrete chunks, related to the primary learning objectives. An overview is provided at the beginning of the program, and signposts throughout help visitors track progress. Learning objectives are repeated and reinforced throughout the presentation, and audience questions and ideas are solicited throughout.

The program was refined during the universal design workshop in order to make it more inclusive of visitors with disabilities. The slides were redesigned to be easy to see and understand, and text was added to cover the major points of the verbal presentation. The slides were printed and provided in a binder for individual access by visitors who might benefit from them. Tactile models were created to represent key images. And, finally, the lesson plan was rewritten to include suggested verbal descriptions of visual elements of the program.



Source: Universal Design Guidelines for Public Programs in Science Museums (Museum of Science, 2010).

CASE STUDY:

CREATING BILINGUAL MATERIALS

NISE Net creates both English and Spanish versions for our NanoDays activities. In order to provide an inclusive experience, the activity titles, concepts, images, and design elements must work well in both languages and for both cultures.

In the NanoDays activity "I Spy Nano!," or "¡Veo, veo nano!," visitors try to find hidden objects on a game board. The objects they are seeking are presented in a deck of cards. The first player to find an object on a card keeps that card. Players compete to find the most nano-related objects and collect the most cards.

In this case, "I Spy!" is a familiar game to many English- and Spanish-speaking families, so it is an equally accessible entry point. The game is known as "¡Veo, veo!" in Spanish, so the English and Spanish titles are not literal equivalents. The game boards were designed with images only (no text), so they can be used to play the game in either language. Separate English and Spanish game cards are provided. To ensure that the images and concepts were relevant and accurate in both English and Spanish, this game (like all NISE Net bilingual products) was reviewed by both English- and Spanish-speaking educators and scientists.

Sources: Bilingual Design Guide (Ostman et al., 2012) and Translation Process Guide (Jensen et al., 2011).

Process

Program development workshops

Program workshops are essential to the NISE Net development process. Our workshops include program critiques where educators focus on improving in-progress programs to help them better meet their goals and objectives. Critiques are a valuable way to gather ideas and work through problems with a group of invested, supportive peers. Regular participation in program critiques can help individual practitioners to become more articulate and reflective about their practice and to improve development skills related to program goals, structure, and design.

Beginning a workshop with an informal improv exercise sets the stage for a supportive and positive environment for a program critique. Generally, NISE Net allows an hour to critique each program. If possible, the program developer will circulate a draft lesson plan or activity guide ahead of time. The critique begins with a brief description by the developer of the program's objectives, target audience, and anticipated format or setting of use. The developer presents the program, and the group debriefs and discusses it. Often, the developer asks the group to help resolve specific questions or challenges, as well as seeking general feedback and suggestions. If available, the developer also summarizes the results of visitor testing so the group can take that information into account.

Program templates

NISE Net documents and shares our programs using three basic templates: an activity guide for NanoDays activities, a lesson plan for full-length programs, and a slide template for presentations that use slides.

"I think the most important thing about the NISE Net is the capacity to partner with other, like institutions. Actually doing work together creates a deeper level of partnership and exchange. It's what the NISE Net really has contributed to the field."

- Ray Vandiver, Tulsa Children's Museum

Tips and tools for program development

Program objectives

Be explicit about your audience and learning objectives, and be ruthless about designing for them. No matter how much you love a program or an element of a program—or how much work you put into it—if it doesn't engage your audience or support learning, it needs to be improved or removed. Be realistic about what's possible in an informal learning environment. Even seasoned educators can get carried away and attempt to pack in too much! Visitor testing and peer review can help you identify the most important messages and strongest elements of a program.

Best practices

Using best practices, keeping your eye on your goals, and taking advantage of other perspectives will improve your programs. Visitor evaluation and feedback from a range of professionals (such as educators and scientists) are essential. Always be open to input, and learn from every delivery of a program. Universal design principles improve programs for all audiences. They make content accessible and interesting for visitors of all ages and backgrounds. Generally speaking, it's not much harder to make a program inclusive—it may even be easier—and the resulting experience will be much more effective.

Practical considerations

Think ahead to implementation, even in early stages of development. Consider the likely setting where your program will be delivered. This may help you to recognize constraints that determine or radically change your plans for the way you structure or design it. And don't underestimate the importance of ease of use! If a program is easy to learn, set up, and put away, more educators will use it more often. If it's a hassle, it won't be used very often—even if it's a great program.

Tools:

- Universal design checklist
- Activity guide template
- Lesson plan template
- Slide template

Examples of these tools can be found at the back of the guide.
Editable versions can be downloaded from nisenet.org.

Tips and tools for program critiques

Keep it real

If you're doing development work around specific, defined programs, it is best if presenters do a full delivery of their draft program as they would for the intended audience. If the program isn't far enough along, or it is a very long-format program (e.g., a summer camp curriculum), the group can walk through the lesson plan and the presenter can focus on selected key features of the program.

But not too real

In our experience, if you have more than a few educators participating in your critique, it usually doesn't work to present the program on the museum floor with actual visitors. The exceptions are programs that are intended for a large group of people. In this case, a group of educators can sometimes observe and take notes without disrupting the experience for the public audiences. But for small-format programs, like tabletop activities or cart demonstrations, the educators won't be able to hear or see if they're crowded behind visitors, and visitors may not enjoy the experience of being surrounded by museum staff. If you do critique a program after watching it with real audiences in a public space, move to a private space for your discussion.

Keep it small

Critiques, charrettes, and other "working" meetings are most productive if the group includes a large enough number of people that you get diverse perspectives, but a small enough number that everyone participates and is invested in the process. At least 5 and no more than 20 people is ideal. If you have a larger group, you can divide into smaller breakout groups. If you have a smaller group, you'll probably want to work together in a different format (e.g., by observing the prototype program being delivered to visitors, then debriefing it afterwards).

Align goals and agenda

As you plan your critique, set explicit goals and check that your agenda addresses each one specifically and adequately. Think critically about the value of different agenda items and try to get as much out of each minute as you can. A couple of quick improv exercises can introduce participants to each other, get everyone moving, and create a positive environment—in the same amount of time it would take to go around the table and give verbal introductions.

Consider group dynamics

Think about how to get the best contribution out of your group. Would it help to keep people from "clumping" with the folks they know best? Can you use different facilitation techniques to make sure everyone participates and feels comfortable? In some meetings, we use anonymous feedback forms. Consider the advantages and disadvantages (and feasibility) of anonymous feedback.

Mix it up

If the critique includes more than two or three programs, try to mix things up so the meeting doesn't start to drag. Each program deserves the attention of a fresh, energetic group. You might be able to alternate kinds of programs, or you can always mix in brief improv exercises to get energy back up.

Plan ahead
Circulate an agenda and explain goals and expectations for participants ahead of time. This is especially important if group members are new to critiques. And, obviously, as you develop and refine your plans you'll want to double-check that you have all your logistics under control (time, space, materials).

Get off to a good start
A program critique should feel more like a workshop or retreat and less like a staff meeting. It's important that the group develops trust, gets into the right frame of mind, and is able to focus on the task at hand. Start off with participatory activities that involve the whole group. This will warm everyone up and create a positive atmosphere.

Set ground rules
Everyone should participate in the agenda with good will and help keep things moving along productively. Everyone should offer genuine opinions and share expertise, while also being respectful of others. As much as possible, participants should share important information and insights with the whole group, but it can also be better to share some feedback offline (for a variety of reasons).

Stay on track
During the critique, participants should focus on offering constructive criticism that supports the program goals. A critique is not a brainstorm: all advice is not equally good. Everyone should feel comfortable offering ideas, and equally comfortable discarding them after fair consideration. The discussion should build on the ideas that are most promising and move on quickly from ideas that don't work. It can be very helpful to have an overall facilitator—other than the program developer—who helps keep the conversation on track.

Stay on time
Allow enough time to genuinely engage with a program—but whatever time you have, stay on schedule. It's easy to spend too much time on programs at the beginning of a workshop, shortchanging ones that come later. Create a mechanism for additional feedback on a program when time is up, such as writing ideas on the critique sheet and passing them in at the end of the meeting.

Follow up
In order for a critique to be useful, it should have outcomes. The organizer should thank participants, send out meeting notes and action items, update the group on new developments, and explain how participants can be involved moving forward (as relevant). Participants should follow up as required, and can take the initiative to work together in smaller groups on ideas that emerge during the critique.

Tools:

- Questions to guide program critiques
- Universal design checklist
- Improv exercises

Examples of these tools can be found at the back of the guide.
Editable versions can be downloaded from nisenet.org.

Implementation

NISE Net programs are used all over the country by museums, universities, and other organizations. Our partners engage a great range of audiences—including families, school groups, scout troops, and even university students—with programs they've adopted, adapted, or created themselves.

To maximize the use and impact of Network resources, we design the majority of our educational products to correspond to the most common types of engagement experiences already offered by our partners. NISE Net also develops a targeted set of innovative educational products to enrich and advance the kinds of public educational experiences typically offered by museums and universities.

Program formats

Hands-on activities and cart demonstrations are designed to engage small groups of visitors in a variety of settings

Stage programs allow educators to engage large groups of visitors

Classroom programs are designed for school, field trip, and out-of-school learning experiences

Exhibits and media offer unstaffed learning opportunities in museum galleries, university lobbies, classrooms, and other locations

Forums and science cafés offer new approaches to bringing scientists and visitors together to discuss current scientific research, its potential, and its implications

Museum theater offers entertaining ways to engage with current science, as well as a powerful entry point into difficult issues

Open-ended conversations allow educators, scientists, and members of the public to engage in explorative, mutually informative learning

Best practices for program delivery

There are many basic strategies that can help educators create connections with audiences and support learning:

Establish a foundation

Start with the fundamentals, using clear, simple language. Focus on one idea at a time—don't feel that you need to tell visitors everything at once! Be aware of differing abilities, keeping in mind that children do not have the same skills or vocabulary as adults.

Foster open-ended investigation

Find ways for audience members to explore, discover, and try out ideas. Try to use questions that have more than one answer, such as: "What do you see happening?" or "Does this remind you of anything you've seen before?"

Explore together

Help visitors observe and think about the activity. Be interested in what visitors tell you, and let their curiosity and responses drive your conversation forward.

Support group learning

Create opportunities for sharing and discussion among friends or family. Set up activities so that more than one person can participate at a time. Consider proposing roles so that every visitor has an active role to play.

CONVERSATIONS ABOUT SCIENCE AND SOCIETY

NISE Net encourages our partners to engage audience members in conversations about the social and ethical dimensions of science, engineering, and technology. Conversations allow visitors to share their own ideas and experiences and to reflect and build on them in light of new facts and ideas from others.

In conversation, educators and audience members:

- Contribute their own perspectives
- Consider both facts and values
- Take on different roles, asking and answering questions
- Explore ideas and form opinions

Source: Nanotechnology and Society: A Practical Guide to Engaging Museum Visitors in Conversations (Wetmore et al., 2013).

Relate to visitors' lives
Find connections between the activity and the everyday lives of audience members at home, work, or school. Familiar examples can help explain abstract concepts. Ask them to tell you about a time they saw or experienced something similar, or where they might imagine using or doing something related in the future.

Highlight social dimensions
Feature ways that scientific discoveries or new technologies have been used (or may one day be used) to help people. Encourage visitors to brainstorm ways the technology might be useful or express concern about ways it could do harm.

Foster conversations
Encourage conversations among visitors by asking questions and keeping different group members engaged.

Encourage further learning
Suggest ways that visitors can learn more.

Dissemination

NISE Net has a comprehensive online library of public programs, exhibits, and media that meets the needs of diverse partner organizations and public audiences. These are available on our website, www.nisenet.org. For each resource, we include full documentation and downloadable digital files of slides, posters, and other materials needed to implement the program. Additional supplies, materials, and equipment are clearly indicated, along with sources for obtaining them (where appropriate). For many of our programs, we also offer training videos for staff and volunteers.

The Network seeks to make our products and resources widely available to our partners for educational use. Most of the products created by the NISE Network are available under a Creative Commons Attribution-NonCommercial-ShareAlike license. This allows educators to print, download, reproduce, distribute, publicly perform and/or publicly display most NISE Net resources for noncommercial, educational use, provided they are credited appropriately. Educators can also make adaptations of or modifications to most NISE Network resources.

We also share our programs with Network partners, and the field of informal science education more broadly, through a variety of professional development activities. These include in-person workshops, conference presentations and preconference workshops, and online workshops.

"The materials provided by the Network allow us to offer high-quality public events for our museum guests and members. The content is highly sophisticated and our staff has utilized the website, activities in the kit, and other resources to make nanoscale science and engineering accessible."

- Anne Herndon, Fort Worth Museum of Science and History

Partner stories

Network partners use our educational materials in a variety of settings, including museums, universities, schools, and out-of-school time programs. Partners frequently adapt, integrate, build on, and improve NISE Net materials to fit their needs. They also create new nano programming tailored to meet their organization's goals, audiences, and local partnerships. The partner stories that follow are just a few examples of the many thoughtful and creative ways museums and universities use NISE Net programming resources.

EXPERIMENTING WITH INNOVATIVE FORMATS

North Museum of Nature and Science collaborated with local organizations to provide nano outreach in a flash mob style. The program mimics traditional flash mobs, but instead of dancing, educators and teen volunteers assemble suddenly in a public place to perform science experiments. At one event, families were treated to a liquid nitrogen demonstration involving frozen marshmallows and shrinking balloons and learned about heat transfer.

Contributed by Nora Sampaio,
North Museum of Nature and Science, Lancaster PA

INCORPORATING NANO & SOCIETY IDEAS

Maryland Science Center created a new nanotechnology program combining on-stage demonstrations, such as a lycopodium fire ball, and multiple hands-on activities exploring nano in nature and technologies, such as Blue Morpho butterflies and dichroic glass. This was the museum's first program allowing the general visiting public to explore the societal and ethical implications of technology—with more to come!

Contributed by Abby Goodlaxson, Maryland Science Center

COLLABORATING AMONG MANY ORGANIZATIONS

Maine Discovery Museum worked with several community and education partners to reach out to two Native American communities. The museum worked closely with the Penobscot River Educational Partnerships (PREP), Raising Education Attainment CHallenge (REACH) partners, Next Generation in Science Standards curriculum coordinators, the target school administrators and teachers, and an advisory panel of STEM educators from two local colleges. In the first year, the program was presented at the Passamaquoddy reservation in western Maine and as part of a first-ever Science in the Park event at three rural libraries in the Newport area. Each program was developed in response to local needs and conditions. Now that they have a personal connection with local parents and educators in these communities, museum staff are confident they can sustain the new programs.

"This project has greatly enhanced our ability to provide current and relevant STEM education to previously underserved populations and put us on the map for curriculum planning and development."

- Gertrud Plummer

Contributed by Gertrud Plummer, Maine Discovery Museum

ENGAGING TEENS

Stepping Stones Museum for Children has integrated nanoscale science and technology content into a youth enrichment program designed to help students grades 6-12 develop workplace-readiness skills, leadership abilities, and increased social and emotional awareness. The program includes "clubs" organized around various interests. A new nano club lets youth explore STEM topics and interact with museum visitors through hands-on activities, festivals, and multimedia events.

"Being part of the nano club gives the participants a chance to develop program facilitation skills that can be utilized throughout their lives."

- Stephanie Kadam

Contributed by Stephanie Kadam, Stepping Stones Museum for Children

EMPOWERING GIRLS

The Leonardo Museum created a week-long summer camp to inspire girls to pursue STEM. Campers explored various activities from NanoDays as well as other lessons supporting nano science and technology. Each day, the girls were responsible for teaching their favorite lesson from the day to younger children in another camp program. They also spent time with female role models working in the fields of science and technology. At the end of the week, the girls developed their own nano games, which were prototyped with the younger campers.

Contributed by Brooke McNaughton, The Leonardo Museum

ENCOURAGING STEM

Montana State University infused nano into an annual event that inspires girls around the state to recognize their potential and pursue opportunities in STEM. The event organizers added a plenary session and breakout sessions featuring several NISE Net activities and experiments. The breakout sessions were led by university students, serving as approachable STEM role models.

"This program allowed us to reach a large, statewide audience of underserved rural and Native American girls, many coming from schools that lack science labs and teachers with a scientific background."

- Jamie Cornish

Contributed by Jamie Cornish, Montana State University Extended University

OFFERING BILINGUAL PROGRAMMING

Las Cruces Museum of Nature & Science collaborated with New Mexico State University to create a series of bilingual teacher and student resource kits focusing on different themes of nanoscience. This program takes advantage of NISE Net's bilingual educational materials to bring cutting-edge science into southern New Mexico classrooms in an accessible, engaging, and hands-on way. The museum loans teachers their "suitcases" free of charge, offers teacher training workshops on how to use them, and sends an educator to the classroom for a pre- or post-visit.

Contributed by Tim Hecox, OMSI

INCREASING RELEVANCY FOR LOCAL AUDIENCES

'Imiloa Astronomy Center takes the natural curiosity of all children in Hawai'i and uses the foundation of traditional knowledge to make NanoDays activities relevant and fun. The Scented Balloons activity explores the nano science behind the custom of using flowers and lei as adornment. Visitors can also observe taro plants in the center's garden and explore the science behind the plants' superhydrophobic leaves. In a final example, the Static Electricity activity helps center educators to explain the phenomenon of thunder snow at the top of Mauna Kea.

Contributed by Ahia Dye, 'Imiloa Astronomy Center of Hawai'i, and Frank Kusiak, Lawrence Hall of Science

SHARING CURRENT RESEARCH

The **University of Vermont** and the ECHO Lake Aquarium and Science Center brought together an interdisciplinary group of scientists and researchers to engage museum visitors in issues important to the local community. In one of many activities, visitors investigate how polarization is used in liquid crystal displays. In another, they learn how university researchers use polarized light to detect zebra mussels, an invasive species actively monitored in Lake Champlain.

Contributed by Luke Donforth, University of Vermont

REACHING UNDERSERVED AUDIENCES

California Science Center collaborated with the University of California, Los Angeles to develop a nano curriculum for a free program offered to underserved local youth. The curriculum explores fundamental concepts of nanoscale science, its growing use in consumer products, and possible effects nanotechnologies might have on the environment. Activities include growing *E. coli* to investigate the antibacterial effect of silver nanoparticles and learning how nanotechnology may assist in cleaning up oil spills. Students connect with researchers and graduate students through guest presentations, field trips, and videoconference lab visits.

Contributed by Katharine Mendivil, California Science Center

INCREASING ACCESSIBILITY

The Discovery Museums modified four NanoDays activities using universal design guidelines to increase accessibility for all audiences, including children on the autism spectrum and children that are deaf or hard of hearing. Museum educators worked with audiences of all ages and abilities to prototype and test the activities. General strategies that were used for all four activities included: creating new instructional signs with pictures and large type; highlighting key messages and concepts; adding visual and tactile components and models; creating holders and/or larger handles for easier grasping and manipulation of materials; and including a notepad or whiteboard for visitors and presenters to write words, questions, or diagrams. As a result of the project, staff are now more knowledgeable about improving sensory, physical, and cognitive access to museum programs, and teen volunteers feel more confident presenting the activities.

"Applying universal design guidelines to the nano activities improves access for all audiences and also allows layering of content for preschool through adult audiences."

- Denise LeBlanc

Contributed by Denise LeBlanc, The Discovery Museums

CREATING PROGRAMS FOR SCHOOLS

The **Children's Museum of Brownsville** partnered with the University of Texas at Brownsville to develop a school outreach program, the Nano Circus, for grades K-5. The program includes a presentation by a nano research scientist and hands-on activities facilitated by university physics student volunteers. The students present NanoDays favorites, such as Oobleck, alongside new activities, such as examining objects with a Proscope. Teachers receive a classroom lesson plan appropriate for their grade level. The program has forged a lasting relationship between the museum and the Physics department of the university, and strengthened the museum's relationship with the local school district. The program has proven so successful that the university also uses the materials in a local science and art festival.

Contributed by Jennifer Williams, Children's Museum of Brownsville

Tips and tools for program implementation

If you want to share your programs with other educators, provide the resources they will need to use and adapt them.

Documentation

It's essential to document your programs well. Include information on all aspects of the program, from advance preparation through setup, delivery, and cleanup. Don't forget information regarding safety!

- Use both words and images to explain how to set up and use all the props and materials.
- Provide clear talking points that resemble words an educator might actually say to the audience during the program. Include accessible explanations of key concepts and relate them to what visitors observe in the program.
- Ask others to read through the program instructions and offer suggestions to make them easier to follow.

Resources

Provide source materials so others can adapt and modify your program. Consider offering your materials as Creative Commons resources, which allows others to adapt and modify them. Include editable digital files, images, and informational sheets. This will allow others to tailor a program to a different audience, for example, or create a poster in place of slides.

Cautions

Be ethical and use common sense about what you share. Use images fairly and credit other people's ideas, and keep in mind that fair use of intellectual property is sometimes limited to your own use for educational purposes. Don't distribute identifiable images of audience members if you don't have an appropriate photo release, and be especially cautious with images of children.

Tools:

- Engaging all audiences
- Engaging girls
- Engaging bilingual audiences
- Improv exercises

Examples of these tools can be found at the back of the guide.
Editable versions can be downloaded from nisenet.org.

Impact

NISE Network partners work together to engage the public in new topics related to science, engineering, and technology. Working together, we reach sizeable and diverse public audiences across the United States.

Programs

NISE Net has created a wide variety of programs for a range of public audiences and conducted substantial evaluation on all of our products. Overall, this work indicates that NISE Net programs enhance museum visitors' awareness, knowledge, and interest in nano.

Interest and enjoyment

Visitors find NISE Net programs to be both interesting and enjoyable. In our summative evaluation, the majority of visitors give NISE Net programs the highest possible rating for interest and enjoyment.

Visitors attribute their interest in a program to the type of experience it offers and its content. Generally, visitors give higher ratings to hands-on activities and cart demonstrations than longer programs. Brief, small-group formats seem to be more effective for generating interest and enjoyment on this challenging topic.

Awareness and understanding

After participating in NISE Net programs, visitors understand the main messages, feel more confident in their awareness of nano, and, in some cases, develop more sophisticated definitions of nano. These results are seen for both short and long programs.

Relevance

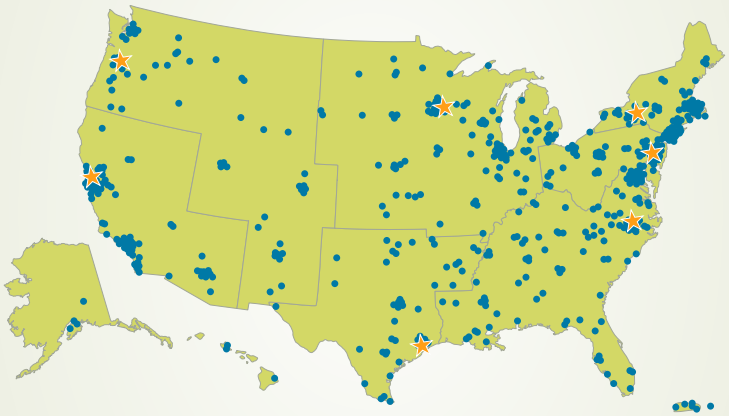
Visitors who participate in NISE Net programs see a stronger connection between nano and their everyday lives than visitors who do not. Interest and relevance are not synonymous for visitors: they can find a program can be interesting even if it's not relevant to them, and vice versa. Evaluation data indicate no relationship between a high relevance rating and high interest rating for any given program.

PROGRAM IMPACT

- NISE Net programs effectively engage visitors with nano content
- Visitors who see NISE Net programs show higher levels of nano awareness
- Many visitors associate "nano" with "small," even before seeing nano programs
- Programs offer ways for visitors to deepen their nano knowledge
- Visitors find relevance to their own lives in NISE Net programs

Sources: Review of NISE Network Evaluation Findings: Years 1-5 (Reich et al., 2011) and Year 5 Summative Evaluation of Exhibits and Programs (Bequette, Svarovsky & Ellenbogen, 2011).

620 ORGANIZATIONS
regularly participate in Network activities



368 *museums*

208 *universities*

44 *industry, other*

★ Regional hub

NanoDays

NanoDays is NISE Net's signature event—an annual celebration of nanoscale science, engineering and technology. It is the most widely used set of resources the Network has created. NanoDays mobilizes hundreds of NISE Net partners across the country to engage staff, volunteers, and members of the public in learning about nanoscale science, engineering, and technology. NanoDays reaches over a million visitors throughout the year, at the annual event and during other programming.

NanoDays activities are simple yet powerful, allowing visitors to explore the unusual properties of nanoscale materials and technologies. Favorite activities include a tiny teacup that won't spill water, a mysterious magnetic fluid, red-colored gold, and glass objects that seem invisible.

NANODAYS IMPACT

- From 2008 to 2015, 8 million people participated in NanoDays, through the annual event and other uses of the kits throughout the year
- NanoDays events are successful in providing event attendees and volunteers with an engaging experience
- NanoDays is successful in promoting learning of nano concepts by public audiences and event volunteers
- Volunteering at NanoDays positively impacts interest in STEM activities/careers and confidence around engaging the public in nano

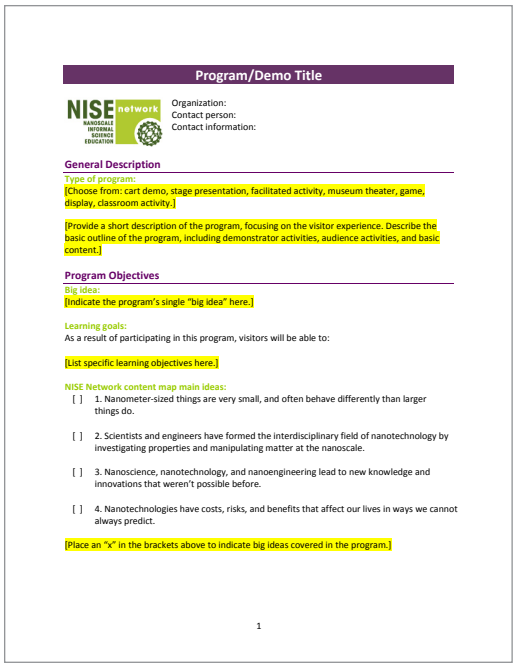
Sources: Public Reach Estimations for the NISE Network. (Svarovsky et al., 2015) and Summative Study of NanoDays 2014 Events (Svarovsky et al., 2014).

Tools

Program templates

The NISE Net program and activity templates package includes tools for developing educational programs, including a lesson plan template, NanoDays activity guide template, and slideshow presentation template.

Editable digital files for these tools can be downloaded from:
http://nisenet.org/catalog/tools_guides/nise_network_program_activity_templates


Program/Demo Title

NISE network

Organization:
Contact person:
Contact information:

General Description

Type of program:
[Choose from: cart demo, stage presentation, facilitated activity, museum theater, game, display, classroom activity.]

[Provide a short description of the program, focusing on the visitor experience. Describe the basic outline of the program, including demonstrator activities, audience activities, and basic content.]

Program Objectives

Big idea:
[Indicate the program's single "big idea" here.]

Learning goals:
As a result of participating in this program, visitors will be able to:

[List specific learning objectives here.]

NISE Network content map main ideas:

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

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

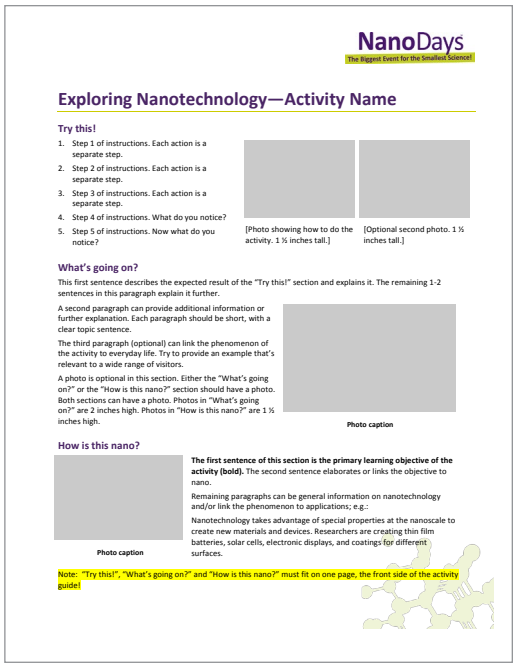
[ ] 3. Nanoscience, nanotechnology, and nanoengineering lead to new knowledge and innovations that weren't possible before.

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

[Place an "x" in the brackets above to indicate big ideas covered in the program.]

1

Lesson plan


NanoDays
The Biggest Event for the Smallest Science!

Exploring Nanotechnology—Activity Name

Try this!

1. Step 1 of instructions. Each action is a separate step.
2. Step 2 of instructions. Each action is a separate step.
3. Step 3 of instructions. Each action is a separate step.
4. Step 4 of instructions. What do you notice?
5. Step 5 of instructions. Now what do you notice?

[Photo showing how to do the activity. 1 ½ inches tall.]

[Optional second photo. 1 ½ inches tall.]

What's going on?

This first sentence describes the expected result of the "Try this!" section and explains it. The remaining 1-2 sentences in this paragraph explain it further.

A second paragraph can provide additional information or further explanation. Each paragraph should be short, with a clear topic sentence.

The third paragraph (optional) can link the phenomenon of the activity to everyday life. Try to provide an example that's relevant to a wide range of visitors.

A photo is optional in this section. Either the "What's going on?" or the "How is this nano?" section should have a photo. Both sections can have a photo. Photos in "What's going on?" are 2 inches high. Photos in "How is this nano?" are 1 ½ inches high.

Photo caption

How is this nano?

Photo caption

The first sentence of this section is the primary learning objective of the activity (bold). The second sentence elaborates or links the objective to nano.

Remaining paragraphs can be general information on nanotechnology and/or link the phenomenon to applications; e.g.:

Nanotechnology takes advantage of special properties at the nanoscale to create new materials and devices. Researchers are creating thin film batteries, solar cells, electronic displays, and coatings for different surfaces.

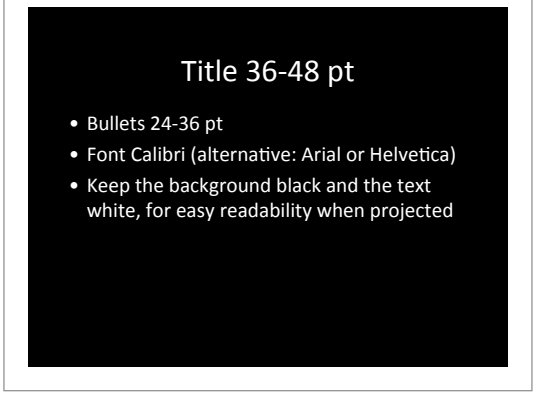
Note: "Try this!", "What's going on?" and "How is this nano?" must fit on one page, the front side of the activity guide!

Activity guide


PROGRAM TITLE

Program Subtitle

NISE network


Title 36-48 pt

- Bullets 24-36 pt
- Font Calibri (alternative: Arial or Helvetica)
- Keep the background black and the text white, for easy readability when projected

Slide template

Questions to guide program critiques

Does the program achieve its objectives?

Does it have clear, appropriate messages and objectives?

- Does it communicate an explicit big idea and learning objectives?
- Do the objectives support the big idea? Is the connection among objectives clear?
- Will the big idea remain relevant as science advances?
- Does the program support NISE Net main messages?

Is there a good fit between the program and its target audience?

- Are the scientific concepts and vocabulary at the right level for the target audience?
- Would the program be more successful if it targeted a different audience?

Is the program well designed?

Is this the best format for the program?

- Is the format a good fit for the content, or would another format be more successful?
- Is the length about right?

Does the program successfully build on prior knowledge?

- Does it review essential concepts and stick to the most important points?
- Does it reiterate difficult concepts in several different ways, using different examples?
- Does it identify and address misconceptions?

Does it follow the universal design guidelines for museum programs?

- Does it repeat and reinforce main ideas and key concepts?
- Does it provide multiple entry points and multiple ways of engagement?
- Does it provide physical and sensory access to all aspects of the program?

Is the program relevant and engaging?

Is it clear why the topic is important, or how it is related to everyday life?

- Does the program focus on issues of broad public concern and interest, such as medicine or the environment?
- Does it present examples of current research and potential applications that are relevant to visitors?
- Does it establish connections with visitors' personal lives?

Does it provide an engaging visitor experience?

- Does it include a variety of experiences?
- Does it provide concrete examples of nanoscale phenomena?
- Is the topic intrinsically interesting?

If you were going to revise this program…

What would you keep?

What would you change?

Universal Design checklist for program critiques

Repeat and reinforce main ideas and concepts	
☐ Explicitly state the program's overarching main idea and other key concepts.	
☐ Break the program into defined chunks and focus on one concept at a time.	
☐ Present a content map (outline) of your presentation.	
☐ Keep messages simple and clear to avoid information overload.	
☐ Repeat key concepts frequently during the program.	
☐ Present each concept through multiple senses (sight, hearing, and touch).	
☐ Check in with the audience along the way.	
☐ Provide handouts that summarize the main idea and key concepts with text and images.	
Provide multiple entry points and multiple ways of engagement	
☐ Allow learners to enter at different places and take away different messages.	
☐ Ask questions and actively involve learners in the program.	
☐ Connect the content to a range of prior experiences and examples from everyday life.	
☐ Use multiple analogies to represent the same idea.	
☐ Provide examples and non-examples.	
Provide physical and sensory access to all aspects of the program	
☐ Present key concepts visually and aurally, through concise key phrases.	
☐ Use large, high-contrast text and images for all graphics. Choose fonts that are easy to read.	
☐ Use color to impart meaning or draw distinction.	
☐ Use demonstration materials and models that can be seen at a distance.	
☐ Caption video presentations.	
☐ Provide tactile models that are easy to handle and manipulate.	
Comments and suggestions	

Improv exercises

Improv exercises help create a supportive and upbeat environment and provide an opportunity to practice and strengthen essential skills.

Why implement improv exercises?

Improv exercises can improve program delivery skills:

- Prepare staff to have conversations with visitors, rather than reciting scripts
- Warm up critical skill sets required for program facilitation and visitor interaction
- Empower staff to think on their feet and respond in the moment
- Focus on integrating visitor feedback into presentations
- Prepare staff to ask guest questions and better tailor content based on visitor responses
- Encourage creativity
- Position staff to be equals with visitors, rather than being "the expert"

Improv exercises can strengthen team dynamics:

- Generate laughter and create a fun, supportive, positive work environment
- Foster interpersonal relationships and teamwork

How do you implement improv exercises at your institution?

Prepare leaders:

- Set up internal structures, such as ongoing meeting times, for your leaders to learn how to lead exercises in a "safe play" environment
- Allow leaders adequate time to practice explaining and setting up exercises
- Make sure leaders participate in and facilitate all aspects of improv professional development: learning, playing, leading, and debriefing exercises

Implement with staff and volunteers:

- Select a physical space that is conducive for playing a game (adequate space, appropriate for loud noise levels)
- Match the size of the group with the game (different games work for different size groups)
- To build the energy of the group, leaders should lead with energy
- Create a supportive positive environment ("yes-and" and "your first choice is right")
- Be sure the participants and the team understand why they're doing improv exercises
- Debrief each game by asking the players how the skill sets relate to their jobs and their daily work
- Be inclusive and mindful of different skill sets within a team
- Allow time for questions and discussion
- Positively reinforce great performance at individual and group level
- Celebrate team achievements, acknowledging skills practiced

Establish ground rules for participants:

- Remain work appropriate
- Support all teammates and the group
- The game is about the team, not the individual being funny
- Say "yes-and" to each other and the ideas shared
- Bring positive energy
- Give 100%
- Let go of judgment

http://www.nisenet.org/catalog/tools_guides/improv_exercises

- Have fun
- Ask your leader for help if you need it
- If individuals choose to exclude themselves from playing an exercise, they should also leave the area

Institutionalize improv at your institution:

- Develop routines for everyone to play and lead exercises
- Rotate days so all team members can participate in exercises
- Play one game per week to cycle through all team members
- Tailor exercises to your institution
- Tailor exercises to your mission and vision
- Ensure leaders are strong at leading and debriefing exercises and can help explain why we use improv exercises in the workplace

Downloadable improv exercises are available from:
http://www.nisenet.org/catalog/tools_guides/improv_exercises

Source: Leading Improv Exercises (Museum of Science & Industry, 2012).

Tips for engaging all audiences

Greet visitors
Say "hello," make eye contact, and smile. Simply looking like you're available and friendly will bring visitors to you.

Let visitors do the activity
As much as possible, let visitors do the hands-on parts of the activity, and let them discover what happens. (If your activity has a surprise, don't give it away!)

Share what you know
Use clear, simple language. Focus on one main idea—don't feel that you need to tell visitors everything at once! Keep the information basic for starters, and be willing to expand on an idea for interested learners.

Use examples from everyday life
Familiar examples can help explain abstract concepts. Be aware of visitors' abilities, keeping in mind that children do not have the same skills or vocabulary as adults.

Ask questions
Help visitors observe and think about the activity. Try to use questions that have more than one answer, such as: What do you see happening? Why do you think that happened? What surprised you about what you saw? Does this remind you of anything you've seen before?

Be a good listener
Be interested in what visitors tell you, and let their curiosity and responses drive your conversation forward.

Offer positive and encouraging responses
If visitors haven't quite grasped a concept, you might say, "That's a good guess," or "Very close, does anyone else have something to add?" Don't say, "No" or "Wrong" in response to visitors' observations or explanations.

Share accurate information
If you aren't sure about something, it's OK to say, "I don't know. That's a great question!" Suggest ways that visitors can learn more.

Remain positive throughout the interaction
Remember that nonverbal communication is important, too. Try to maintain an inviting face and body language.

Thank visitors
As your interaction ends, suggest that visitors explore other activities.

Have fun!
A positive experience will encourage learning.

Tips for engaging girls

Feature female role models
Feature images and stories about women and showcase female scientists. Learning about women role models is inspiring for girls, and it's also important for boys and parents to see female scientists. Have female facilitators when possible—seeing women leading the activity can encourage girls to participate.

Use inclusive language
Make pronouns gender neutral whenever possible.

Make it social
Encourage sharing and discussion of the activity with friends or family. Set up activities so that more than one person can participate at a time. Consider assigning roles so that every visitor has an active role to play.

Engage the senses
Promote a multisensory experience with a variety of colors, sounds, smells, and textures. Take time to make sure the activity remains aesthetically pleasing and inviting.

Tell stories
Engage participants during the activity by telling a story they can relate to, such as a story about the person who discovered a technology or a story about someone who might use it. Encourage visitors to tell their own stories.

Make it personal
Find common connections between the activity and the everyday lives of audience members. Encourage them to tell you about a time they saw or experienced something similar, or where they might imagine using something related in the future.

Encourage creativity
Find ways to allow for creative self-expression in the activity. Invite audience members to draw, paint, make, or act!

Highlight social dimensions
Feature ways that scientific discoveries or new technologies have been or may be used to help people. Encourage visitors to brainstorm ways the technology might be useful or express concern about ways it could do harm.

Encourage open-ended exploration
Encourage open-ended investigations by finding ways for audience members to explore, discover, and try out ideas. Avoid activities or questions that have only one "right" answer.

Tips for engaging bilingual audiences

Identifying audiences

Spanish-speaking populations in the United States are not homogeneous. US Hispanic and Latino audiences represent many different countries of origin, comprise both US-born and immigrant residents, and include communities with varied levels of assimilation, socioeconomic status, and education.

- Before you begin, develop an understanding of the makeup of the non-English speaking population(s) within your community.
- Be focused and clear about which audience(s) you're engaging or hope to engage.
- Prototype and test out different offerings so you can figure out what works and what doesn't.

Marketing strategies

Read up on and talk to other organizations about ways to engage and communicate with different audiences. Establish an institutional culture around including community members in your programming and events.

- Build relationships, establish trust, and make active use of community partners.
- Encourage "word of mouth" marketing. People are more likely to become involved when an individual from their own community invites them or has provided endorsement.
- Establish personalized (bilingual) communication with parents and family members. Build opportunities for communication in multiple ways (such as mailings, online newsletters, and announcements on social networking sites).
- Make advertising and promotional materials available in Spanish.
- Partner with Spanish-language radio shows, television, and newspapers.

Programming strategies

Provide authentic, relevant experiences.

- Deliver programming in the most comfortable language(s) for families.
- Encourage participants to use their home language(s) as they participate.
- Link science programming to everyday experiences and topics that are culturally relevant and engaging (for example, cooking).

Include family members and role models.

- Design projects that allow opportunities for adults and children to participate, either working together or separately.
- Consider incorporating family members as event helpers or facilitators.
- Actively seek and include ideas, thoughts, and opinions from members of the audience you hope to engage.

Use facilitators who are culturally aware and fluent.

- It isn't necessary for staff to be native Spanish speakers, but it is crucial that they relate to and are accepted by the audience.
- Encourage bilingual staff to identify themselves by wearing a button or special name tag.

Become familiar with tools for bilingual education.

- Techniques like Sheltered Instruction—an approach to teaching that integrates language and content—can promote understanding and inclusiveness.
- Incorporate extra cues, such as models, pictures, charts, props, and body language.
- Provide a glossary of pertinent terms in both languages.

Make events at your organization accessible—or go where people are.

- Identify barriers that could prevent the audience from participating and develop strategies to overcome them. For example, you might provide an orientation to your organization, provide multilingual interpretation and support, waive fees, provide snacks, offer childcare, provide transportation, or accommodate work and family schedules.
- Host activities at churches, libraries, after-school programs, and community centers.
- Build partnerships with diversity-focused organizations such as cultural centers, community centers, faith-based organizations, and academic societies (such as the Society of Hispanic Professional Engineers or Mexican-American Engineers and Scientists).

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Additional resources

See nisenet.org for a variety of additional resources, including NISE Net educational products, professional resources, and tools for staff and volunteer training.